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KINGDOM OF SAUDI ARABIA

Abstracts

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Problem Identification Using Swarm Based Bio-Inspired Algorithms for Solar Maximum Power Point Tracking

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Abstracts

The Solar Maximum Power Point Tracking (MPPT) is an important feature, taking into account costs of making the PV system in its optimum operation. Solar modules are connected in series to provide high voltage input to grid-connected inverters. The use of bypass diodes triggers several peaks during the Partial Shading Condition (PSC) on a Power-Voltage (P-V) and Current-Voltage (I-V) curve. In general, the MPPT algorithms can be divided into conventional, Artificial Intelligence (AI) and bio-inspired metaheuristic-based algorithms. Conventional MPPT algorithms can track the peak point during unshaded condition with fast-tracking speed. Nonetheless, they cannot track the peak point when there are several peaks for all PSCs at the output. To track the maximum point for all PSCs, AI and bio-inspired algorithms are introduced. The state-of-the-art bio-inspired algorithms are capable of tracking the peak point region and are less complex than AI-based MPPT algorithms. Because of its simplicity and less storage burden, swarm-based bio-inspired algorithms are efficient to use, but few problems are highlighted in this paper while using swarm-based bio-inspired algorithms for MPPT that affect the tracking time and complexity in various environmental and dynamic system scenarios.

Keywords:

MPPT, Partial Shading Condition, Swarm-based bio-inspired algorithms

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Impact of Solar Distributed Generation on Power Loss and Voltage Stability of Distribution Networks

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Abstracts

This paper discusses the integration of solar distributed generations (SDG) with distribution networks to reduce the active power loss and to enhance voltage stability. In order to solve the distribution networks, a forward/backward sweep (FBS) load flow method is adopted using Matlab coding. The optimal placement and sizing of the solar distributed generator are determined using adaptive Particle Swarm Optimization (PSO) and a Repeated Load Flow (RLF) method over the system buses for minimization of active power loss. For the improvement of the voltage stability of the network, a stability index is used for the optimal location of the SDG. The SDG works in two different scenarios. In the first scenario, the SDG supplies only active power to the distribution network, such as photovoltaic (PV) sources or batteries. In the second scenario, the SDG supplies both active and reactive power, such as inverter-controlled PV systems. The adopted methods are applied to the 10-bus and 15-bus distribution networks. From the obtained results, it is found that adding the SDG minimizes the total losses and enhances the stability of both distribution networks.

Keywords:

Solar distributed generation, Backward/forward sweep, DG allocation, Distribution systems, PSO

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Assessment of Crystalline Silicon Photovoltaic Module Operating Conditions Frequency Distribution for Riyadh

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Abstracts

Performance of photovoltaic (PV) module varies under outdoor field conditions and it can be better analyzed using frequency distribution under different operating conditions. In this work, operating conditions of crystalline Si PV module in Riyadh, Saudi Arabia have been estimated from historical meteorological data using PVsyst software. The purpose of this study is to find most frequent operating conditions of PV modules which can be used for planning, designing and sizing of PV power plants. The operating conditions in terms of irradiance and module temperature have been derived from Faiman temperature correlation. The IEC 618531- standard has been used to analyze operating conditions of PV module based on their frequency of occurrence. The most frequent operating condition has been determined from frequency distribution under equidistant irradiance and temperature conditions. The most frequent operating conditions of the Riyadh is found to be 900 W/m^2 and 70^{0}C. Thus, it can be concluded that Riyadh has availability of abundant solar resources which can be utilized for deployement of large scale power plants.

Keywords:

Frequency distribution, IEC 618531- standard, operating conditions, photovoltaic, PVsyst

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Degradation in crystalline silicon photovoltaic modules under hot climate conditions

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Abstracts

Crystalline silicon photovoltaic (PV) modules are vulnerable to defects and degradation under hot climatic conditions like in desert regions, and experience multiple environmental stressors viz. high temperature, ultraviolet (UV) radiation along with temperature variation and moisture with gases ingression. These stressors can induce structural, thermo-mechanical, and chemical changes within the PV module, affecting its electrical performance. This paper presents an overview of defects and degradation that can arise under hot climatic conditions categorised on the basis of dominant environmental stressors in the field and accelerated testing conditions. The defects have been detected and investigated using visual observation, illuminated current-voltage analysis, imaging and microstructural characterization techniques. High temperature is generally a primary degradation stressor which operates with other factors. Encapsulant degradation like delamination and discoloration are commonly observed due to high temperature and UV radiation. Whereas, chemical changes causing corrosion in cell metallization, are induced under high temperature due to moisture and air ingression. On the other hand, variation in temperature can cause breakages and cracks in different components of PV modules. This paper summarises the defects and degradation that can be anticipated under desert climate conditions.

Keywords:

PV module, degradation, hot climate, encapsulant degradation, finger breakages

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Solar Energy as an Alternative of Electric Power in Saudi Arabia's Houses Vision 2030

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Abstracts

This research aims to find out the opinion of the Saudi's people of using solar energy as an alternative of electric power in houses. The researchers applied a questionnaire Contains 216 samples from different segments of society. The questionnaire contains four parts. When asked the sample about the necessity of using renewable energy sources to generate electricity instead of generating from petroleum derivatives: 88.8% of the samples agree when asked them what the most suitable source of renewable energy sources for investment in Saudi Arabia, 93% recommended solar energy, and 23% the construction of areas in the desert.19% of the sample use solar energy at home , 88.9% strongly agree that the government contribution to support the costs of solar technologies will encourage citizens to use solar energy and 83.3% of them recommended that the contribution support from Government on costs of solar technologies will encourage citizens to use solar energy. 92% strongly agree that the Government agencies must support solar users by reducing their electricity tariffs by connecting to the main electricity grid and 57% view that solar technologies in Saudi Arabia is high prices due to the lack of government support.

Keywords:

Solar energy: opinion of the Saudi's people - renewable energy - electricity tariffs - The National Renewable Energy Program (NREP) - yellow oil

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THERMAL CHARACTERISICS OF A PARABOLIC TROUGH COLLECTOR (A COMPARISON STUDY)

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Abstracts

It is well commercially proven that parabolic troughs are the most developed of the concentrating solar power technologies. Operating temperatures in the range of 350 - 550°C could be achieved in the parabolic troughs. Solar plants using parabolic trough can produce from 5 to 280 MWe. Heliotrough collector is a parabolic trough collector with increased aperture length and width. Therminol VP-1 and molten salt were used asheat transfer fluids. The optical and thermal losses from the Heliotrough are estimated by applying energy balance on the absorber tube. Engineering Equation Solver (EES) software was used to simulate the Heliotrough. Comparison with Eurotrough was conducted for two cases; constant mass flow rate and constant Reynolds number in the absorber tube. In addition, absorber tube with a vacuumed glass envelope around the absorber was used. Finally, performance of Heliotrough is studied with the molten salt as heat transfer fluid.

Results showed that heat losses from Heliotrough are in the range of about 100 - 500 W/m for the given conditions. When using Therminol VP-1 as HTF, the operation temperature were in the range of 100°C to 400°C while they were in the range of 260°C to 550°C for molten salt.

Keywords:

HelioTrough, thermal performance, heat transfer fluid, Engineering Equation Solver (EES).

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Porous Block Column Type Solar Desalination Unit

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Abstracts

The sources of quality drinkable water have been reducing rapidly in many urban and rural areas of the world especially in Middle East, Africa and Asia due to several valid reason. Among the other impurities present of raw water, removal of salinity by any conventional method is still costly. Researcher and policy maker have been thinking for all possible cost-effective alternatives. One of the low-cost methods to produce distillate (distilled water) is solar desalination. The production rate per square meter per day is still low. To improve the production rate, an innovative method is exercised by using different porous blocks in a vertical transparent column. The vertical column made of porous blocks (PB) can hold more raw moisture than that of a horizontal basin type surface. The porous blocks including absorbed raw water are heated by solar radiation and can provide a large surface area for evaporation. This is an innovative highly efficient new technology in solar desalination field and the technology is accepted by Bangladesh patent department. Results of full-scale study using several type of vertical columns have showed average 3.5 to 6.5 times more production than a column without PB.

Keywords:

Saline water, Porous block column, Temperature, Distillate

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Using GIS and Multi-criteria Analysis (MCA) techniques to Locate Suitable Sites for Desalination Solar Stations, A Case Study from Egypt

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Abstracts

Water is one of the most important elements of economic and sustainable development. Water shortage is the primary current and future world issue. The rapid population growth and economic development in Egypt leads to an increasing demand of water. In addition to that, there are some other challenges such as climate change and the construction of the Ethiopian dam. Water desalination using solar cells is considered one of the available alternatives for water supply in Egypt especially because of its location in arid climate zone with the highest rates of sun shining hours almost all year round in the world. The objective of this paper is to locate the suitable areas for the installation of future solar desalination stations in Egypt as a necessity to sustain water resources. Geographical Information Systems (GIS) and Multi-criteria Analysis (MCA) techniques are the main techniques to assess the land suitability for the installation of solar desalination cells. The suitability was divided into five categories starting from very high to very low suitability. Results showed that approximately 18.5% of the area is classified as very high suitability, 18% high, 12.5% moderate, 30% low and 20% as very low for installing desalination stations. These results suggested promoting the use of solar energy in the construction of solar water desalination projects as a strategic option to cope future estimates of water shortage in Egypt.

Keywords:

GIS; Multi-Criteria Analysis; desalination; solar energy; site suitability.

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Rotating wheel solar stills for water desalination: Comparative study

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Abstracts

Novel design of rotating wheel solar still is fabricated and studied under Al-Kharj City, KSA Climatic conditions. A rotating wheel is usage to enhance the performance of conventional solar still. A conventional still and a rotating wheel still are fabricated to investigate the solar stills performance. A rotating wheel solar still (RWSS) is uses a rotating wheel with a horizontal shaft, which fixed on the internal back side of solar still. A motor powered by a small photovoltaic system is utilized to rotate the wheel. The effect of the speed of the wheel and the water depth on the still performance is studied experimentally. The wheel still was tested under different rotational speeds for the wheel, from 0.1 to 2.0 rpm (0.1, 0.5, 1, and 2 rpm). It is found that, the productivity of the solar still strongly depends on the speed of the wheel. In addition, the maximum daily productivity of wheel still is achieved at a wheel speed of 0.1 rpm. The results showed that RWSS showed a productivity rise of 35% over that of conventional still productivity at 0.1 rpm. The thermal efficiency of conventional still and rotating wheel still was 34 and 39%, respectively.

Keywords:

Solar still; Desalination; Rotating wheel; Thermal efficiency.

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Influence of adding trays on the performance of solar still, an experimental approach

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Abstracts

The productivity of the solar still is proportional with the depth of water and surface wetted area in the still. Water productivity can be increased by increasing the area of the basin plate. To maintain minimum depth in solar still, a trays solar still is used. Two solar stills are designed and fabricated. The first one is a conventional type and the second is a modified tray solar still. A solar still system has been designed, manufactured, and operated for experimental investigation to enhance productivity. In addition, it has been designed according to the safety standards. The goal of this work is to increase freshwater productivity by change the design of solar still. Finally, it was found productivity of the trays solar still (TSS) was increased approximately by 45% over the conventional still (CSS), and the daily efficiency was 47% and 34% for TSS and CSS respectively.

Keywords:

Tray solar still; Conventional solar still; Solar energy; Desalination.

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Solar Desalination using Multiple Effect Membrane Distillation: Experimental results

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Abstracts

This work deals with the performance of a solar desalination system using a membrane distillation process. The system is composed of solar photovoltaic panels, solar thermal collectors, and a membrane distillation unit. The latter is based on vacuum multiple effect membrane distillation (V-MEMD) in which heat is recycled and reused in the system. For active condenser cooling, a heat pump is used. Experimental results for several typical days of two months (i.e., May and December) in Riyadh for brackish water are presented and discussed. The maximum productivity rate of distillate water and the corresponding specific electrical energy consumption were around 30.4 L/h and 58.3 kWh/m^3 for the overall system and 5.7 kWh/m^3 for the V-MEMD unit, respectively when the heat pump mode was used. Furthermore, when the inlet heating (evaporator) temperature is over 69^{o}C, cold-side absolute pressure is lower than 115 mbar, and the heat pump mode is active, high water mass flux up to 11.7 kg/m^2.h, and recovery ratio up to 49.5% can be obtained. Moreover, the specific thermal energy consumption reaches 149.6 kWh/m^3, and the specific electrical energy consumption is reached to 58.3 kWh/m^3. Besides, special attention is turned to the systematic evaluation of the specific energy consumption of water production and to develop methods to reduce it. Specifically, the effect of condenser cooling on the overall performance of the solar desalination system is investigated for several weather and operational parameters.

Keywords:

Solar desalination system, mass flux, recovery ratio, specific thermal energy consumption, specific electrical energy consumption.

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Ultra-flexible, Ultra-stretchable, Lightweight and High efficiency Silicon Solar Cells for Unmanned Aerial Vehicles Application

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Abstracts

The demand on unmanned aerial vehicles (UAVs) is exponentially growing due to their ever-increasing range of applications including, but not limited to, agricultural inspection, fire-fighting and border security. Augmenting the existing electric powered UAVs with solar technology could enable longer flights and heavier payloads transportation, however, most of the existing solar cells are too heavy, too rigid, too expensive or too inefficient for UAV platforms. Here, we demonstrate the development of ultra-flexible and ultra-stretchable lightweight silicon solar cells with high-efficiency which can fully conform to the curved and foldable surfaces on the drones without affecting the aerodynamics of the flight. The flexible and stretchable solar cells are developed using a corrugation technique where high-efficiency (19%) rigid monocrystalline silicon photovoltaic devices with interdigitated-back-contacts (IBC) are transformed into ultra-flexible cells with no degradation in their original efficiency. Several corrugation patterns are studied to enable different abilities related to flexing orientation, minimum bending radius and maximum stretchability. An eco-friendly polymer is used to encapsulate the cells which improves their mechanical robustness. Finally, theoretical calculations are conducted to assess the performance of the corrugated photovoltaic devices compared to commercially available flexible cells in terms of UAV flight endurance.

Keywords:

Drones, photovoltaic, silicon, flexible, stretchable.

VSESA
Applications and Challenges

Investigation of different types of defects in newly manufactured crystalline silicon PV modules

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Abstracts

The solar photovoltaics (PV) is now-a-days emerging as a promising renewable energy technology with large installation around the world. However, PV modules face several manufacturing stage defects even before deployment in the field. These defects not only affect the module performance, but potentially may cause severe degradation within few years of field operation. This essentially affects the reliability of PV modules. Therefore, there is a need for detail investigation and analysis of such manufacturing stage defects in typical commercial PV modules for detail understanding of these defects. For the same, a large number of modules from a wide range of manufacturers have been investigated. Electroluminescence (EL) imaging and dark lock-in thermography (DLIT) have been exploited for spatial investigation and classification of defects. The commonly observed defects those affect module performance, or potentially degrading in future perspective are discussed in detail. The severity of these defects has been investigated. Simulation has also been performed in particular cases for this purpose. This type of detailed study would be useful to researchers and manufacturers to identify common defects and understand their severity, which would further be helpful to take precautionary measures for minimization of these defects.

Keywords:

Characterization, Crystalline silicon, Defects, PV module

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Design, Fabrication and Testing of Low-Cost Flat Plate Collector Under Central Qassim Climate

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Abstracts

Energy is the main foundation for economical, technical and social development. With increase of global awareness on energy challenges, huge attention was given to solar energy as a promising solution. In this work, a low cost small size flat plate solar collector (FPC) passive system with an aperture of 0.75 m^2 was designed and fabricated at College of Engineering- Unaizah, Qassim University. The collector was tested to heat 20 liters of water during the day at Unaizah (Qassim) in the period of 18th October to 4th November. The variation of water temperature, thermal useful load, heat removal factor and collector efficiency at different operating modes and tilt angles including 21°, 26° and 31° were recorded and investigated. For four-hour operating mode, the highest temperature for the water leaving the collector was found to be 84°C while the highest plate temperature was found to be 113.8°C. The maximum system's efficiency was found to be 55% which was collected at six-hour operating mode and at 31° tilt angle. For Unaizah city, the optimum tilt angle for water heating at the studied period was found to be 31°.

Keywords:

Thermal solar energy, Flat Plate Collector, Hot water, Tilt angle, Passive system

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Inorganic metal halide perovskites AMX3 as promising candidate materials for future photovoltaic solar cell technologies

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Abstracts

Since the first advent of photovoltaic (PV) solar cell in 1954, many scientists have directed tremendous efforts mainly to improve the performance of traditional PV solar cells and increase their efficiency. Formerly, a range of inorganic semiconductors have utilized for the fabrication of PV solar cells, such as, amorphous silicon (a-Si), single- and multi-crystalline Si, and polycrystalline thin films like coper indium gallium di-selenide (CuIn1-xGaxSe2), gallium arsenide (GaAs) and cadmium telluride (CdTe). The next generation is based mainly on organic PV solar cell that designs from bulk and thin film polymers. In last few years, PV solar cell technology has found a remarkable progression by generating a novel class of PV materials based on inorganic metal halide perovskites (IMHPs) having the crystal structure (AMX3). Several AMX3 have emerged as promising alternative materials for analogous organic HMPs (CH3NH3MX3) that loss their stability at high temperatures. AMX3 exhibits high electrical power conversion efficiency and some superior properties like notable chemical stability, broad emission and tunable semiconducting gap. In this study, the structural, stability and electronic and magnetic properties of a new series of MHPs with AMX3 (A+ = Rb, Cs; M2+ = V, Mn; X– = Br, I) are systematically investigated and their probable applications in photo-electronic technologies, such as in PV solar cells, photo-detectors, and light-emitting diodes (LEDs) are reported. Moreover, this work identifies the exclusive characteristics of AMX3 compounds that make them a promising candidate for future generation of highly efficient PV solar cells.

Keywords:

Photovoltaics solar cell; Semiconductors; Metal-halide perovskites.

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Silicon Nanowires for photovoltaic applications

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Abstracts

Silver nanoparticles based chemical etching is an excellent developed method used for silicon Nanowires formation on mono-crystalline silicon. The etching time effect on optical and optoelectronic properties was studied during the elaboration of silicon Nanowires. As a result, surface recombination velocity (Seff) and the effective lifetime (τeff) evolution of silicon nanowires after passivation were ameliorated and exhibited extremely low reflection of barely 1% in the wavelength range of 300 to 1100nm. Such result plays a key role in raising the efficiency of the solar cells-based silicon nanowires; in the present study, an increase from 9% to nearly 15% has been achieved for passivated solar cells- based silicon nanowires in $HF/HNO_3/H_2O$ solution.

Keywords:

monocrystalline silicon; nanowires; etching; recombination velocity; silicon solar cell.

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High Quality Aluminum/Porous silicon Passivation of multicrystalline Silicon nanostructure for solar cells applications

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Abstracts

In this work, we demonstrate that the combined treatment of Aluminum/Porous silicon provide excellent passivation quality of multicrystalline silicon (c-Si) surface. The electronic quality of multi-crystalline silicon by aluminum nanoparticles was investigated and the level of surface passivation is quantified using photoconduction system (WCT-120) and Fourier-Transform Infra-Red (FTIR) absorption techniques. In this work 8 µm thickness films of aluminum was deposited on the front surface of the silicon after 500 - 550 °C annealed for 30 min, the covered surface by aluminum nanoparticles was treated in H_2O_2 /HF /HNO_3 acid solution at few seconds to produce porous silicon (PS). Results of this treatment, the reflectivity reduce from 38% to about 2% and the surface recombination velocity drop to about 1.5 cm s^{-1}. The obtained results indicate that surface passivation after aluminum nanoparticles deposition is a valuable method to high efficiency multi-crystalline silicon based solar cells.

Keywords:

Aluminum nanoparticles, multi-crystalline silicon surface treatment, reflectivity. Lifetime, solar cell.

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Applications and Challenges

Applications of Solar Energy based Technologies in Transportation Engineering: Opportunities and Challenges

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Abstracts

The energy demand of Saudi Arabia is increasing continuously due to construction boom, and growing population. The expected demand of electrical energy would be three times by 2030. Now a days, most of the electrical power is generated through conventional fuels which causes the environmental pollution and negatively impacts the human health through emission of harmful gases. Therefore, the use of renewable energy resources is invigorated because of many reasons such as climate change, increasing price and depletion of fossil fuels. The use of solar energy-based technologies is encouraged because of its availability in abundance and many other advantages. Further, the government of Saudi Arabia has an ambitious plan of achieving 54 GW from renewable energy sources which would be having a significant mix of 16 GW through solar photovoltaic power generation by the end of 2032. In view of the above, the application of solar energy-based technologies in the field of transportation engineering is one of prominent area where reduction in environmental pollution and energy saving may be achieved significantly. The solar energy can be used for many applications in transportation engineering such as charging of electric vehicles, dynamic message sign, traffic signals, and street light poles etc. However, there are certain challenges in the adoption of solar energy-based technologies for aforesaid applications. In this paper a comprehensive review of opportunities and challenges associated with the exploitation of solar energy in the field of transportation engineering is provided. Finally, some important recommendations that would improve the solar energy applications in transportation engineering in Saudi Arabia are also presented.

Keywords:

Solar energy, solar photovoltaic, transportation engineering, electric vehicles, energy efficiency.

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The Photovoltaic Characteristic of Silicon Solar cell using Solar Tester through Different Temperature

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Abstracts

The objective of this paper to measure the temperature effect on the performance of Silicon -based photovoltaic cell , a given cell put in Solar tester then exposed to the radiation source exactly 1000 W/m^2 act as the Sun , the cell temperature could be changed using a blower with heating element within temperature range 300^{o}C to 600^{o}C , the data achievement from the device directly given cell I-V characteristic., that show the increasing of a short circuit current with decreasing in open circuit voltage values that related to temperature increased the obtained efficiency range mainly between 10.9%-10.3% this results agreement with other research.

Keywords:

Solar Cell, Photovoltaic Condition, Temperature

VSESA
Applications and Challenges

PV Penetration Sizing Limitation and Challenges to the Saudi Grid: Achieving the Lowest Energy Cost; Considering Static Constrains with No Battery Storage

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Abstracts

The objectives of this study are threefold: First, to define the limitation of reserves on future PV expansions. Second, to size the largest possible PV expansion within the limits of feasibility and system static-stability. And third, to estimate the financial gain of PV integration on both the power sector Saudi Electricity Company (SEC) and on the governmental body and its subsidy on fuel prices. In addition, due to the accurately unpredictable nature of the PV system generation, the system's required reserves are expected to increase with the size of PV systems integrated. This affect will be investigated in this paper, in order to size the penetration of PV systems to the grid by comparing energy costs. Furthermore, this paper will investigate the limitations and challenges of replacing costly generation units by PV. Finally, this paper will take the financial aspects on SEC and on the governmental subsidy into consideration and give an estimate on the total annual savings in million SAR. Studying possible dynamic system constraints will require far more complex tools to determine the limitations of transient stability, and therefore only static system constraints with no battery storage will be taken into consideration. This study will undergo Actual load and generation data of 2018.

Keywords:

PV Penetration, Energy Cost, Sizing Limitation, abnormal conditions, fiscal gain.

VSESA
Applications and Challenges

Current reality and challenges of solar energy in the Kingdom of Saudi Arabia (KSA)

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Abstracts

Due to various issues related to global warming and its negative impacts on the environment, there is a growing interest in the utilization of various sources of renewable energy with a major focus on the scope of solar energy in the kingdom of Saudi Arabia (KSA). The use of solar technology is a national, environmental, economic and social necessity for the country owing to the higher availability of solar energy throughout the year.

The presented work discusses various issues related to solar energy in terms of its viability, applications and the difficulties encountered in its application in the KSA. Various issues related to the effects of dust accumulation on solar devices are discussed. The use of different computer interfaces demonstrated the potential and feasibility of using different solar technologies. For the sake of comparison, some of the experiences in the gulf area and around the globe are also presented. Additional conclusions and recommendations are also presented with the aim of achieving Vision 2030 which is a major current subject of policies being framed currently in the Kingdom.

Keywords:

Solar energy, Solar cooling, Solar potential, Dust accumulation.

VSESA
Applications and Challenges

Solar Energy based Hybrid Power System for a Small Community near Yanbu, Saudi Arabia

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Abstracts

Saudi Arabia has an extensive network of electrical power transmission in place. However, there are many remote locations that still rely on stand-alone power generation because it is economically not feasible to connect them to the national power grid. Hence, the electrical power requirements of a typical residence in a remote area of Saudi Arabia are to be met using alternative systems. In this paper, a hybrid power system based on solar power and a diesel generator is proposed to meet the daily need of a small remote community near the city of Yanbu. The solar data obtained from King Abdullah City for Atomic and Renewable Energy (K.A.CARE) has been employed to design a hybrid system using Homer Pro software. The aim of the study is to provide a cost efficient and environmentally friendly solution for the isolated community, meeting their daily power need throughout the year. The simulation has been carried for a small village in the outskirts of Yanbu.

Keywords:

Renewable energy, Hybrid power system, Solar Energy

VSESA
Applications and Challenges

PC1D as a computer-assisted learning tool in graduate-level solar PV courses

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Abstracts

Recently, many Saudi universities–including Qassim University–have started offering graduate programs in renewable energy to fulfill their role (education/training and research) in achieving VISION 2030 renewable energy targets and objectives. Solar Photovoltaics (or PVs) is a particularly promising renewable energy technology, in which the distinctive properties of semiconductor materials are utilized to fabricate innovative solar energy converting devices. However, the extensive list of intertwined material and structure parameters affecting the performance of such devices can seem overwhelming to the student/non-expert. Similarly, the nonlinearity of device-physics equations governing the behavior of solar PV cells makes it very hard to predict the influence of a single material/structure parameter on the efficiency and so the power-generating capability of a PV cell. Such difficulties can be overcome by integrating computer-assisted learning (CAL) tools in graduate-level solar PV courses. In this paper, we propose using PC1D–an industry-standard software widely recognized and used by the PV community–as a powerful yet cost-effective CAL tool in teaching key material and/or structure aspects of solar PV cells. The paper presents a realistic PC1D model of a typical low-cost silicon solar PV cell. By using this model along with an exemplary instructional scenario, the paper demonstrates how the student can immediately observe and quantify the impact of front-surface texturing, doping concentration of emitter layer, thickness of emitter layer, and device operating temperature on the short-circuit current, open-circuit voltage, maximum output power, fill factor, and power conversion efficiency.

Keywords:

Computer-assisted learning, Simulation, Solar cells, Silicon

VSESA
Applications and Challenges

Solar Energy Regulations System in the Kingdom of Saudi Arabia

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Abstracts

The aim of this work is to present new systems of Small-scale Solar PV regulations in the Kingdom of Saudi Arabia. In order to attain the goals of the Kingdom›s Vision 2030, in developing the field of solar energy applications, the document «Small Solar Systems» was adopted. The target of this document is to give rise the residential and non-residential Customer to accept solar power generation systems. The document regulates conditions and requirements for ensuring, effective construction and installation of the solar systems, as well as ensuring the effective maintenance, and safety of all establishments.

Keywords:

Small-scale Solar PV regulations- Kingdom›s Vision 2030-. Small Solar Systems- residential- Net Metering

VSESA
Applications and Challenges

Adaptive Neuro-Fuzzy Inference System (ANFIS) Based Model for Short-Term PV Power Forecasting

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Abstracts

Solar energy is one of the majorly available Renewable Energy Resources (RES) at most of the places particularly in India because it is located in the equatorial sun-belt of the earth. The generation of solar photovoltaic (PV) power depends to a great extent onto incoming solar energy and may create various issues such as grid stability and reliability. Therefore, it becomes a necessity to forecast PV power from solar power plants for its integration with the electricity grid. The PV power forecasting in sunny weather condition is easily done; however, to forecast PV power under the influence of foggy and cloudy weather conditions is a major challenge for the researchers. Further, the regression-based models do not provide accurate results for cloudy and hazy conditions. Therefore, an intelligent model using ANFIS methodology is proposed to forecast short-term PV power under distinct weather environments namely sunny, hazy, hazy & cloudy, and cloudy weather conditions using meteorological parameters. The obtained results are validated using the measured data by considering the evaluation indices. The ANFIS based forecasting model is developed in MATLAB platform.

Keywords:

Solar Energy, Solar Photovoltaic, Energy Management, Meteorological Parameters, Power Forecasting.

VSESA
Applications and Challenges

Numerical and experimental investigation of heat transfer in mixed solar dryer

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Abstracts

COMSOL Multiphysics Software is used in this paper to solve a 3D temporal non-isothermal flow for a mixed solar dryer. The numerical results show a best concordance with experimental results. The study was performed at several mass flow rates between (0.00785 kg/s) and (0.0239 kg/s). The results reveal that when the mass flow rate is improved, the efficiency of the collector is improved due to the increase in the heat exchange coefficient, which extracts maximum amount of stored thermal energy in the panel. The heated air generated by the PV/T collector is injected in the drying chamber in order to force the convection in the solar dryer. Further, the improvement of the mass flow rate dropped approximately the PV temperature from 70 to 60°C. Furthermore, the high outlet temperature reaches 77.76 °C in the case where the mass flow rate is 0.00785 kg/s, and 60.5°C for the highest mass flow rate (0.0235 kg/s). The best recorded mean thermal efficiency of the PV/T was 53% for the maximum mass flow rate (0.0235 kg/s), while the average thermal efficiency of the PV/T was 29% when the mass flow rate decreases to 0.00785 kg/s. The recorded temperature in the drying chamber reaches 55°C. Consequently, the mixed solar dryer is able to dry some vegetables and fruits such as tomatoes and dates.

Keywords:

photovoltaic thermal air collector (PV/T), heat transfer, solar energy, numerical simulation, mixed solar dryer.

VSESA
Applications and Challenges

A Feasibility Study of an Autonomous Integrated System for a Conventional Household Power Supply in Saudi Arabia: The Vision of 2030

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Abstracts

This paper describes the potentials of a stand-alone hybrid system design using Homer software for power generation. The proposed hybrid system consists of a photovoltaic (PV), wind turbine, battery and a diesel generator in order to provide the required economical and technical aspects of the feasibility study. To do so, an extensive examination was carried out to provide the desired energy load for a typical household building for both Albaha and Buraydah cities in Saudi Arabia. A comparison between the two cities was carried out in order to study the effect of the weather on the building performance in terms of cost of energy, energy penetration, and load met. With the aim to enhance the performance of the proposed design, some constrains were selected, such as Net Present Cost (NPC), and Total Annual Cost (TAC). The data was obtained from [1] for a conventional household building. It was identified from the results that the integration of PV/wind turbine/converter/battery/diesel generator is the best configuration to have the minimum cost of energy of $0.596/kWh and $0.603/kWh for Albaha and Buraydah cities, respectively. After relatively minor design and control modifications, the simulations indicate that these designs can provide the necessary energy load to operate the household building at Al Baha and Buraydah cities in Saudi Arabia, while lessening the need for conventional power supply. The work demonstrates that stand-alone hybrid renewable energy systems can be applied to improve conventional buildings energy efficiency and economics, and that it can be easily adapted to provide excellent performance in diverse climates.

Keywords:

Homer, stand-alone, hybrid, photovoltaic (PV), diesel.

VSESA
Applications and Challenges

A comparison of techno-economic analysis and optimization of a solar system for energy reduction dependency at Al Baha and Al Qassim.

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Abstracts

According to the King Abdullah Petroleum Studies and Research Center, the residential and commercial sectors occupies about 50% of the total electric energy consumption in Saudi Arabia. The objective of this manuscript is to investigate the potential of reducing the dependence on the consumed energy from the main grid using solar and battery resources at two locations in the Kingdom of Saudi Arabia (KSA), namely; Al Qassim and Al Baha regions. Two university campuses were selected in these regions which has two different climate conditions as well as solar radiation variety. Two different systems are proposed and compared based on the same load demand for each. The simulation and optimization techniques using HOMER software have been carried out to identify the feasibility analysis and cost configuration. The results show that the proposed grid-connected photovoltaic (PV) can generate the required load's power as well as reduce its dependence on the main grid. In addition, it shows that the proposed system minimizes the levelized cost of energy and increases the reliability and efficiency of the system.

Keywords:

Renewable energy; Grid-connected PV; HOMER; Net Present Cost (NPS); levelized Cost of Energy (LCOE).

VSESA
Applications and Challenges

Feasibility Study of Dual-Axis Tracking Systems for PV Panels in Saudi Arabia

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Abstracts

In Saudi Arabia, there is an increasing demand of PV solar panels to be used commercially and residentially. There are many factors that affect the performance of a PV panel. The most effective factor is the orientation of the PV panel with respect to the angle of the sun's radiation line. Solar trackers are used to solve this problem. However, solar trackers are not always feasible, and their feasibility depends on many factors like the operating location. The objective of this paper is to study the feasibility of dual-axis solar trackers in Saudi Arabia. Data of solar radiation is collected from Photovoltaic Geographical Information System (PVGIS) of European Commission Joint Research Centre. MATLAB software is used to analyze the data. Finally, the paper concludes whether it is feasible to use dual-axis tracking systems or not in Saudi Arabia and recommend some future area of development to increase the feasibility.

Keywords:

Solar energy, PV panels, Feasibility study, Residential PV system cost.

VSESA
Applications and Challenges

Performance and economic analysis of a solar-assisted heating and cooling network in Cairo, Egypt

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Abstracts

Buildings have a share of more than 30% of the global energy consumption, while being responsible for more than 10% of direct energy-related CO2 emissions. One energy-efficient solution, that has a relatively low environmental impact, is replacing the common low-efficiency decentralized heating and cooling systems with centralized systems. This also facilitates the integration of renewable energy sources. However, centralized heating and cooling systems are not widely adopted in the MENA region, especially in Egypt, and there is an apparent lack of relevant research compared to e.g. Europe. This study investigates the integration of solar energy in a heating and cooling network to fulfill the energy requirements of a hospital in Cairo, Egypt, as a case study. The hospital is selected due to its relatively higher heating requirements throughout the year, where solar energy systems have higher energy efficiency. The system has been simulated in MATLAB® and the developed models have been validated against experimental data. The system performance and cost have been analyzed for three scenarios. It was found that a system limited to the roof area can supply 54.6% or 6.2% of the heating or the total loads, accordingly.

Keywords:

Modelling, Solar energy, Parabolic trough collectors, Sensible energy Storage, Absorption chiller.

VSESA
Applications and Challenges

Techno-Economic Feasibility Investigation of a Hybrid Energy System

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Abstracts

Due to the shortage of energy resources available and harmful consequences of fossil fuels, the wind energy system and solar photovoltaic system have taken attention. So this fact makes the solar photovoltaic and wind energy systems more attractive in comparison of other resources for many uses, especially in rural areas in India. This boosts up many researchers to propose proper design of hybrid energy system to get rid the problem of shortage of energy supply for residential areas in India. This paper proposes the feasibility analysis of a wind and solar energy based hybrid system to supply electricity to the residential home in India. The site for this study is selected near the Trivandrum in India. The outcomes of the analysis shows that supplying power to a single home using hybrid energy system is useful and appropriate for long standing investments, particularly the price of the hybrid energy systems are lowering as the per unit cost of electricity generated from hybrid energy system is reducing. Therefore the whole system is considered and investigated in such a way that it is economical as well as efficient.

Keywords:

Solar photovoltaic system, wind energy system, feasibility analysis, cost, grid

VSESA
Applications and Challenges

Deep Learning Enabled Condition Monitoring of Photovoltaic Modules using Thermal Imaging

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Abstracts

Reliable and cost effective operation of photovoltaic power generation is of utmost importance in achieving the Kingdom of Saudi Arabia's (KSA) ambitious plan of 41 GW power productions by 2032 using solar photovoltaic sources. Fault detection and diagnosis of PV modules is the key to reliable and cost effective power generation. In recent years, a number of thermal imaging based fault detection techniques have been proposed, but most of these techniques are based on traditional region of interest (ROI) detection and feature extraction methods which require expert knowledge of relevant features which may be a source of error in results. Proposed work presents a deep learning enabled architecture for fault detection and diagnosis of solar PV modules using thermal imaging. Deep learning convolution neural network (CNN) consists of 16 convolution layers and was trained on 3072 thermal images. It classified the tested images into 7 fault categories which commonly occur in PV modules. Network was tested for three common training solvers named as adam, rmsprop and sgdm to find out the most accurate and fast network training algorithm. Among the three solvers, adam was the most accurate with an accuracy of 93.76% and fastest with training time of 115 sec and testing time of 0.171 sec. Proposed method will help to determine the health of PV modules installed in large PV power plants and can predicts various types of faults like physical damage, dusting, bird dropping or faultyinter-connections.

Keywords:

Condition Monitoring, Deep Learning, PV Module, Thermal Imaging.

VSESA
Applications and Challenges

Optimization and techno-economic analysis of an autonomous hybrid PV-diesel-battery energy system for rural electrification in the Kingdom of Saudi Arabia

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Abstracts

The economic development of Saudi Arabia relies on fossil fuel price. The perpetual dwindling of these fossil fuels and its environmental impacts has become a thing of concern for countries that depend on it for energy generation. Due to Saudi Arabia's vision 2030, which is designed to reduce dependency on oil economy and support the national economy, presence of abundant solar energy in the Kingdom of Saudi Arabia makes it necessary to shift its energy generation from fossil fuels to solar energy using solar photovoltaic (PV) systems. In this study, the optimization and techno-economic feasibility study of an autonomous hybrid PV-diesel-battery (PV/DG/BS) system is examined for electricity generation in Saudi Arabia using hybrid optimization model for electric renewable (HOMER) simulation software. From the obtained results, the optimal configuration comprising of PV/DG/BS system has the least COE and NPC of $0.1534 and $59,744.67 respectively, with a renewable fraction of 17.2%. The configuration also achieved about 21.42% reduction in GHG annually when compared with the DG/BS system.

VSESA
Applications and Challenges

Evaluation of Multiple Linear Regression and K-Nearest Neighbor Methods for Predicting Solar Radiation in Saudi Arabia

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Abstracts

Determining the values of solar radiation is crucial in the design and assessment of solar energy utilisation systems. The aim of this study was to evaluate the effectiveness of the multiple linear regression (MLR) and k-nearest neighbors (k-NN) methods in their ability to predict daily global solar radiation based on meteorological observations. The input parameters were maximum and minimum air relative humidity, maximum and minimum ambient air temperature, and sunshine duration, and solar radiation data were the outputs. The training and testing data sets were formed with data from 10 meteorological stations located in Saudi Arabia. The k-NN method with no distance weighting generated better results than the MLR method. The test dataset correlation coefficients were 0.8170 and 0.6895 for the k-NN method (with the seven nearest neighbours) and for the MLR method, respectively. This study suggests that the k-NN method with k = 7 is suitable for estimating solar radiation where there are no direct measurement devices installed, at least in regions that have similar weather conditions.

Keywords:

Machine learning algorithms, solar radiation, k-nearest neighbors, modeling.

VSESA
Applications and Challenges

Fast Conversion of Industrial Pollutants to Carbon dioxide and Water by Solar Energy and Effective Photocatalysts

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Abstracts

Water pollution and deficient energy have emerged as major challenges for scientific community because of the rapidly growing industries and population. Scientists across the world have focused on discovery methods to solve these energy and environment related problems. Following this trend, the solar energy has used to purify water by converting the industrial pollutants to carbon dioxide and water through photocatalytic degradation of green dyes. Therefore, series of titanium oxides nanoparticles were prepared through hybrid method between both solvent thermal and sol-gel techniques. By changing solvent and thermal treatment, four samples of titanium oxides nanoparticles were characterized by different techniques. These nanoparticles have used to purify water through decomposing the green dyes in presence of sunlight. Decolorization and mineralization of acid green 1 completed after 3 h of sun light of Al-Hassa area. By modifying the preparation method through changing the solvent from methanol to ethanol, purification of water was approximately achieved during 2 h. It means that the prepared nanoparticles with solar energy accelerated the photocatalytic degradation of the pollutants. These results concluded that the preparation method of titanium oxides has a positive effect towards purification of water using solar energy.

Keywords:

Hybrid preparation method, Solvent-control process, Band gap energy, Purification of water, Solar energy