OV2040REP

Oman Vision 2040: Renewable Energy Program

NEWSLETTER

Volume 1, Issue 2, December 2020

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Articles

A novel model and experimental validation of dust impact on grid-connected photovoltaic system performance in Northern Oman

Evaluation of PV output in terms of environmental impact based on mathematical and artificial neural network models

1. Project initiation

1.1. To consider the scope of the problem

Renewable energy utilization in Oman is a topic with growing interest by the Omani government and the private sector. The existing renewable energy resources, which can be used as an energy alternative and eco-friendly energy systems, needs further research, development, planning and awareness. This initiative presents a step in the direction toward renewable energy vision of Oman 2040 along with a detailed discussion with regards to sustainable energy, energy sources, technologies, building capacity, and strategic planning, all with relation to the vision.

1.2. Goal

This goal is to be in line with the aims of the Oman vision 2040, aim to reduce the dependency on non-renewables and effectively develop resources such as renewable energy to lower production cost and enhance competitive element in economic sectors. Also, develop the infrastructures and building the human capacity of Omanis to meet the vision 2040.

1.3. Objectives

- Conduct scientific research to investigate renewable and sustainable energy sources parameters, options, and improve its applications in Oman.
- Establish a massive collection of research committed to improving sustainable power sources incorporation in Oman power and energy systems for private and public sectors.
- Assist, through research, governmental and private associations to arrive at the top of the line innovative improvements in the field of renewable and sustainable energy sources and technologies.
- Initiate scientific and technical discussion between researchers and experts in the renewable energy field with younger Omani researchers.
- Increase Oman community awareness toward renewable energy.

1.4. Phases of the work

- Establish a database of resources that are useful to conduct research and development in Oman.
- Start local and international collaborations to brainstorm and carryout projects to fulfill the aims of the initiative.
- Plan for targeted efforts to achieve the main aims and goals of Oman's vision 2040 with relation to the energy sector and to renewable energies in particular.
- Acquire funding for research projects centered around solutions for Oman's energy situation.
- Carryout colloquiums and public talks to enrich the discussion around the topic of Oman's vision 2040 in Renewable Eneryg.
- Update the work structure annually, according to the changes that occur in the energy and renewable energy industry.

Evaluation of the electrical performance of a photovoltaic thermal system using nano-enhanced paraffin and nanofluids

Energy, exergy and efficiency of four photovoltaic thermal collectors with different energy storage material

1.5. Conceptual framework

To generate technical reports and research data that will serve research and development in Oman. The focus of research should be in original research, case studies, technical reports and other mediums to aid fellow researchers in acquiring useful information and data for their own research studies. Moreover, collaborations will encourage and open the door to create local and international joint research and funding which will be helpful to boost research in Oman.

1.6. Community awareness campaign

- Increase the awareness of the public about renewable energy vision 2040 for Oman.
- Increase the awareness of the public about different types of renewable energy and how to be part of the new vision.
- Contribute to the development of local people by providing the needed energy which will help them socially, economically, culturally and educationally.
- Raises the standard of living of the people living in rural areas, by providing them with energy solutions to get clean water, preserve their foods and enjoy a healthier life.
- Contribute to the current energy policy in Oman.
- Develop a team of researchers who are aware of the needs of the Omani energy and environment.

1.7 Family of Omani younger researchers

This family or group focus on the Omani younger researchers interested in renewable energy from different levels (i.e. undergraduate, fresh graduate and postgraduate). The group will work together as a family to collect and analyze related data, training and increase awareness, discuss and collaborate toward the vision 2040. This group will prepare the new generation to participate positively when Oman is approaching 2040 based on education, knowledge, experience, and new ideas.
Note: to be part of this family, click “Follow” to this project in RG.

2. Communications

2.1. Founders meeting
2.2. Drafting first letter of communications
2.3. Approval of the project objectives and scope

3. Annual Report

3.1. Publishing the first Oman2040 Annual report
3.2. Setting suitable venues to distribute the report
3.3. Preparing follow up of report for the Oman2040 newsletter

4. Seasonal Newsletter

4.1. Objectives and scope of the newsletter
4.2. Primary components
4.3. Newsletter management and logistics

5. Annual Address

5.1. Future plans and recommendations
5.2. Main findings and achievements of the first year
5.3. Video of the annual address

A new achievement for scientific research in Oman ... a perspective and reflection.

By: Hussein A Kazem

The database published by Stanford University experts of the list of the top 2% of scientists around the world, the governments, universities, and scientific and research institutions interacted with the event with a celebration and honor for their scientists and researchers. We find that governments and institutions have taken different forms of honor with media coverage commensurate with the event. The importance of the event may come to one's mind in that it was published through Stanford University, which is one of the top three universities in the world, and because it has accomplished many inventions in terms of medicine, engineering, computers, space and other fields, which reflected positively on human life. But the reality is that the importance of this classification lies in that it is the first to classify scholars around the world. As we know, there is more than one classification for universities such as the QS classification, the Times classification, and others. As for scholars, this is the first of its kind.

This classification was released in its first version in December 2019, and the second version was released on November 7, 2020. Experts at Stanford University created a database led by Dr John Ioannidis, who in turn also utilized inputs that are based on a database from SCOPUS that classifies journals and provides citation index.

This database includes the world's top 2% of scientists from various fields based on standardized citation indicators, includes information on the number of citations, H-index, co-authoring, and Compound Citation Index. Note that a citation means the sourcing of a scientist's research work by another scientist, in their research, because they have benefited from it. As for the H index, it is used to measure the productivity and outreach impact of research work and world publications, while the citation index determines the compound of the impact on the job term.

The results were recently published in PloS Biology and are categorized into 22 scientific fields and 176 subspecialties in the report. The comprehensive list includes 159,683 scientists from all scientific institutions in the world, with 43 scientists in 2019 and only 21 scientists in 2020 from Omani higher education institutions. It is a pleasure to be on both lists.

This classification helps in controlling the quality of scientific research, researchers and scientists, and serves to classify them annually to ensure the continued quality of performance and productivity.

Here it is necessary to analyze and refer to critical points in order to enter and stay in this classification:

- In this classification, the number of scientists in Oman decreased from 43 to 21 in 2020. Should consideration and evaluation be given?
- The mechanisms and criteria that are used in classification must be analyzed for consideration by scientists and researchers in the coming days.
- The scholars who were included in this classification must be honored to thank and to encourage them and to encourage other scientists, researchers and academics to do more to enter the classification.
- The number of scientists from the Kingdom of Saudi Arabia is 556, the United Arab Emirates 178, Qatar 129, Kuwait 43, Oman 43 and Bahrain 7. This situation is an essential indicator of the level of scientific research in Oman compared with the rest of the Gulf Cooperation Council countries.
- If there is a tendency in higher education institutions to enter the QS classification and to rise in the rank, scientific research must be supported, so it is the guarantee towards progress and building an advanced and productive industrial society.
- I may not be surprised that this classification, and/or similar forms of classifications, will be linked in the future with the classification of QS universities and others.

All the best of luck to the Omani universities' distinguished scholars, who have entered this world ranking with years of efforts. Also, thanks and appreciation go to the Research Council of Oman, the partner in this achievement. It is a call for evaluation and planning to see more scholars in Omani universities enter this classification next year, looking forward to 2021 list.

Evaluation and comparison of different flow configurations PVT systems in Oman: A numerical and experimental investigation

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[3]Energy and Renewable Energies Technology Research Center, University of Technology-Iraq

Highlight:

- Increase of mass flow rate from 10 to 40 kg/h led to increase in useful heat gain.
- Using spiral flow collector enhances electrical efficiency of PV modules.
- PV/T with spiral flow channel outperforms PV/T's with direct and web flow channels.
- Electrical efficiency of PV/T systems outperform conventional PV module.

Brief:

The electrical efficiency of photovoltaic modules reduces with increase in cell temperature. However, using photovoltaic/thermal systems to enhance thermal, electrical, and overall outcomes is an excellent option. In this study, three water cooling PV/T systems that have variable flow channels (web type, direct type, spiral type) installed, tested, evaluated, and compared with conventional PV in terms of electrical performance. The systems were tested outdoors in Sohar, Oman. The water mass flow rate was tested at 40 kg/h. The proposed systems reduced cell temperature on average by a minimum of 3°C. The temperature reduction improves the voltage, power, and efficiency, significantly. The highest average maximum voltage and power were observed for the spiral flow PV/T system, which are 17.7 V and 51.3 W, respectively. The overall efficiency for the conventional PV, web, direct and spiral type PV/T systems were around 7.8%, 18.5%, 28.0% and 35.0%, respectively. The spiral flow collector was found to produce the best efficiency compared to web and direct flow collectors. The results confirm that the use of the proposed PV/T design is very suitable for the Sultanate of Oman and neighboring countries with similar environmental conditions.

Achievements:

Three different PV/T types of flow configurations were installed, tested, and evaluated in terms of the electrical performance and temperature. The type of flow configurations used are direct, web and spiral flow. The electrical efficiency of PV and PV/T systems were calculated and analyzed in this study. It is found that the PVT systems' efficiencies are comparatively higher than conventional PV. In addition, it is inferred that the conventional PV module (that is used in this study) generally transforms around 7.8% of solar radiation energy to electrical power when the cell temperatures are high, whereas the PV/T systems are highly efficient in terms converting the solar radiation energy to electrical and thermal energy. The highest achieved PV/T electrical efficiency found is 9.1% by spiral flow collector. Both experimental data and numerical predictions are in agreement that the spiral flow type PVT exhibits better thermal performance and cooling than its counterparts. The studied web and spiral PV/T systems generated electrical efficiencies of 8.5% and 9.1%, respectively compared to conventional PV system. As for thermal efficiencies produced by these systems, it was 9.8%, 19.4% and 26%, respectively. The spiral flow and direct flow collectors gave the highest overall efficiencies 35% and 27.5%, respectively. The numerical study showed that the highest temperature for the PV module was 68 °C for the PV/T web flow system at a mass flow rate of 10 kg/h. While the lowest temperature for the photovoltaic module achieved by the spiral flow system at 40 kg/h and reaches about 45.2 °C.

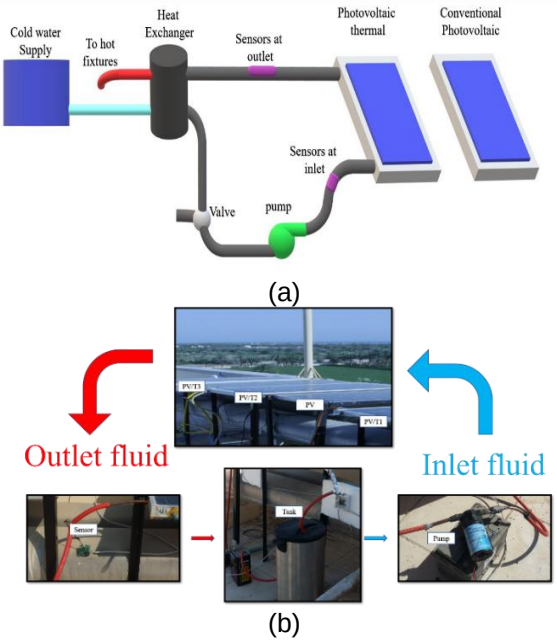

Fig. 1. PVT system, (a) schematic diagram, (b) experimental setup

Theory:

The theoretical and experimental work on PV/T technology has evolved far and wide with further awareness. The PV system's overall efficiency will be improved by employing extremely high quality and cost-effective solar cells. In addition, there are possibilities of artificially controlling and maintaining the inlet and outlet temperatures of the coolant fluids.

The context of Oman fossil fuels is quickly depleting. Basically, fossil fuel reserves contribute approximately 40.0% of the country's GDP. Consequently, if these resources deplete, then country will encounter major crisis because the entire system will stop functioning if the adequate energy resources are not supplemented. Moreover, the climatic conditions of the country are so harsh that there is no sustenance without electricity and energy. However, the major plus point of the country is that it receives ample amount of solar energy, which can transform into electrical and heat energy through PV/T system and solar collectors. As a result, integrating PV electricity and thermal energy as a hybrid PV/T system can be implanted by energy producing and supplying companies to overrule the constraints of growing energy concerns. Also, PV/T system will help to meet Oman vision 2040 regarding achievements by the year 2030, which are to reach anticipated renewable energy share of up to 30% of the country energy profile.

The present research work aims to evaluate three PV/T systems with three variable collectors' types under desert climatic conditions and variable coolant mass flow rates. The aim behind doing so is to explore if PV/T systems are suitable for Oman and GCC countries. In addition, the present study provides an insight on, the hybrid PV/T design that is developed to estimate the electrical and thermal performance both on residential and commercial purposes. The focus is on the electrical performance variables such as current, voltage, power, and efficiency. However, effect of temperature on the inlet, outlet, and surface of cell for the three systems will be investigated too and compared with conventional PV. Thus, numerical, and experimental verification was done to compare the three PV/T collectors. At the end of the study, the numerical and experimental results of the studied systems will be compared with the results of other studies published in the literature.

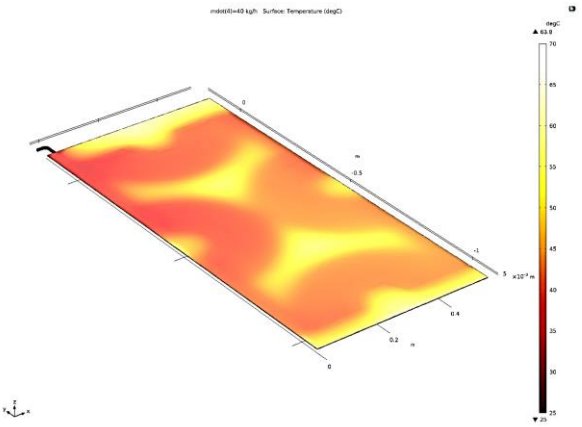

Fig. 2. Effect of cooling water mass flow rate (40 kg/h) on the thermal behaviour (for temperature >20°C) of web flow PV/T system.

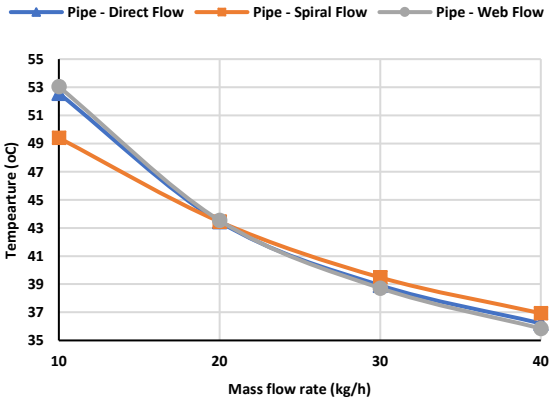

Fig. 3. Water average outlet temperature, for the three types of PV/T when varying the solar irradiance.

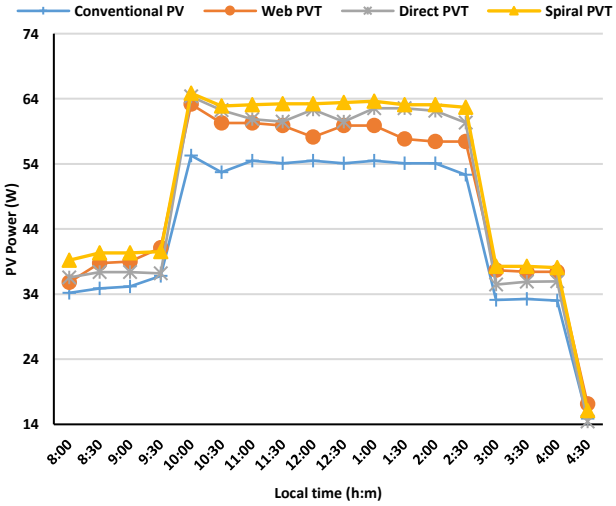

Fig. 4. PV/T electrical performance for the tested systems

Evaluation of aging and performance of grid-connected photovoltaic system northern Oman: Seven years' experimental study

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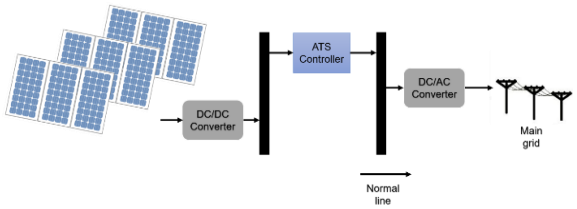
Highlight:

- Evaluation of ageing and performance of grid-connected PV.
- A seven years measured data used to evaluate the PV performance.
- Power losses, degradation of energy, yield, and efficiencies was calculated.
- Ageing impact compared with studies in literature.

Brief:

In this study, the aging measurements of a 1.4 kW grid-connected photovoltaic system were analyzed. The system is located at the Solar Energy Laboratory at the College of Engineering, Sohar University, Sohar, Oman. The system variables were monitored and measured for a period of seven years, starting from 1 October 2012 until 30 September 2019, during which the electricity produced to the network was fed. Weather data metrics measurements showed solar irradiation values, ambient temperature, and the PV module temperature were measured for seven years. The performance criteria for the different PV systems, which included (the PV module and system efficiency), performance ratio, and capacity factor were measured in addition to the different losses and system productivity. The results showed that the system is exposed to aging, although the amount of its impact is relatively small, as the study was conducted for a seven-year-old system, while the effect of aging is more at longer ages. The measured aging caused the system efficiency to decrease by 6.3 % and the production rate to 5.88 % while the mean daily array capture loss and system loss were 6.95 % and 6.13 %, respectively, and the capacity factor decreased by 4.91 %. Measurements during the seven years showed that the rate of degradation is greater during the summer than the rest of the seasons due to the high radiation intensity which causes high temperatures of the PV units in addition to the high dust density during this season. The results showed that the use of GCPV systems in the Sohar region is very successful in terms of the limited aging of the system and its long-term viability with appropriate efficiency.



(a)

(b)

Fig. 1. Installed grid-connected PV system. (a) schematic diagram, (b) capture of the PV system.

In this study, performance evaluation of the grid-connected PV system is presented — the system installed in Sohar University northern Oman. The data from the GCPV were collected every second from October 2012 till September 2019 (seven years). However, data is bulky, so that converted to minutes' average. The measured data used to evaluate the performance technically taken into consideration system aging. Furthermore, power, energy, yield, and efficiencies were calculated.

Achievements:

In the current study, the effect of aging on the 1.4 kW GCPV system was evaluated in Sohar, Oman, after seven years of continuous operation. The effect of aging appears on all variables studied. For example, losses of Ls and Lc due to aging due to continuous operation for seven years increased to 6.95 % and 6.13 %, respectively. The average capacity factor during this period also decreased to 4.91 %. As for the production rate, it decreased by 5.38 %. The system

efficiency decreased by 6.3 % after 7 years of continuous operation, while the PV module efficiency decreased by 5.88 %, which means that both efficiencies decreased by a rate smaller than 1 % for each year of operation. The rate of deterioration is more severe during the summer months due to the high temperatures caused by the high solar radiation intensity and high temperatures of the surrounding air. The results of the study show that the Sohar region is well suited to erect and operate GCPV systems to produce electric energy and to reduce dependence on fossil fuels in Oman.

Theory:

It is found that most of research in the literature focused on design, optimization, and evaluation of GCPV before or after installation. However, little research mentioned regarding the aging of GCPV systems. Aging is the decrease in efficiency generated by a PV module as a result of its reduced ability to convert sunlight into electricity over time. It can be expressed using the concept of the rate of deterioration, which refers to the decrease in electrical energy generated over time. From a financial point of view, this deterioration rate is very important for both investors and researchers, if this rate is high, which means less electrical energy production, which reduces the financial returns for the plant in the future. PV systems operate in external operating conditions subjected to climatic conditions that are sometimes severe, such as snow, rain, dust, high humidity, very high or very low temperatures, in addition to bird dropping, partial shading, hotspots, and corrosion. All these variables affect the operational life of the PV modules and then obtain an uneven distribution of the aging of the PV modules. Asymmetric aging between the PV array causes energy loss and mismatch in the production of PV modules, which in turn accelerates the aging process of the modules. An optimal understanding of the mechanisms behind degradation is very important from a technical point of view. Rapid degradation or a high rate of degradation may cause the failure of the plant before completing its estimated age. Therefore, the identification of the main mechanism causing degradation, whether experimentally or by adopting modelling and treating it, gives improvements to the plant's lifetime. From here, important information must be provided about the aging process in the system, its causes, and methods of treatment.

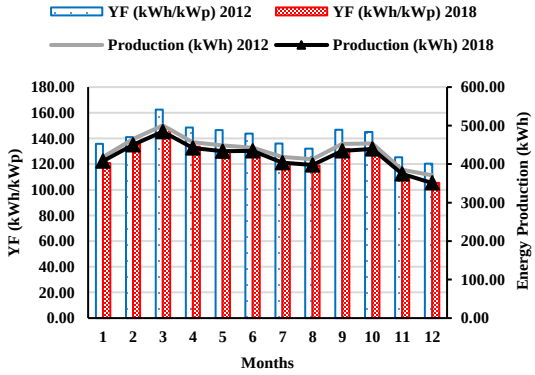


Fig. 2. GCPV performance parameters in 2012 and 2018: (a) efficiency and capacity factor, (b) yield and energy production.

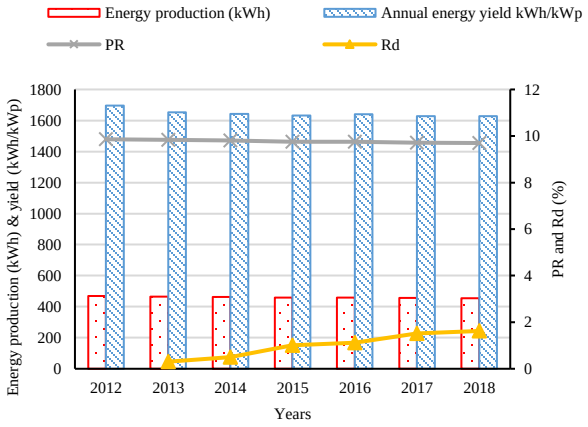


Fig. 3. GCPV seven years (October-to-September) performance analysis: energy production, annual yield, PR and Rd.

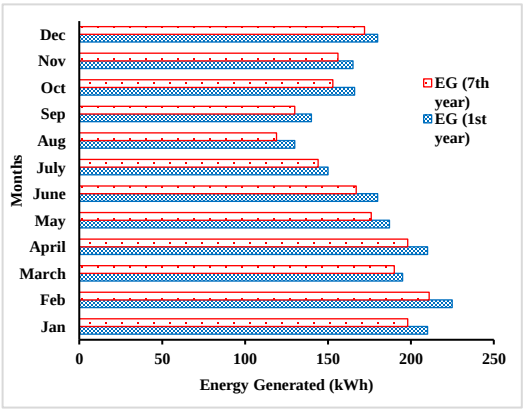


Fig. 4. System's energy generated through the studied period variation

A review of photovoltaic thermal systems: Achievements and applications

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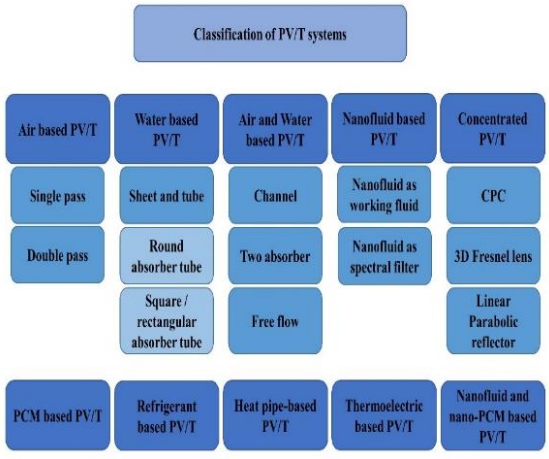
Highlight:

- The review presents a classification of PV/T systems based on the number of cooling channels, type of cooling material and type of coupled systems.
- Focus on novel advances in research that is published between 2017 and 2020. The main technological advancements discussed include nano-PCM and nanofluid based PV/T, TEG-based PV/T, novel Heat pump-based PV/T and nanofluid-based optical filters.
- The novelty of the review in terms of classification, methodology, review aspects, applications and structure were provided comprehensively.

Brief:

The use of photovoltaics has spread widely, and government agencies have begun adopting plans to deploy plants with large capacities, due to their environmental friendliness, low manufacturing costs, and high productivity. In the sunny countries where this technology should spread, the photovoltaics' energy conversion efficiency decreases due to the high temperature of which the cell's operate at; because a large part of the solar radiation is absorbed by the solar panels as heat, while the smaller part converts it to electricity. From here, the benefit of the shift towards the PV/T technology that works to reduce the photovoltaic modules temperature and improve their electricity produced along with yielded thermal energy which can be utilized in other applications. In this study, a thorough review of many recent research and studies published in the field of PV/T has been carried out. The present study was divided into several sections to clarify and focus on the effect of each technology separately. Researchers used one or more fluids to cool the solar panels, and their research dealt with many of these fluids, starting with air, water, oil, etc. Other researchers have tended to increase the thermal conductivity of liquid cooling fluids by adding many types of nanoparticles with high thermal conductivity. Other researchers have used variable-phase materials to take advantage of the large storage of the latent heat of these materials. Other researchers have studied improving heat transfer of PCMs by mixing it with nanomaterials with high thermal conductivity. Others have also combined nano-PCMs and nanofluids together in one system, and they have demonstrated, in theory and practice, that this technique exhibits higher energy collection and utilization than the other types of PV/T. At the conclusion of the study, some critical points are identified that work is still limited and needs more research efforts and studies.



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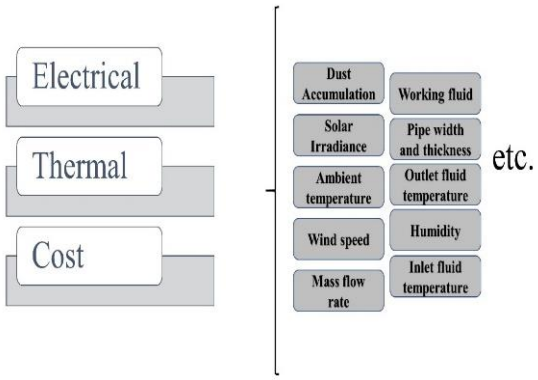

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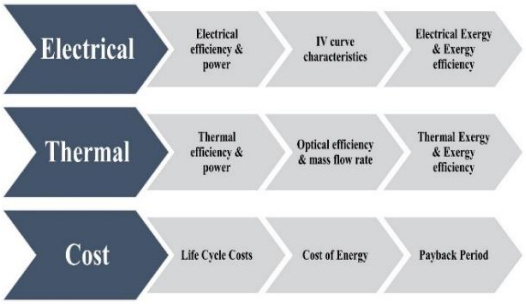


Fig. 1. (a) classifications of PV/T systems, (b) parameters affecting PV/T, (c) criteria to analyze PV/T.

Theory:

In the contemporary era, there have been many types of research on PV/T System emphasizing more focus on the design and its functioning. These intensifying researches reflect the growing interest in making effective use of renewable energy. Consequently, higher prominence is given on discussing and exploring the electrical and thermal efficiencies of PV/T systems. Additionally, the substantial quantum of the solar spectrum will be used, eventually leading to co-generation of heat and electricity.

This article aims to review the latest developments and improvements made on PV/T systems. From a comprehensive review of these systems, a package of the best PV/T systems that produced of the best electrical, thermal, and total efficiencies, which can be applied commercially, will be identified. This field is still wide and dispersed due to the unlimited options of cooling fluids and designs of solar collectors, and by specifying a number of them, it can guide researchers to the best ones, which can be exploited commercially on a large scale, which means a wider spread of PV/T applications globally.

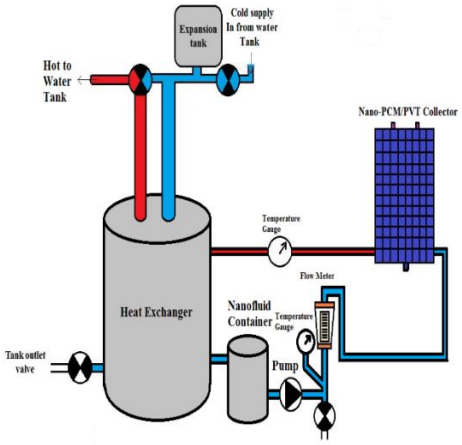


Fig. 2. Nanofluid, nano-PCM PV/T system.

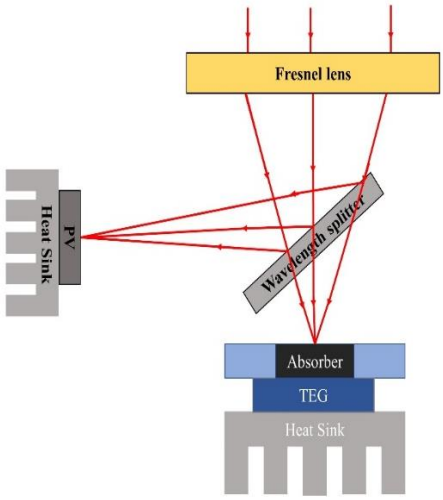
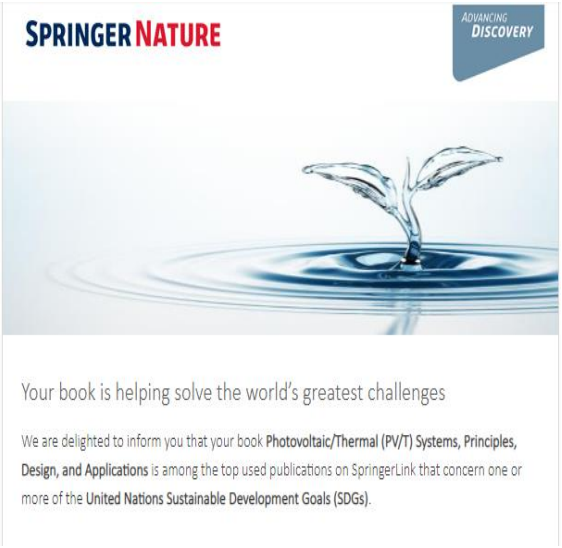


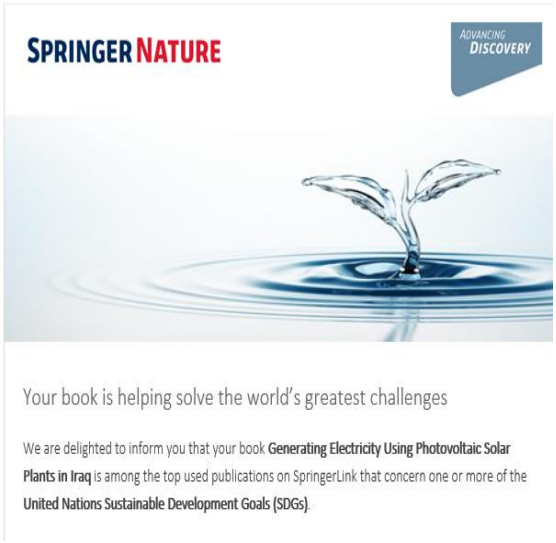
Fig. 3. Schematic diagram of CPV-TEG with wavelength splitter/interference filter.

News, updates, and announcements:

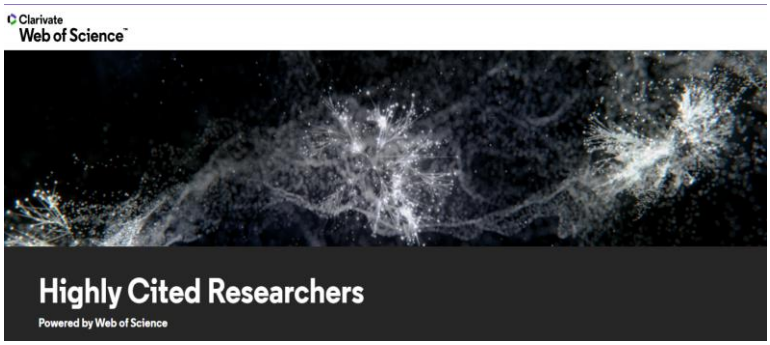
- Congratulation to Prof. K. Sopian, Prof Miqdam T Chaichan and Associate Prof. Hussein A Kazem for been selected in the list among WORLD'S TOP 2% SCIENTISTS from a database published by scientist from Stanford University.

- Congratulation to Dr Ali H. A. Al-Waeli, Dr Hussein A. Kazem, Prof Miqdam T. Chaichan, Prof. K. Sopian for having their book selected as one of the top books addressing United Nations Sustainable Goals.





- Congratulation to Prof. K. Sopian for being selected among the top highly cited researchers in the world by Clarivate.



- Announcement: Dr Ali H. A. Al-Waeli has been selected as a guest editor for a research topic with Frontiers in Energy Research (Q2, Scopus-indexed, and WoS-indexed). The title of the research topic is "Photovoltaic Thermal (PV/T) Collectors: Advances in Design and Implementation". For those working in PV/T research and are interested in participating in this topic, submit your abstract on the topic page. You can find the link in the home page of Dr. Ali's website (https://www.dralialwaeli.org/). The co-guest editors in this topic are: Prof. Dr. K. Sopian, Dr Hussein A. Kazem, Prof. Miqdam T. Chaichan, and Dr Hasila Jarimi. Submission Deadlines: 17 February 2021 (Abstract). 17 June 2021 (Manuscript).

References:

[1] Kazem, Hussein A., Ali HA Al-Waeli, Miqdam T. Chaichan, Karrar H. Al-Waeli, Anwer Basim Al-Aasam, and K. Sopian. "Evaluation and comparison of different flow configurations PVT systems in Oman: A numerical and experimental investigation." *Solar Energy* 208 (2020): 58-88.

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All **OV2040REP** members are kindly invited to submit articles for publication in future **OV2040REP** newsletters. Articles can be on a range of topics surrounding the word of renewable energy technologies. With more than 30 members, the **OV2040REP** newsletter provides a great opportunity to publicise new ideas, technologies or products – all free of charge!

Articles should be no more than 400-500 words and one or two photographs would be very much appreciated. Submissions should be emailed to ali9alwaeli@gmail.com (**OV2040REP** coordinator). Furthermore, please contact **OV2040REP** coordinator regarding any conferences, seminars or symposiums relating to topics of renewable energy technologies that you wish to be advertised in the newsletter.

Once again, thank you for your continued support to **OV2040REP**.