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29th Workshop on Energy and Environment

December 7-8, 2023, Gödöllő, Hungary

Book of Abstracts

Editors: István Farkas
Piroska Víg

Gödöllő, 2023

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CONTENT

PREFACE

Successful events in the series of the Seminar/Workshop on Energy and Environment (EE) were organised yearly since 1995 under the auspices of the Department of Physics and Process Control, Institute for Environmental Engineering Systems, Szent István University Gödöllő, Hungary (recently Department of Physics, Institute of Mathematics and Basic Science and Department Mechatronics, Institute of Technology, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary), including active participation also from foreign institutions working in the field of the application possibilities of renewable energy resources.

The aim of the Workshop to provide a forum for the presentation of new results in research, development and applications in connection with the issues of energy and environment.

This is now a call to take part in the abovementioned event along with to submit two-page abstract of potential contributing papers falling into the Workshop topic. The Abstract Volume of the Workshop will be published and distributed among the participants during the event. The language of the Workshop is English, no simultaneous translation will be provided.

Prof. I. Farkas
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NUMERICAL SIMULATION OF FLAT PLATE SOLAR COLLECTOR USING NANOFLUID

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Energy has consistently been a critical and highly valuable global commodity. As the pollution of the environment deteriorates as a result of the unlimited usage of fossil fuels, there has been increased focus on renewable energies as a substitute for fossil fuels. Renewable energies come in various forms including solar energy, which is beneficial because of it being environmentally friendly and limitless. A keyway in which solar energy is used is by acquiring solar radiation through the use of solar collectors (Ajeena et al., 2022).

There is now significant interest in solar thermal systems in the engineering field. Although Flat plate solar collectors (FPSC) were the first such systems to be developed and have high applicability, the amount of heat lost is comparatively high, thus making them less thermally efficient. Today, the efficiency of such solar systems can be improved via optimisation techniques along with state-of-the-art technologies involving the utilisation of nanoparticles and nanofluids. Improving the thermal performance of FPSCs can reduce their dimensions and result in an increased outlet temperature of the fluid in terms of heating water in commercial and residential buildings (Ajeena et al., 2024).

The aim of the current study is to examine the thermal performance of flat plate solar collector with nanofluid under laminar flow conditions. This study involves using ANSYS-Fluent 2022 for the numerical simulation of FPSC with a nanofluids-based collector. ANSYS (pre-processing, solution, and post-processing) were the primary solution processes used to analyse each model during this investigation. Numerical study has been done on the effect of distilled water and silicon carbide nanofluid (SiC/DW) at concentrations of 0.1% on the FPSC. Table 1 shows the physical characteristics of the base liquid and nanoparticles. The system's geometrical of the computational domain for the FPSC is presented in Fig. 1.

Table1. Thermophysical properties of silicon carbide nanoparticles and distilled water

Properties	Water (base liquid)	Silicon Carbide
Chemical formula	H_2O	SiC
Purity (%)	distilled water	99
Color	—	grayish white
Morphology	—	cubic
Specific Surface Area (SSA) (m^2/g)	—	40-80
Actual particle size (APS) (nm)	—	45-65
Stock code	—	US2028
CAS No.	—	409-21-2
Density (ρ) (g/cm^3)	0.999	3.216
Specific heat (J/kgK)	4187	680
Thermal conductivity (W/mK)	0.6	370

The observed when using nanoparticles, the capability of the fluid to transfer heat via convection increases with the incorporation of nanoparticles leading to more transfer of heat from the pipe and the fluid inside it. As a result, a decline in the absorber temperature is noted. Besides, it was observed that nanofluids gave higher efficiency due to high thermal conductivity compared to the conventional case without nanofluids. Modelling by Ansys can help establish a more efficient and economical of FPSC experimental investigation.

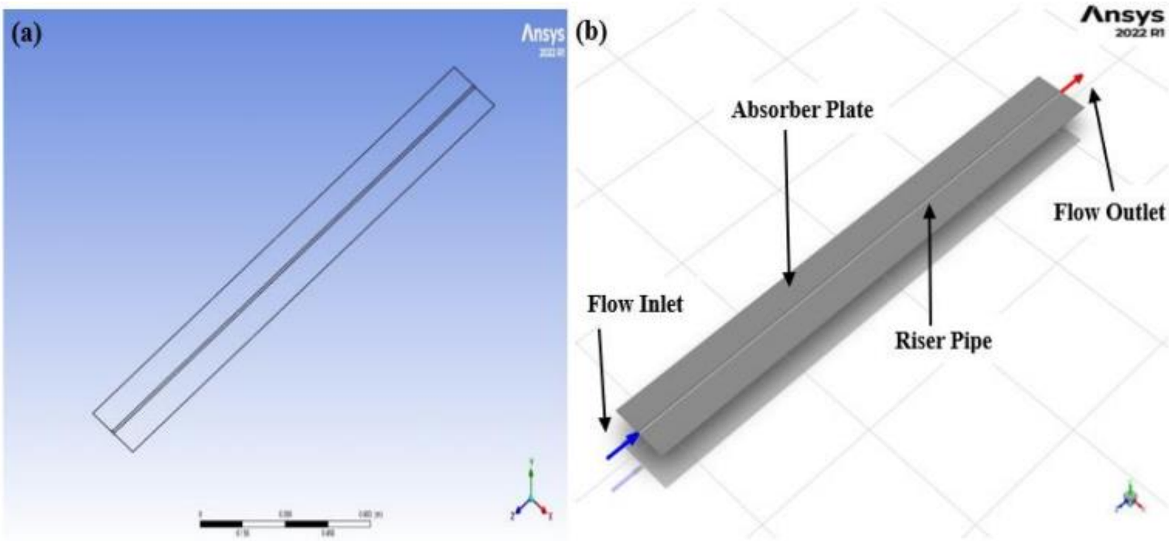

Fig. 1. Model geometry of the computational domain of FPSC: (a) Isometric wireframe view and (b) 3D design

Acknowledgements

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References

Ajeena, A.M., Víg, P., Farkas, I. (2022): A comprehensive analysis of nanofluids and their practical applications for flat plate solar collectors: Fundamentals, thermophysical properties, stability, and difficulties, Energy Reports, Vol. 8, pp. 4461–4490. https://doi.org/10.1016/j.egyr.2022.03.088

Ajeena, A. M., Farkas, I. and Víg, P. (2024): Energy and exergy assessment of a flat plate solar thermal collector by examine silicon carbide nanofluid: An experimental study for sustainable energy, Applied Thermal Engineering, Vol. 236, p. 121844. https://doi.org/10.1016/j.applthermaleng.2023.121844

THE EFFECT OF FORCED AIRFLOW INSIDE THE SOLAR CHIMNEY ON THE PHOTOVOLTAIC MODULE POWER GENERATION

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Through the built-in solar collector, the solar chimney (SC) absorbs solar radiation for cooling or natural ventilation purposes by providing natural airflow for the building or any space. The amount of natural flow in it depends on the difference between the air temperature inside it and the ambient air temperature. Sometimes, this difference is not enough to generate the required flow, so the airflow is stimulated through the thermal effect, which leads to an increase in the air temperature inside the chimney compared to the surrounding air and thus leads to an increase in flow rates to reach the required limit (Ali et al., 2023).

A combination of natural and forced flow can be used for a forced airflow setting of a solar chimney. Forced flow can be waste exhaust airflow from other mechanical ventilation systems of the building, eliminating the need for additional energy (Nguyen and Nguyen, 2023). The induced mass flow rate increases with forced flow temperature, improving ventilation performance (Nguyen et al., 2021). In addition, the SC's flow field and heat transfer characteristics can be improved through passive flow control methods, such as adjusting the number of turbulent generators, throat area, and round edges at the chimney inlet or through air-moving fans.

This study studied the effect of forced airflow inside the SC at different velocities (0.5, 1.0, and 1.5 m/s) using a fan on the power generated by the photovoltaic (PV) module integrated with it. It is done by comparing three experimentally tested cases in Godollo, Hungary. The experimental cases were implemented on three clear days in August 2023.

Each case includes two PV modules with a third reference PV module. One of these modules is integrated with a SC and an earth-air heat exchanger (EAHE) and can be distinguished by the name (PV-EAHE). In this model, the PV module is cooled by the air flowing from the EAHE assisted by the SC and forced air. The second module is integrated only with a SC and draws air from the ambient by assisting the SC and forced air, and it can be characterized by the name (PV-AMB). The third module is not integrated with a SC or EAHE and can be described by the name (PV-REF).

Fig. 1 shows the relationship between the temperature of the PV modules, the power generated from it, and the velocity of the airflow inside the SC (natural flow and forced flow) for the three test models (at the three forced velocities 0.5 m/s, 1.0 m/s, and 1.5 m/s).

As noted by the figure, the velocity generated in each test model is greater than the value of the corresponding forced velocities. This means that additional speed may be caused due to the permeation of pressures inside the SC. Also, note that this speed increase is greater in the test models not integrated with the EAHE due to the lower temperatures of the air flowing from the EAHE system. The PV-EAHE module at 0.5 m/s is the hottest among the other modules due to the lack of sufficient airflow necessary to cool it, as its temperature exceeds 2.14% compared to the PV-REF.

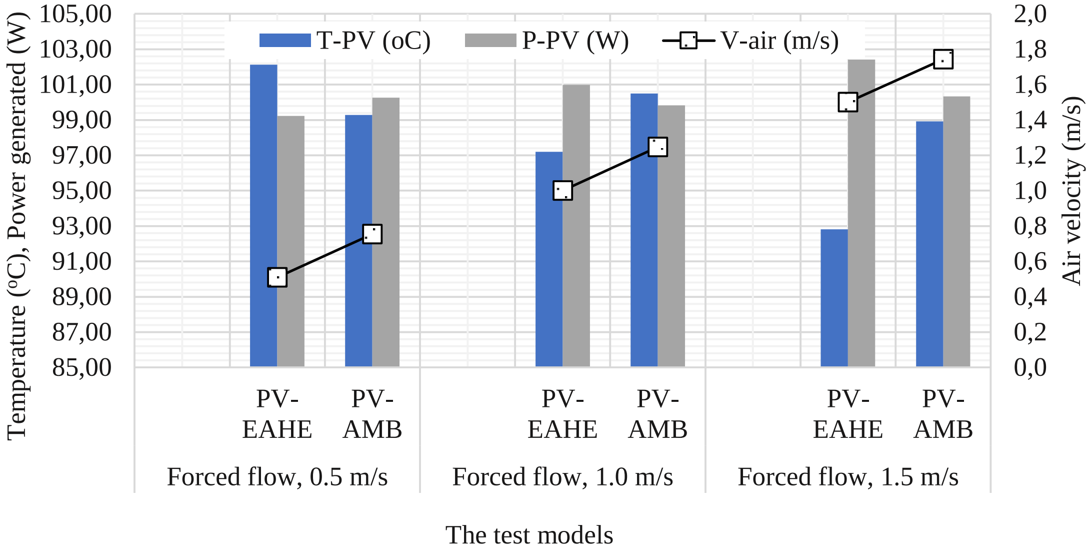

Fig. 1. The relationship between the temperature of the PV modules, the power, and the airflow velocity inside the SC at the three air fan forced speeds: 0.5 m/s, 1.0 m/s, and 1.5 m/s.

As a result, it has the lowest output power among the other PV modules. The PV-EAHE at 1.5 m/s is the most power-producing among the different modules, and its temperature was the lowest among the other modules. Its temperature does not exceed 92.82% compared to the PV-REF. Its power is greater than the power generated by PV-REF by 2.42%

Acknowledgments

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References

Ali, M.H., Kurjak, Z., and Beke, J. (2023): Modelling and simulation of solar chimney power plants in hot and arid regions using experimental weather conditions, International Journal of Thermofluids, 20, 100434. https://doi.org/10.1016/j.ijft.2023.100434

Nguyen, Y Q., Huynh, M.-T. T. and Nguyen, T. V (2021): Effects of the forced air temperature on the induced flow rate through a combined natural–forced flow in a solar chimney, in AIP Conference Proceedings. AIP Publishing. https://doi.org/10.1063/5.0066568

Nguyen, Y.Q., and Nguyen, V.T. (2023): Characterizing the induced flow through the cavity of a wall solar chimney under the effects of the opening heights, Journal of Building Physics, 46(5), 630–653. https://doi.org/10.1177/174425912211404

THE EFFECT OF INTEGRATED SOLAR AIR COLLECTOR ON THE PHOTOVOLTAIC MODULE POWER GENERATION

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The solar air collector (SAC) is one of the main components of the solar chimney (SC). The solar collector absorbs the incident solar energy in the form of radiation to raise the temperature of the air inside it and then directs it to the SC. Therefore, it plays a pivotal role in influencing the efficiency of the SC and the heat transfer process. Geometric parameters, such as the collector's and SC's dimensions and their integration with other energy sources such as photovoltaic (PV) modules, significantly impact their performance. Incorporating a bell-shaped opening and PV modules at the bottom of the collector enhances the flow velocity and significantly increases power production (Singh et al., 2021). Improving the outlet speed and power transfer factor ratio reduces the collector inlet height, improving overall performance (Golzardi et al., 2021), (Ali et al., 2023). In addition, adding reflectors to the collector increases the concentration of solar radiation, leading to higher collector temperatures and improved natural ventilation in bioclimatic buildings (Golzardi et al., 2021).

This study studied the effect of integrating a SAC and a SC on the power generated by a PV module integrated with an earth air heat exchanger (EAHE). This is done by comparing three cases tested based on experimental data measured in Gödöllő, Hungary and Al-Najaf, Iraq, on two clear days in July 2022. The ambient temperature (Tamb) adopted in this study is a selection of temperatures that are typical in summer in a city known for high summer temperatures, such as the city of Al-Najaf, Iraq, and a city known for lower temperatures, such as the city of Gödöllő in Hungary. Temperatures were measured experimentally for the two cities, and three values for these temperatures (25, 35, and 45 ^{o}C) were chosen for comparison purposes, which are believed to meet the research objective.

Each case includes two PV modules with a third reference PV module. One of these modules combines a SAC-SC and an EAHE and can be distinguished by the name (PV-SAC-SC). In this model, the PV module is cooled by air flowing from EAHE with the help of SC and SAC. The second module is only integrated with SC and draws air from the ambient passing by the EAHE and PV module with the support of SC only and can be named by name (PV-SC). The third module is not combined with SAC, SC, or EAHE and can be described by the name (PV-REF).

Fig. 1 shows the relationship between the temperature of the PV modules and the power generated from them, and the speed of airflow inside the SC (integrated and non-integrated with SAC) for the three test models (at Tamb of 25, 35, and 45 ^{o}C).

As can be seen from the figure, the speed of airflow in SC integrated with SAC is greater than the speed generated with the corresponding unintegrated SC. We also note that airflow decreases relatively as the Tamb increases. For example, the speed generated in the PV-SAC-SC model was 1.13 m/s when the Tamb was 25 ^{o}C. At the same time, the airspeed generated in the PV-SAC-SC model was 1.03 m/s when the Tamb was 35 ^{o}C and so on for the model when the Tamb was 45 ^{o}C. But still, the airflow in the PV-SAC-SC model is always the most significant in the three test cases.

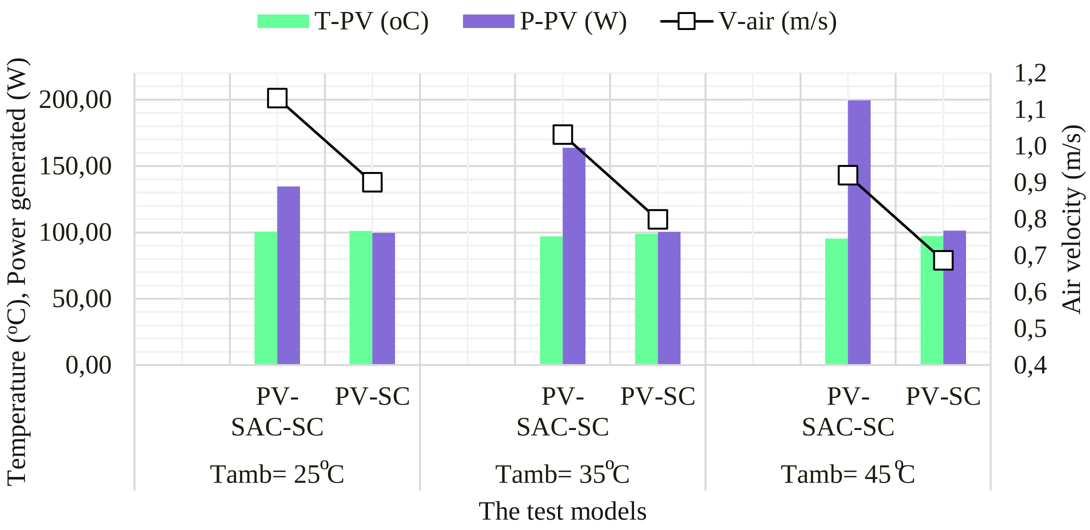

Fig. 1. The relationship between the temperature of the PV modules, the power, and the airflow velocity inside the SC at the three Tamb: 25 °C, 35 °C, and 45 °C

We also notice from the figure that the temperature of the PV-REF module was lower than the temperatures of other modules only when the Tamb was 25 °C, but when the Tamb became 35 °C, the temperature of the PV-REF module became greater than PV-SAC-SC and PV-SC modules by 3.05% and 1.03% respectively. When the Tamb became 45 °C, the temperature of the PV-REF module became greater than PV-SAC-SC and PV-SC modules also by 4.58% and 2.73% respectively. As a result, the productivity of the modules improved significantly compared to the PV-REF modules 4 and 5 times.

Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Ali, M.H., Kurjak, Z., and Beke, J. (2023): Modelling and simulation of solar chimney power plants in hot and arid regions using experimental weather conditions, International Journal of Thermofluids, 20, 100434. https://doi.org/10.1016/j.ijft.2023.100434

Golzardi, S., Mehdipour, R., and Baniamerian, Z. (2021): How collector entrance influences the solar chimney performance: experimental assessment, Journal of Thermal Analysis and Calorimetry, 146, 813–826. https://doi.org/10.1007/s10973-020-10031-3

Singh, A.P., Kumar, A., and Singh, O.P. (2021): Strategies for effective cooling of photovoltaic panels integrated with solar chimney, Materials Today: Proceedings, 39, 1950–1954. https://doi.org/10.1016/j.matpr.2020.08.440

THE EFFECT OF THE GEOMETRIC CONFIGURATION OF EARTH-AIR HEAT EXCHANGERS ON THEIR PERFORMANCE

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The air-earth heat exchanger system (EAHE) is a tube buried underground and surrounded by soil from all directions. Its purpose is to pass air or any other fluid through it to cool or warm it, depending on the temperature of the passing fluid and the temperature of the soil surrounding the EAHE tubes (Ali et al., 2021). The soil is characterized by its relatively constant temperature throughout the year at specific depths 2-4 m underground. Therefore, when the fluid passes through the pipes, a heat exchange occurs between them, leading to a loss or gain of heat that can be used in heating and cooling applications of buildings. One of the reasons that affect the efficiency of the EAHE depends on its geometric configuration and the method of distributing the pipes when installing them (Troina et al., 2020).

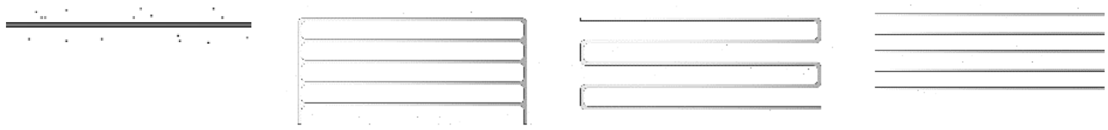
This configuration determines how the ducts are connected and assembled, which can significantly affect the heat transfer efficiency and overall performance of the EAHE. Depending on the specific application, different configurations are used, such as vertical and horizontal layouts. In the case of ventilation systems, horizontal EAHE are commonly used, which can also be classified into ductless and membrane-free designs (Zhelykh et al., 2018).

This study aims to make a comparison of four configurations of EAHE. All components in this study are of the horizontal type of EAHE but differ in how they are geometrically distributed. They are as follows:

a) Single-tube (S-EAHE) is a single pipe extending horizontally in one direction only, with a total length of 22 m.
b) Multi-tube (M-EAHE) is a group of pipes connected by using an elbow with an angle of 90, forming a network of underground pipes with a total length of 22 m.
c) Multi-single tube (MS-EAHE) consists of five pipes separated from each other, each of which is 4.4 m long and has a total length of 22 m.
d) Twist-single tube (TS-EAHE) consists of only one long pipe twisted into five zigzag-shaped twists, with the total length of the pipe used being 22 m.

Fig. 1. shows the four EAHE configurations in this study. Reliable flow ratios for multiple tubes were used to understand and evaluate the performance of these types of heat exchangers. All necessary data will be incorporated into the simulation process to ensure an accurate assessment of the performance of the EAHE. The experimentally measured weather data in Godollo, Hungary, was used for this research. These data will be simulated in MATLAB/Simulink, which was developed for the design and analysis of EAHE systems (Ali et al., 2023).

The results showed that TS-EAHE was the most consuming of the additional energy required to operate the fans needed to circulate the air inside the pipes due to the high-pressure losses generated in this type of system. The MS-EAHE is considered the least in terms of the pressure losses it generates, which leads to its need for the least energy among the other types, as shown in Fig. 2.



(a) S-EAHE (b) M-EAHE (c) MS-EAHE (d) TS-EAHE

Fig. 1. The four EAHE configurations.

Fig. 3. shows each type of system's cooling efficiency and cooling potential. It is clear from this that S-EAHE and TS-EAHE are the most efficient among the other types, as their efficiency reaches 94.07%, and therefore, they are the most capable of cooling potential than the different types, as they achieved a value of 649.73 W. While M-EAHE has the lowest cooling capacity, performing 365.06 W, it is the least efficient among the other of the types.

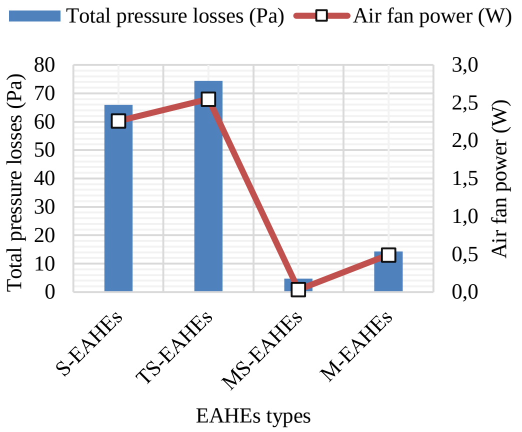


Fig. 2. The total pressure losses and the air fan power of the four EAHE types.

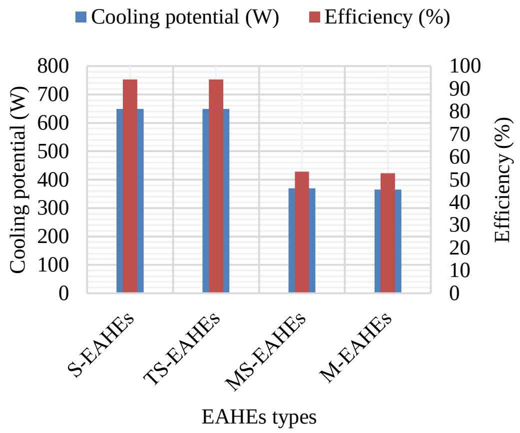


Fig. 3. The cooling potential and the efficiency of the four EAHE types.

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References

Ali, M.H., Kurjak, Z., and Beke, J. (2023): Investigation of earth air heat exchangers functioning in arid locations using Matlab/Simulink, Renewable Energy, 209, 632–643. DOI: https://doi.org/10.1016/j.renene.2023.04.042

Ali, M.H., Kurják, Z., and Beke, J. (2021): The Readiness Investigation of The Ground Soil Temperature for Underground Heat Exchange Systems Installation in Hot Climates, European Journal of Energy Research, 1(2), 1–6. DOI: https://doi.org/10.24018/ejenergy.2021.1.2.8

Troina, G., Cunha, M., Pinto, V., Rocha, L., Dos Santos, E., Fragassa, C. and Isoldi, L. (2020): Computational modeling and constructal design theory applied to the geometric optimization of thin steel plates with stiffeners subjected to uniform transverse load, Metals, 10(2), 220. DOI: https://doi.org/10.3390/met10020220

Zhelykh, V., Savchenko, O. and Matusevych, V. (2018): Horizontal earth-air heat exchanger for preheating external air in the mechanical ventilation system, Selected Scientific Papers-Journal of Civil Engineering, 13(1), 71–76. DOI: https://doi.org/10.1515/sspjce-2018-0021

SHAPING THE FUTURE OF SOLAR: EVALUATING THE POTENTIAL OF SPHERICAL AND HEMISPHERICAL PHOTOVOLTAIC MODULES

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Photovoltaic (PV) technology stands as a paramount source of solar energy, with its prevalence perpetually ascending (El-Atab et al., 2020). A competitive landscape is evident amongst corporations, all striving to enhance the characteristics and efficiency of PV modules. This technology is revered for its capability to transduce solar energy directly into electrical energy, avoiding the necessity for intricate procedures (Almadhhachi et al., 2022). This technology has been seamlessly integrated into architectural structures, manifesting in various building components such as roofs and facades, assuming a significant role in architectural design while concurrently contributing artistic and aesthetic nuances (Alpuerto and Balog, 2019).

In this study, attention is directed toward elucidating the distinctions between spherical and hemispherical modules adorned with flexible cells. The objective is to comprehensively understand the inherent properties of each geometric configuration and to underscore the relevance of these novel structures within the domain of photovoltaic cell technology.

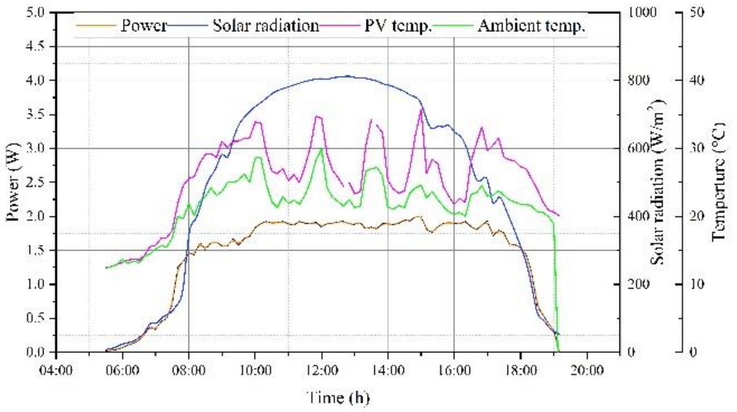

Fig. 1. The power generation from spherical PV module

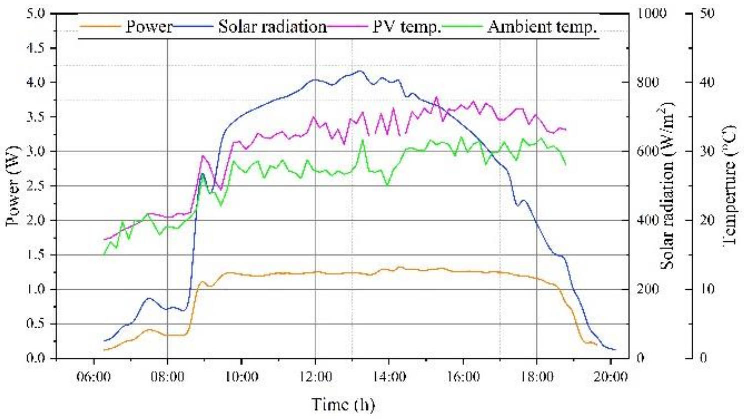

Fig. 2. The power generation from hemispherical PV module

Figs 1-2 delineates the power output manifested by the spherical and hemispherical configurations. The characteristic profile of the power curve distinctly emulates that of solar tracking systems, capable of harnessing solar energy from the onset of dawn until the descent of dusk. This stands in stark contrast to conventional systems, highlighting the innovative capability of these configurations.

The spherical configurations exhibited a power generation reduction of 60% relative to conventional systems when equating the surface area of the flexible cells. Conversely, these configurations afforded a substantial 98% reduction in ground footprint compared to flat systems. In contrast, the hemispherical shapes demonstrated a 30% augmentation in power production compared to their spherical counterparts, alongside a halving of the ground footprint requirement.

Critical factors imperative to augmenting the efficiency of novel systems encompass strategic distribution of cells across the surface of spherical shapes, ensuring maximal coverage of surface area. Additionally, maintaining adequate spacing is crucial for mitigating the temperature of flexible cells. Similarly, when integrating multiple units of spherical and hemispherical configurations, the interspacing between individual units plays a pivotal role. This spacing is instrumental in preventing the formation of shadows upon one another, a phenomenon that could potentially diminish the efficiency of these systems.

Artistic and architectural configurations significantly contribute to the aesthetic enhancement of urban landscapes. Furthermore, they serve as a pivotal means of fostering awareness regarding alternative energy systems, subsequently inspiring a shift towards the adoption of green energy across diverse facets of life.

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This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Almadhhachi, M. Seres, I. Farkas, I.: Significance of solar trees: Configuration, operation, types and technology commercialization, Energy Reports. 8, 2022, 6729–6743. https://doi.org/10.1016/j.egyr.2022.05.015

Alpuerto, L. Balog, R.S.: Energy harvest potential of flexible photovoltaics on curved surfaces, IEEE Texas Power Energy Conf. TPEC, 2019. 1–6. https://doi.org/10.1109/TPEC.2019.8662160

El-Atab, N., Qaiser, N., Bahabry, R., Hussain, M.M.: Large-scale spherical silicon solar cell for advanced light management, Conf. Rec. IEEE Photovolt. Spec. Conf. 2020-June 2020, 0170–0172. https://doi.org/10.1109/PVSC45281.2020.9300766

THE USE OF Cu_2O/WATER NANOFLUID TO IMPROVE THE HEAT TRANSFER PERFORMANCE OF PTC

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Parabolic trough collector (PTC) is the most established solar concentrating technology worldwide. The conventional PTC is used in various applications at medium and high temperature levels.

The thermal and thermodynamic performance of PTC could be enhanced by using nanofluids due to their enhanced thermophysical properties. As a result, it can absorb the most concentrated incident solar radiation while simultaneously improving the heat transfer characteristics of the base fluid.

The aim of the present study is to investigate the thermal performance of the PTC for the LS-2 model with nanofluids.

Therefore, the numerical simulation is implemented using Computational Fluid Dynamics (CFD). The effect of nanoparticle volume fraction on flow and heat transfer characteristics is investigated.

A numerical study is conducted on PTC operating with Cu_2O/distilled water nanofluid at concentrations of 5%. Fig. 1 shows the use of the ANSYS fluent software on PTSC model (LS2) with Renolds number 31750. Table 1 shows the model parameters, and Table 2 shows the thermophysical properties.

Table 1. Physical parameters of the analyzed collector

Parameters	Value
Diameter of outer the tube	70 mm
Diameter of inner the tube	66 mm
Concentration ratio	30
Lower heat flux	19500 W/m^2
upper heat flux	750 W/m^2

Table 2. Thermophysical properties of the base fluids and nanoparticle

	c_p (J/kg K)	ρ (kg/m^3)	k (W/m K)	Viscosity (N·s/m^2)
Distilled water	4178	907	0.603	0.001001
Cu_2O	474	6080	42	-
Nano fluid	3212	1165	0.7	0.00111

The nanoparticles have higher heat transfer properties than the base fluid (distilled water). The maximum enhancement of Heat Transfer Coefficient and Nusselt Number were 17% and 2.4%, respectively, for nanofluid with a concentration of 5%.

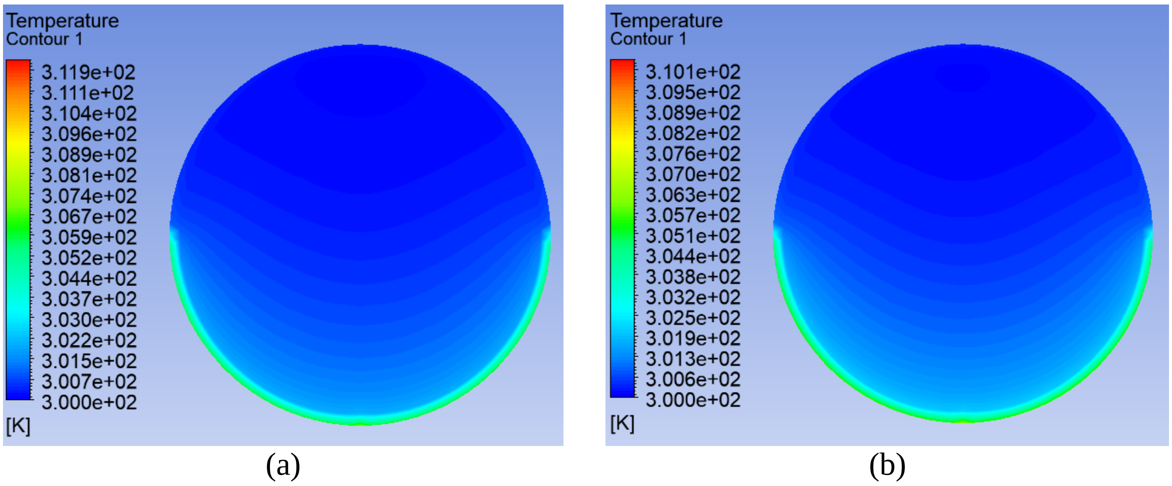

Fig. 1. Temperture countoures: a) water, b) nanofluid

Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Al-Rabeeah A.Y., Seres I., Farkas I.: Recent improvements of the optical and thermal performance of the parabolic trough solar collector systems, Facta Universitas, Series: Mechanical Engineering, Vol. 20, No 1, 2022, pp. 73–94. https://doi.org/10.22190/FUME201106030A.

Al-Rabeeah A.Y., Seres I., Farkas I.: Effects of concentration and temperature on the viscosity and thermal conductivity of graphene–Fe3O4/water hybrid nanofluid and development of new correlation, Journal of Engineering Thermophysics, Vol. 31, 2022, pp. 328–339. https://doi.org/10.1134/S1810232822020138.

Vahidinia. F, Khorasanizadeh. H, Aghaei.A.: Experimental and numerical investigations on performance of evacuated tube solar collectors with parabolic concentrator, applying synthesized Cu2O/distilled water nanofluid, Energy for Sustainable Development, Vol. 31, 2019, pp. 88–106. https://doi.org/10.1016/j.esd.2018.10.008.

Al-Rabeeah A.Y., Seres I., Farkas I.: Selective Absorber Coatings and Technological Advancements in Performance Enhancement for Parabolic Trough Solar Collector, Journal of Thermal Science, Vol. 31, 2022, pp. 1990–2008. https://doi.org/10.1007/s11630-022-1634-5.

EXPERIMENTAL PERFORMANCE ASSESSMENT OF SERPENTINE COPPER TUBE-BASED PHOTOVOLTAIC THERMAL MODULE

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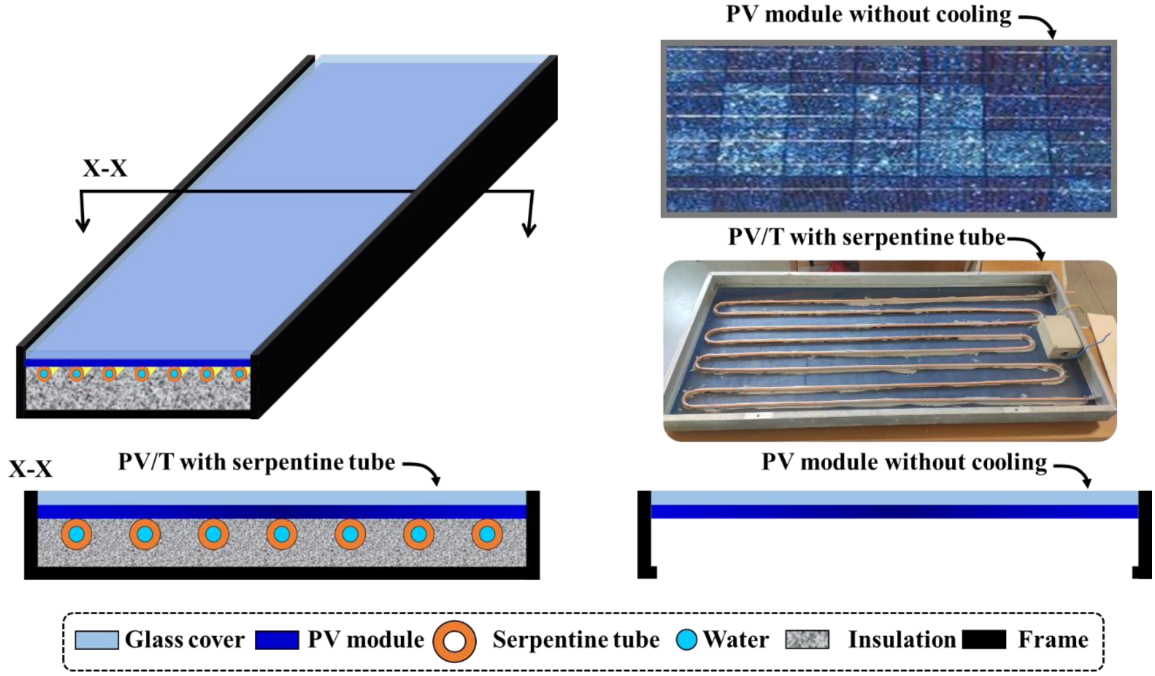
Renewable energy is the primary and most promising energy source. It is approaching the future. The rapid exhaustion of fossil resources, environmental issues, and the volatility in fossil fuel prices are the primary drivers for the shift toward renewable energy. Photovoltaic thermal modules (PV/T) are a promising technology due to their ability to harness both thermal and electrical energy simultaneously (Alshibil et al., 2023c).

The hybrid photovoltaic/thermal collector (PV/T) is a system that combines the production of heat and electric energy. It comprises a solar collector positioned underneath the PV module and is used in numerous applications. The increasing temperature of solar cells leads to a loss in electrical productivity (Alshibil et al., 2023a). Any configuration that extracts this heat from the solar cells would utilise it for space heating or hot water purposes, leading to performance enhancement of the PV module (Alshibil et al., 2023b).

Furthermore, the implementation of a (PV/T) collector results in a reduction of both the required installation area and associated expenses. This hybrid technology's most commonly employed coolants are water, air, and nanofluids.

This study utilises two different solar photovoltaic modules belonging to the Hungarian University of Agriculture and Life Sciences solar lab. The first was without cooling as a standalone unit, and the second was water-cooled through a serpentine copper tube mounted directly to the back side of the photovoltaic module. As shown in the following figure, these were the two modules used in this study.



This experiment aims to assess the performance of a presented module of the water-cooled PV/T by improving the heat extraction through a serpentine tube mounted to the PV module to decrease the cell temperature, which effectively enhances the productivity of the PV/T modules.

Besides the fabrication and evaluation work of the water-cooled PV/T module, this study compared the enhancement performance of the PV/T module with the standalone PV module with the same specifications.

As a consequence of the findings of this research, the serpentine tube-based water-cooled PV/T module that was created effectively lowered the temperature of the solar cells. Additionally, the fabricated PV/T module was efficient in electrical efficiency compared to the classical unit of the photovoltaic module.

Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Alshibil, A.M.A., Farkas, I., and Víg, P.: Experimental performance comparison of a novel design of bi-fluid photovoltaic-thermal module using Louver fins, Energy Reports, Vol 9, 2023a, pp. 4518–4531. https://doi.org/10.1016/j.egyr.2023.03.110

Alshibil, A.M.A., Farkas, I., and Víg, P.: Sustainability contribution of hybrid solar collector towards net-zero energy buildings concerning solar cells wasted heat, Energy for Sustainable Development, Vol 74, 2023b, pp. 185–195. https://doi.org/https://doi.org/10.1016/j.esd.2023.04.001

Alshibil, A.M A., Farkas, I., and Víg, P.: Thermodynamical analysis and evaluation of louver-fins based hybrid bi-fluid photovoltaic/thermal collector systems, Renewable Energy, Vol 206, 2023c, pp. 1120–1131. https://doi.org/10.1016/j.renene.2023.02.105

IDENTIFYING THE RELATION BETWEEN ENERGY AND FOOD THROUGH OPEN-FIELD FARM USING SEMITRANSPARENT PHOTOVOLTAIC

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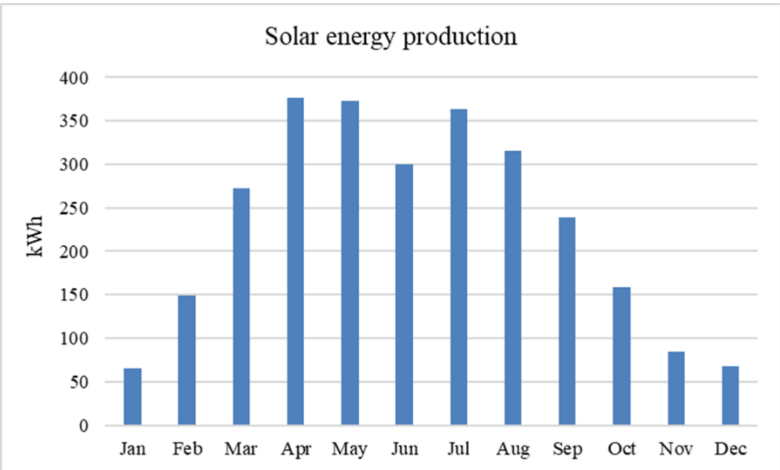
In agrivoltaic systems, the photovoltaic (PV) performance is determined by the quality of the solar radiation as a function of light intensity, which is determined by the weather, cloud cover, daytime, altitude, and latitude of the location. In contrast, crop yield is determined by the efficiency of converting the photosynthetically active radiation (PAR) to biomass (Gorjian et al., 2022). Because of their importance in the water-food-energy (WFE) relation, agrivoltaic systems have been the subject of various studies in recent years.

For this reason, optimizing crop productivity while meeting solar radiation needs for solar electricity generation is essential to raising power and agricultural yield. A new generation of PV modules with semi-transparent materials is now possible thanks to advancements in PV cell materials and fabrication techniques. The thin film semi-transparent photovoltaic (STPV) modules are promising for greenhouse applications as they can replace the current glass covers.

This study investigates the effects of using semi-transparent PV in open-field farming. According to the current study, three characteristics – optical, thermal, and electrical – are required to evaluate the performance of semi-transparent photovoltaic systems (Anggraeni et al., 2022).

Solar energy systems are designed primarily to capture and convert sunlight into electricity, rather than to optimize for the specific needs of plant photosynthesis. At Gödöllő, Hungary's Hungarian University of Agriculture and Life Sciences, the semi-transparent modules were installed. The systems total 3,3 kWp and are made up of 2x10 pieces of 165 Wp Solarwatt Vision. The relationship between solar production and PAR seems to be less about precise PAR range that plants use for photosynthesis and more about the overall amount of sunlight available and how it affects the efficiency of solar panels (Anggraeni et al., 2023).



Photosynthetic active radiation (PAR) is an additional crucial, measurable characteristic. PAR measurements quantify the amount of light in the photosynthetically active range. The growth and development of plants depend on this radiation. The wavelength range of visible light, or 400–700 nm, is included in PAR. PV densities can be used to determine the available PAR above the plant level and the accompanying photosynthesis rates.

Furthermore, measuring PAR allows for a better understanding of the quantity of available sunlight that reaches crops beneath photovoltaic modules and regulates their photosynthetic processes (Baxevanou et al., 2020).

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This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Anggraeni, N.D., Seres I., Farkas I.: Approaches to the performance evaluation of semi-transparent photovoltaic modules, Mechanical Engineering Letters, Gödöllő, Hungary, 2022, Vol. 22, pp. 4-14. HU ISSN 2060-3789.

Anggraeni, N.D., Seres, I., Farkas, I.: Average solar energy generated every month on semi-transparent solar panels, BioPhys Spring 2023, 22nd International Workshop for Young Scientists, Gödöllő, Hungary, June 15-16, 2023, p. 19.

Baxevanou, C., Fidaros, D., Katsoulas, N., Mekeridis, E., Varlamis, C., Zachariadis, A., and Logothetidis, S.: Simulation of radiation and crop activity in a greenhouse covered with semi-transparent organic photovoltaics. *Applied Sciences (Switzerland)*, 2022, *10*(7). https://doi.org/10.3390/app10072550

Gorjian, S., Bousi, E., Özdemir, Ö. E., Trommsdorff, M., Kumar, N.M., Anand, A., Kant, K., and Chopra, S.S.: Progress and challenges of crop production and electricity generation in agrivoltaic systems using semi-transparent photovoltaic technology. *Renewable and Sustainable Energy Reviews*, 2022, *158*. https://doi.org/10.1016/j.rser.2022.112126

PHASE-CHANGE MATERIAL SELECTION AND ASSESSMENT FOR PHOTOVOLTAIC THERMAL SYSTEMS

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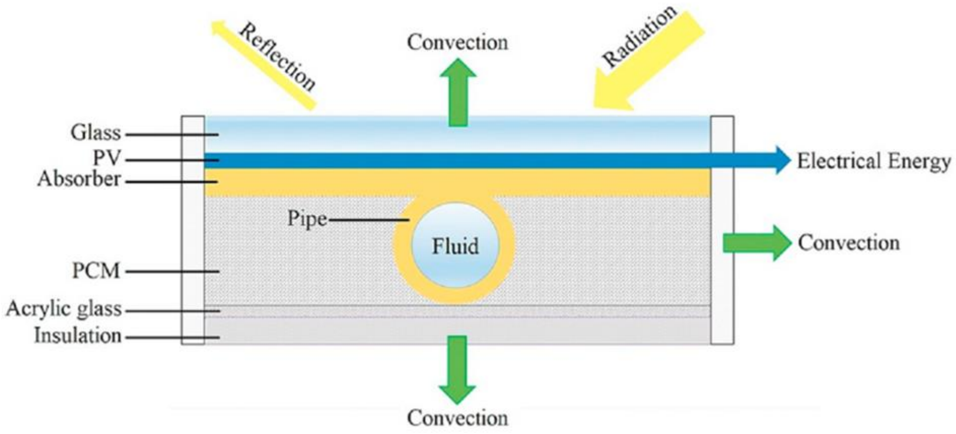
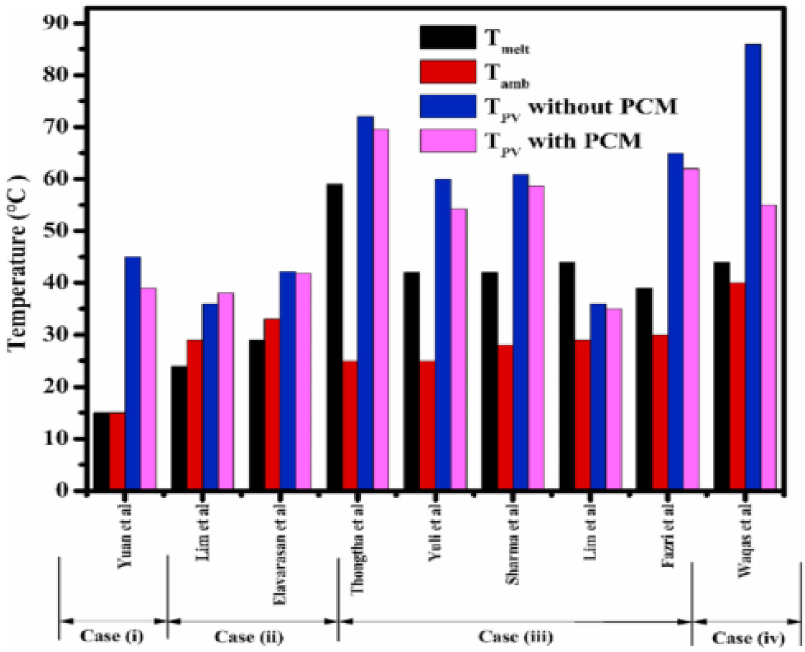
The nations that hold the greatest concern for the issue of global warming are not necessarily the most active ones; rather, they are the ones who have a desire to reside in more comfortable residences and possess the financial means to cover the required repairs. Their main source of energy, which also happens to be environmentally friendly, is solar energy. As a result, there exists a significant amount of potential in utilizing phase change materials (PCMs) to harness additional energy, whether it be to diminish a country's dependence on foreign energy sources or to furnish emerging nations with the necessary technological support.

Therefore, there is an imperative need to foster the advancement of novel energy storage and renewable energy utilization technologies to enhance energy efficacy. A group of energy-storage substances, commonly known as phase change materials (PCMs), emerges as an exceptional alternative for efficiently storing and harnessing renewable thermal energy to meet essential needs (Huang et al., 2021).

PCM technology operates by undergoing a phase transition while assimilating substantial quantities of latent heat without any elevation in temperature. Enhanced conversion efficacy is anticipated to arise from the capacity of this type of PV-PCM module to sustain the lower temperature of the PV cells by situating the PCM at the back of the PV module. A hybrid system or module based on materials that undergo a phase transition, such as phase-change materials, absorbs excessive heat directly from photovoltaic modules, thereby increasing the effectiveness (Tao et al., 2019).



In addition, phase change material (PCM) has been classified into three distinct categories based on the temperature at which the phase transition occurs. Firstly, the low-temperature category is typically employed in the food and air conditioning industries. Secondly, the medium-temperature category is the most prevalent type and finds applications in diverse fields such as solar energy, medicine, electronics, textiles, and energy-efficient architectural design. Lastly, the high-temperature category, which possesses a phase transition temperature exceeding 90 °C, is primarily utilized in the aerospace and industrial sectors (Velmurugan et al., 2021).



The numerous characteristics exhibited by phase change materials, including their economical nature, wide accessibility, lack of toxicity, malleability, durability, and qualities associated with temperature, chemical reactions, kinetics, and physical attributes, are considered to be the most significant factors when deciding upon phase change materials. The thermophysical properties of PCMs are considered to be the most significant among all their attributes. More precisely, the essential characteristics of phase change materials include the ambient temperature and the latent heat.

Finally, PCMs are less effective in storing energy due to their high degree of supercooling and low thermal conductivity. These kinds of problems have been resolved by using performance enhancement to increase their efficiency. Therefore, PCMs can be enhanced via fins and expanded surfaces, PCM-embedded porous matrices, PCM microencapsulation, dispersion of highly conductive particles within the PCM, and several PCM techniques.

Acknowledgments

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Huang, J., Luo, Y., Weng, M., Yu, J., Sun, L., Zeng, H., Liu, Y., Zeng, W., Min, Y. (2021). Advances and Applications of Phase Change Materials (PCMs) and PCMs-based Technologies. 23–39.

Tao, M., Zhenpeng, L., Jiaxin, Z. (2019). Photovoltaic panel integrated with phase change materials (PV-PCM): technology overview and materials selection. Renewable and Sustainable Energy Reviews, 116(July), 109406. https://doi.org/10.1016/j.rser.2019.109406

Velmurugan, K., Kumarasamy, S., Wongwuttanasatian, T., Seithtanabutara, V. (2021). Review of PCM types and suggestions for an applicable cascaded PCM for passive PV module cooling under tropical climate conditions. Journal of Cleaner Production, 293, 126065. https://doi.org/10.1016/j.jclepro.2021.126065.

ELECTRICAL AND INSTRUMENT CONTROL BASIC DESIGN FOR COAL-FIRED POWER PLANT 105 MW TO INCREASE PRODUCTION

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The increase of PLN’s (Indonesia state electricity company) electricity tariff for the industrial sector gives a heavy cost burden for their factory especially to compete in the cement market, since electricity contributes to 20% of the production cost.

On the other hand, facing the increasing demand of cement, the Factory has to expand its production lines accordingly. Dealing with such condition to minimize the increasing electricity bill and to meet the need for its production capacity expansion, the Factory seek for alternative electricity supply by building private power plants using cheap primary energy such as coal.

The average electricity demand in cement factory plant is 59.5 MW consisting of demand for factories power plants units II, III and IV. Electricity demand of factory is partly (± 46 %) supplied from PT PLN and the remaining is from Company’s own steam power plant (existing).

The supply from PLN is basically for cement plant II and III factories based on supply contract of 42.25 MVA at I4M tariff rate. Electricity supply from existing steam power plant is mainly utilized for cement plant IV factory and it is transferred from the power plant in 13.5 km far away from cement plant of 70 kV double circuit transmission line to the substation. It is reported that to produce about 2.3 million tons of cement per year, 40 – 50 MW of electricity would be consumed while a literature stated that the specific electricity consumption of a cement factory is 120 kWh/tons of cement produced.

The cement factory planned to build a new production line with a capacity of 2.5 million tons of cement per year, which will consume approximately 41 MW of electricity. The new factory is planned to be operated by 2010. Factory also planned to replace or at least reduce its supply from PLN considering the increasing electricity bill to be borne in the coming years. Obviously, this will need a further supply in the order of 35 MW of electricity. Therefore, the prospected load would be in the order of 80 MW of Nett power or roughly 90 MW gross power, which would be generated by 3 (three) units of coal fired power plant of 35 MW each unit of capacity.

This article will comprise the installation of three (3) units of Coal Fired Steam Power Plant of 35 MW each. The total installed capacity will be 105 MW nominal. The Power Plant will utilize once- through seawater cooling water system. Water for the Boiler and auxiliaries is supplied from the desalinated water. Existing Power Station (2x25 MW) has been connected cement plant 70 kV substation through 12 km double circuit transmission lines from power plant to cement factory.

The Coal Fired Steam Power Plant (CFPP) consisting of three (3) Steam Turbine Generators (STG). Each generator will be connected by Isolated Bus Duct (IPB) integrated with Generator Circuit Breaker (GCB) to one (1) two- winding generator step- up transformer. The high voltage side of the Generator Step- up Transformer will be connected to the new 70 kV Gas Insulated Switchgear (GIS) Substation. Each unit auxiliary power supply will be provided by tapping from IPB that connecting GCB and the lower side of Generator Step- up Transformer through a fused disconnecting switch. Auxiliary electrical power will be distributed from medium and low voltage switchgears and distribution equipment in the power plant for normal operation of the plant auxiliaries. The gross capacity generated at the existing 2 units of an existing power plant amounts to 50 MW which is used to supply a new cement factory. Unit II

& III factories are supplied by PLN with a power contract of 42.25 MVA. The additional gross power capacity added by this extension project will be about 3x35 MW which comprises three (3) units of boilers, steam turbines, and generators. The table shows Power Plant and 70 kV Transmission Line Configurations:

Power Plant (Generating)			70 kV Overhead T/L (Outgoing)	
CFPP	Available Capacity (MW)		Circuit	Available Capacity (MW)
Exst. Unit # 1	17.5		Exst. 70kV T/L Unit IV Factory–Line I (Single ACSR $300mm^2$)	50
Exst. Unit # 2	17.5		Exst. 70kV T/L Unit IV Factory–Line II (Single ACSR $300mm^2$)	50
New CFPP Unit # 3	31.5		New 70kV T/L Unit V Factory–Line I (Double ACSR $240mm^2$)	120
New CFPP Unit # 4	31.5		New 70kV T/L Unit V Factory-Line II (Double ACSR $240mm^2$)	120
New CFPP Unit # 5	31.5			
Total power	**129.5**		**Total Power**	**340**

According to the configuration operation i.e. one (1) unit of new CFPP as substitution of PLN's power supply will operate in parallel with two (2) existing power plant means that the total capacities of (2x17.5+31.5) MW is available transmitted by existing double circuit 70 kV overhead T/L. For Instrumentation and Control systems design the whole plant will be able to be:

- Operated, supervised, and monitored continuously and centrally from the Central Control Room under all operating conditions i.e., plant startup, normal operation, plant shutdown, transient and abnormal conditions like operating at island mode, not all units are operating.
- Operated, supervised, monitored safely, reliably, efficiently, economically, simply, comprehensive operation, and easy maintenance

Acknowledgments

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References

A. Arismunandar and S. Kuwahara, "Teknik Tenaga Listrik, Jilid II: Saluran Transmisi: Buku Pegangan," 1973.

P. Thosar and R. Mathur, "Design and Development of High Efficiency Rectenna for Rf Harvesting," Materials Today: Proceedings, Vol. 29, Pp. 278–285, 2020

A. B. Sumadiyana, "Simulasi Aliran Daya Sistem 150 kV Region Jakarta-Banten dengan Perbandingan Sistem Grid Dan IBT," Fakultas Teknik Program Studi Teknik Elektro, Universitas Indonesia, Depok, 2009

Sugiyanto, "Studi Analisa Kestabilan Tegangan Pada Saluran Transmisi Sistem Jawa Timur Subsistem Paiton – Grati dengan Menggunakan Line Collapse Proximity Index," Institut Teknologi Sepuluh Nopember, Surabaya, 2017

J. Pramono, "Makalah Teknik Tenaga Listrik", Transmission of Electrical Energy (Transmisi Tenaga Listrik)," Departemen Teknik Elektro, Fakultas Teknik, Universitas Indonesia Depok, 2010. http://staff.ui.ac.id/system/files/users/chairul.hudaya/material/papertransmission ofelectricalenergy.pdf

SPLN 1 1978: Tegangan - Tegangan Standar, 1978

DEVELOPING A SUSTAINABLE BIOREFINERY MODEL BASED ON ENERGY WILLOW – FOCUS ON THE PRODUCTION OF ADDED VALUE COMPOUNDS

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Energy willow (*Salix vimialis* var. Inger) is acknowledged as a rapidly growing forest crop, characterized by a substantial polysaccharide content that can reach close to 60% (dry basis). Among the others, it also exhibits elevated levels of extractives and lignin, turning it into a rich source of bioactive compounds such as salicylates, flavonoids, lignans, and tannins (Tyśkiewicz et al., 2019).

As such, energy willow stands out as an ideal feedstock for a wide range of biorefinery applications that goes beyond its conventional application as a bioenergy fuel for heat production in boilers of varying scales.

Aligning with G. Olah's recommendation to explore biomass resources before resorting to burning (Olah et al., 2018), this study aims to contribute to the advancement of a sustainable biorefinery strategy tailored for energy willow.

Leveraging the inherent extractives content, the proposed approach involves biomass fractionation and hydrolysis processes to convert hemicelluloses into monomeric pentoses. Subsequently, these sugars undergo a selective fermentation process targeting high-value products, with a primary focus on the production of xylitol. Several samples of energy willow cultivated in Romania's Central Region, particularly in Covasna District, were collected in earlier and late spring.

The samples were segregated into subsamples of wood and bark, and then subjected to thorough chemical characterization using NREL's proposed analytical methods. A mild dilute acid hydrolysis process was applied, yielding xylose as the main sugar present in the liquid hydrolysates and preventing a significant production of microbial inhibitors derived from sugar degradation (e.g. furans).

Furthermore, acetic acid and phenolics content is not significant, in face of the intended use of the hydrolysate as a culture medium for the yeast *Debaryomyces hansenii*, (Carvalheiro et al., 2007).

This paper also provides insights into yeast growth under varying conditions and outlines the overall process yields showcasing the versatility of willow biomass, as a valuable feedstock for producing high-demand compounds such as phenolics and xylitol.

Acknowledgments

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References

Carvalheiro, F. et al.: Xylitol production by Debaryomyces hansenii in brewery spent grain dilute-acid hydrolysate: effect of supplementation. Biotechnol Lett, 2007. 29(12): pp. 1887-91.

Olah, G.A., Goeppert, A. and Prakash, G.K.S.: Beyond oil and gas: The methanol economy, 3rd ed. 2018: Wiley-VCH

Tyśkiewicz, K. et al.: Characterization of bioactive compounds in the biomass of black locust, poplar and willow. Trees, 2019. 33(5): pp. 1235-1263.

SUSTAINABLE BIOECONOMY-BASED STRUCTURE DEVELOPED FOR ROMANIAN RURAL VILLAGE

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Bioeconomy is an important part of sustainable rural development – according to modern economic theory – is defined as an economy in which the basic building blocks for materials, chemicals and energy are obtained from renewable energy resources (McCormick, Kautto, 2013).

Sustainably producing and utilizing renewable biological resources from agriculture and forestry, developing and applying different bio-based solutions to create value–added products can make a positive impact on rural communities, considering environmental, social and economic dimensions.

The first part of the paper is an overview of the state-of-art of the European bioeconomy, presenting innovative technologies, sustainable energy production schemes and products that can be integrated in the rural area.

The recently presented schemes have an important role in the rural development addressing the need for increasing agricultural productivity, forest conservation and rural livelihood improvement.

The rural village areas are rich in renewable resources such as crops, livestock and forest resources that can be harnessed for a wide range of products from biofuels and bioplastics to specialty foods and pharmaceuticals.

Based on these aspects, the paper presents a sustainable bioenergy model applicable in rural areas: thermal energy production from local biomass to ensure the heat and warm water for the local public buildings.

In this concept, local biomass – wood, forestry, and agro-residues are collected in a sustainable way with the involvement of the local community. Residues are then transported and stored in biomass storage centres, transformed into woodchips that will serve as fuel for biomass heating systems.

In this part of the paper, the technical and economic data are presented from the implemented best-practice applications from the Romanian rural area of Covasna County.

Finally, it can be concluded that the bio-based thermal energy production scheme is presented, a circular bioeconomy scheme where the feedstock comes from agricultural and wood waste from public area and form the energy wood plantation, like energy willow (Negreanu et al., 2014).

Acknowledgment

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References

Kes McCormick, Niina Kautto: The Bioeconomy in Europe: An overview, sustainability 2013, No 5, pp. 2589-2608.
https://www.mdpi.com/2071-1050/5/6/2589, accessed, November 2023

Negreanu G., Berbece, V., Mihăescu, L., Oprea, I., Pîşă, I., Andreescu, D.: Thermal power plant for energy willow use, Design Pererformances, 2014.
file:///C:/Users/User/Downloads/TPPforEnergyWillowuse.pdf, accessed November 2023

ADVANCING SOLAR DESALINATION THROUGH A PORTABLE THERMOSOLAR CYLINDRO-PARABOLIC COLLECTOR

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Solar desalination offers a promising solution for water scarcity, but conventional systems are often bulky, complex, and expensive. Portable thermo-solar CPC offers efficient, lightweight, and low-cost solar desalination for arid regions and disaster relief (Fei Cao et al., 2023). The Table 1 shows the STC application suggestions.

Table 1. STC application suggestions

STC Type	*Light Reception*	*Uniformity*	*Concentration Ratio*	*Absorber Types*	*Application Field*
PTC	Full area	Low	High	Circular tubes, flat plates, cavity receivers	High-temperatures solar thermal, DSG, CPV
CPC	Full area	Low	Low	Circular tubes, flat plates, cavity receivers	Solar thermal, solar photocatalysis, solar desalination
SUC	Full area	High	Low	Circular tubes, cavity receivers	Solar thermal, solar photocatalysis, solar PV
TTC	Part area	High	Low	Flat plates, cavity receivers	Solar thermal, solar PV

This research targets optical losses from Earth's rotation on cylindro-parabolic concentrators, addressing sunrise-sunset and single-axis tracking challenges for improved solar applications.

Optimized designs and intelligent recovery boost solar collector efficiency, tackling sunrise-sunset energy loss (Shri Ram et al., 2023). As shown in Fig. 1, emphasizes essential CPC elements for effective performance.

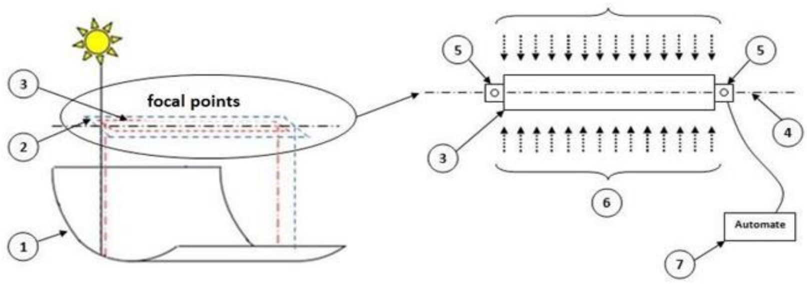

Fig. 1. Components of a cylindro-parabolic concentrator (CPC)

1. The cylindro-parabolic concentrator.
2. The reflection image.
3. The focal point.
4. The axis of focal point movement.
5. The photoresistor sensors.
6. The reflected solar ray.
7. An automaton.

As illustrated in Fig. 2, the automated system aligns reflections with the focal point for solar recovery. During sunrise, misalignment peaks, gradually decreasing until solar noon for minimal loss. As the sun sets, misalignment rises, reaching its maximum at sunset.

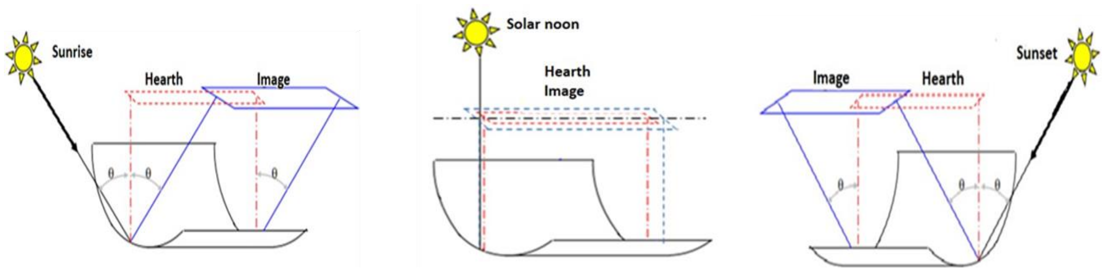

Fig. 2. Schematizes the issue

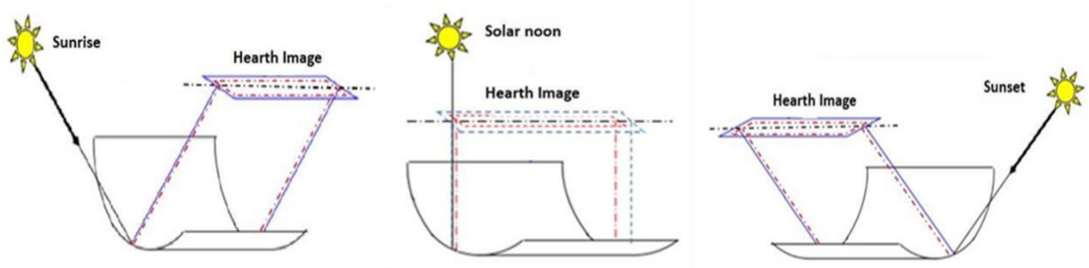

Fig. 3. Schematically illustrates the solution of the studies

As shown in Fig. 3, solar recovery and alignment: automated system aligns reflections with focal point for solar recovery. As shown in Fig. 4, Night Heating and Self-Cleaning: Thermal coils use stored solar energy; self-cleaning prevents dirt accumulation.

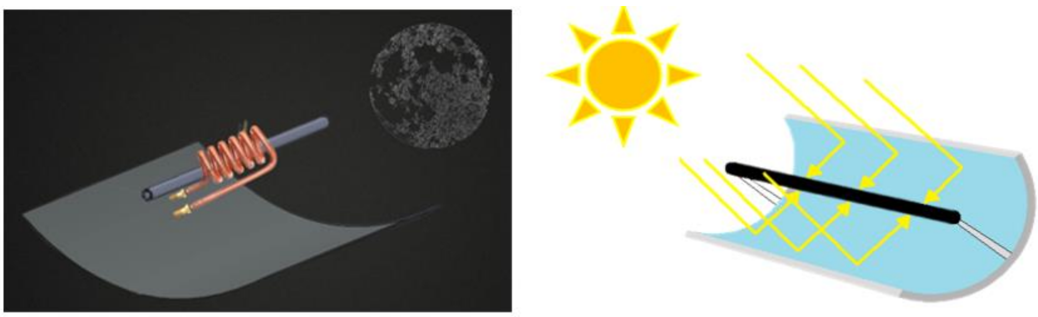

Fig. 4. CPC at day and night

Acknowledgements

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References

Fei Cao, Jiarui Pang, Xianzhe Gu, Miaomiao Wang and Yanqin Shangguan: Performance simulation of solar trough concentrators: Optical and thermal comparisons, Energies Journal, https://www.mdpi.com/1996-1073/16/4/1673, p. 18, 2023.

Shri Ram, H. Ganesan, Vishnu Saini, Abhinav Kumar: 'Performance assessment of a parabolic trough solar collector using nanofluid and water based on direct absorption', Science Direct Journals, Vol. 214, pp. 11-22, September 2023.
https://www.sciencedirect.com/science/article/abs/pii/S0960148123007930?fr=RR-7&ref=pdf_download&rr=8191c0b54e07213e,

PHOTOVOLTAIC TECHNOLOGIES TRANSITION TOWARDS RENEWABLE ENERGY TECHNOLOGIES

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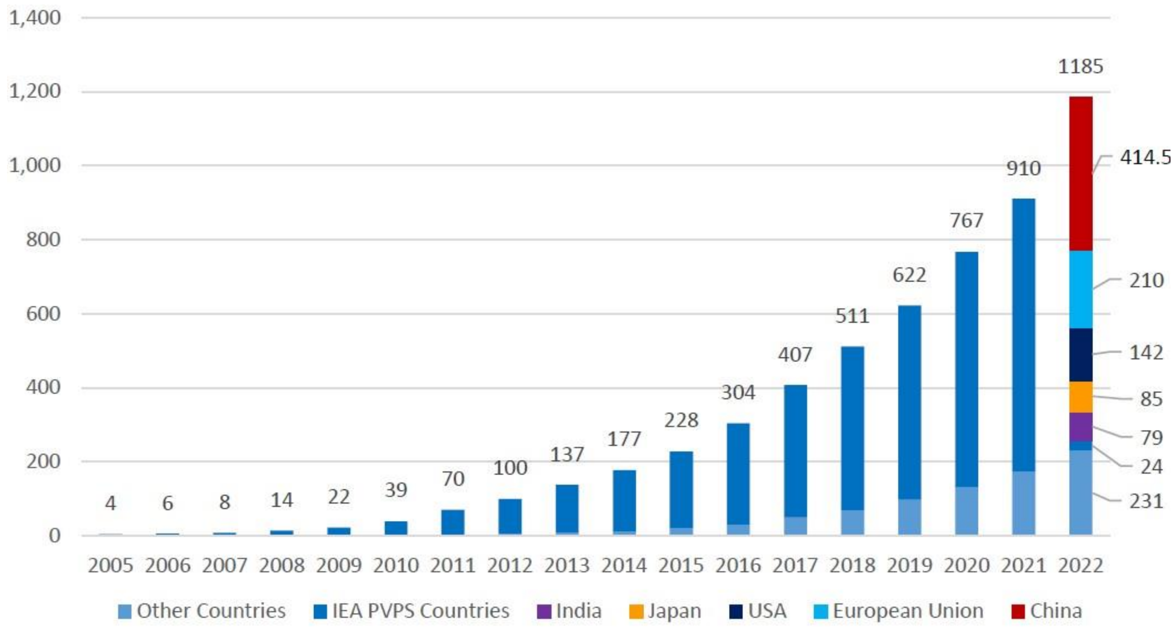
This paper is dealing with the status and future scenarios of the rapidly developing field of solar photovoltaic technologies. The worldwide situation is analysed based on the topics discussed intensively at the at the EuroSun 2022 Solar Conference organized in Kassel, Germany and the Solar World Congress (SWC 2023) to be organised by the International Solar Energy Society in New Delhi, India. Additionally, a relevant event was the COST Action PEARL PV's Conference on Enabling the PV Terawatt Transition, Enschede, The Netherlands in 2022. In the framework of that project, the most recently published books in this topic serve information on the recent statements.

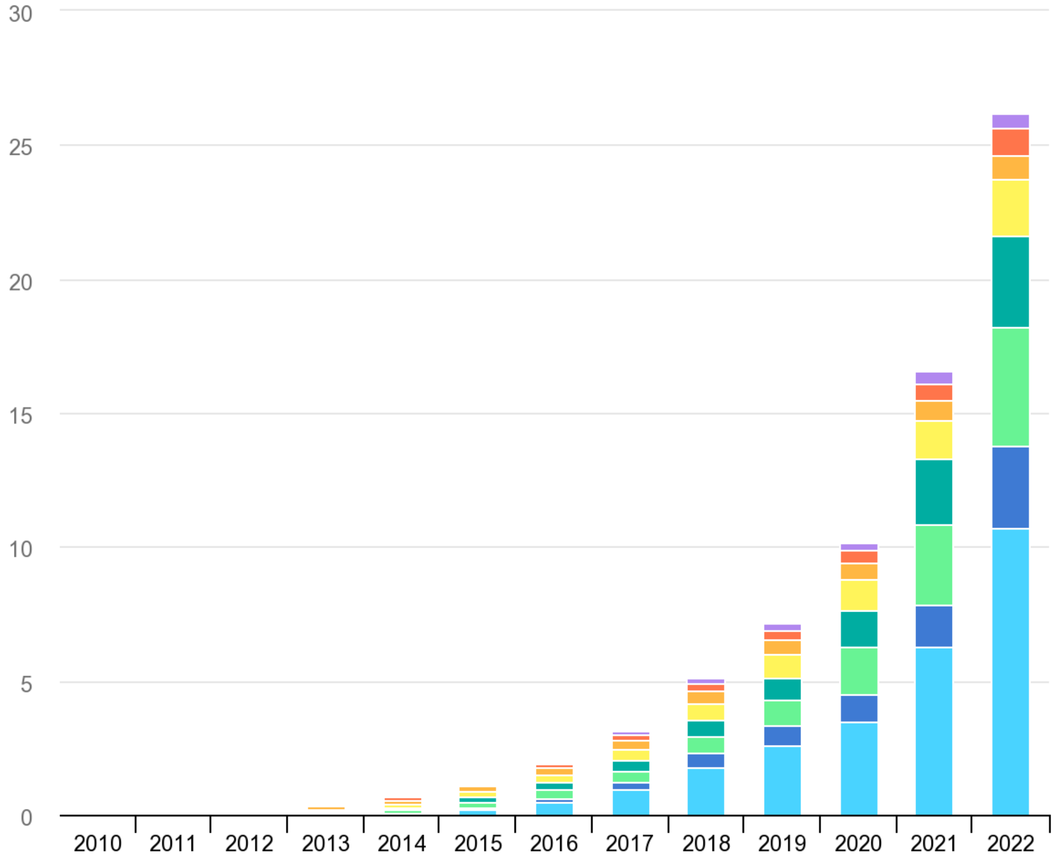
In 2022, the solar PV market increased by about 26% reaching the global capacity of 1185 GW passed the symbolic 1 TW mark along with the annual additions of 243 GW (Renewables 2023; IEA PVPS, 2023). The EU saw a significant increase in solar power capacity installed in 2022, with 41.4 GW added, up 47% from the 28.1 GW installed in 2021.



Solar PV capacity (in GW) and annual additions in 2022

Most of the solar photovoltaic energy application areas continouosly show significant increase. In 2022 the agricultural PV projects were continued, especially in China. In Europe, among France, Greece, the Netherlands, Spain, and Italy are the main actors in in this field. Similarly, the floating PV plants also continued to expand with installed capacity exceeding in 2022. The world’s largest floating PV plant in China. In Europe, Portugal held an auction for 500 MW of floating solar to be located at hydropower dams (Renewables, 2023).

The global investment in electric vehicles and related charging infrastructure surged 53.6% in 2022 to reach USD 466.1 billion, which is a remarkably high yearly development. There are also approximately 1 m electric vans, heavy trucks and buses. The main actor in this market indicated in colours in the bellow figure are China (in blue), Europe (in green), US (in yellow) and the others (in red). The light intensity of the colours means the *battery electric vehicles* and the higher insity means the *plug-in hybrid electric vehicles*.



Global electric passenger car stock (in million), 2010-2022

After several years of declines, PV module costs increased by estimated 57% in 2021, from an average of USD 0.21 to 0.33 per Wp, as because the cost of raw materials increased sharply. The main factors contributing to rising module costs included a polysilicon shortage and a rise in shipping costs from China, as he is the world's dominant module producer. At the same time, the solar module prices have become increasingly unpredictable and changeable, especially due to the supply chain disruption.

Concerning to the PV cell efficiency, in the laboratory, the high concentration multi-junction solar cells achieved an efficiency of 47.6%, and modules with concentrator achieved 38.9% (NREL report, 2023). The record cell efficiency for Perovskite is 23.7% (Fraunhofer ISE, 2023). At module level it is intended to develop higher power ranging at 600 W-plus mainly for building applications.

References

Renewables 2023 - Global Status Report, REN 21, Renewable Energy Policy Network for the 21th Century

Trends in photovoltaic applications 2023, Report IEA PVPS T1-43, 2023

Fraunhofer ISE, Photovoltaics report, February 21, 2023

Snapshot of global PV markets 2023, Report IEA PVPS T1-44, 2023

NREL report, May 1, 2023

POSSIBILITIES OF THE NEW GENERATION SILICON PHOTOMULTIPLIERS FOR RADIATION SENSING

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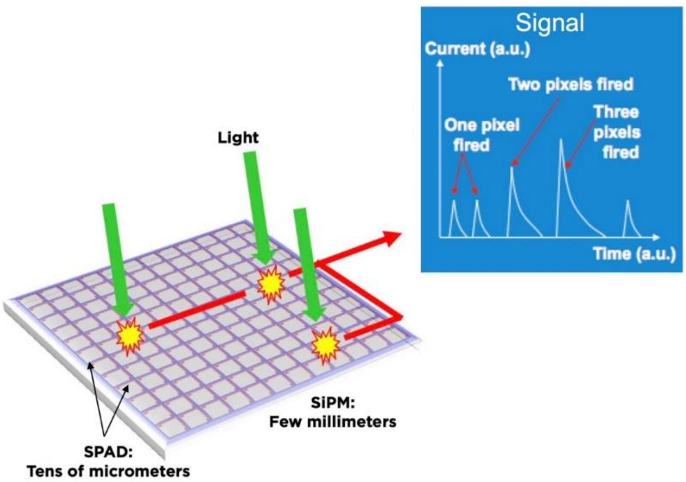
Today with the development of technology, more and more information about our world is available, and with the new achievements of measurement technology, humanity can get a more and more detailed picture about our planet and our environment.

Ionizing radiation is present in our environment, and the living organism has adapted to the permissible level. However, in many areas of our lives, in laboratories, hospitals, various factories and in our environment, there is an increasing need to measure, monitor and control the intensity of ionizing radiation due to artificial applications.

Today, there is a growing demand for semiconductor-based instruments due to the proliferation of electronic devices and their many advantageous properties such as small size, reasonable power consumption and the endless possibilities for high-tech portable and remote applications such as space research, nuclear industry, medical applications and others (Owens, 2019; Chen et al., 2010).

The silicon photomultiplier (SiPM) is an array of single photon avalanche diodes (SPADs), sensitive to single photons, with very fast response and the capability to provide high internal gain (up to the 10^7 range) compared to the photodiodes (unity gain), the avalanche diodes (10^2 range) and the SPADs (10^3 range) (Cates et al., 2022).

The technological advancements of the semiconductor industry made this architecture possible, with the capability to measure the impacts of single photons with the huge output gain which could be further processed by the follower electronics. The output of the SiPM could provide information about the energy of the radiation source using the amplitude of the pulses, and the severity could provide information about the intensity of the radiation environment around the SiPM. The essence of radiation measurement using SiMP is shown in the figure (Wikimedia, Politecnico Milano, www.everyphotoncounts.com).



The silicon photomultipliers have several advantageous characteristics, including high photon detection efficiency (PDE), good single photon time resolution (SPTR), high gain that translates to single photon counting capabilities, and ability to be tiled into large arrays with high packing fraction and photosensitive area fill factor. However, they also have a trade off in high uncorrelated and correlated noise rates (dark counts from thermionic emissions and optical photon crosstalk generated during avalanche) which may complicate event positioning algorithms (Chen et al., 2016).

The presentation will give an overview of the possibilities and use-cases of the most up to date SiPMs with the advantages and disadvantages and important tradeoffs of these novel semiconductor parts.

Acknowledgements

This work was supported by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Cates, J., Steele, J., Balajthy, J., Negut, V., Hausladen, P., Ziock, K., Brubaker, E. (2022), Front-End Design for SiPM-Based Monolithic Neutron Double Scatter Imagers, Sensors, 22. 3553. 10.3390/s22093553.

Chen, X.J., Johnson, E.B., Staples, C.J., Chapman, E., Alberghini, G., Benton, E., Christian, J.F. (2010), Space Dosimeters Based on CMOS SSPM Technology. *IEEE Trans. Nucl. Sci. 2010*, *57*, 3450–3455.

Chen, X.J., Johnson, E.B., Stapels, C.J., Fernandez, D., Podolsky, M., Vogel, S., Christian, J.F. (2016), Effects of Proton Radiation on Noise Performance in Solid-State Photomultipliers, *IEEE Trans. Nucl. Sci.* 2016, *63*, 1109–1116.

Owens, A. (2019), Semiconductor Radiation Detectors (1st ed.), CRC Press https://doi.org/10.1201/b22251

DESIGN METHODOLOGY FOR AUTONOMOUS HOUSES WITH HYDROGEN ENERGY STORAGE

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Hydrogen is considered as one of the promising alternative energy carriers due to its high energy density, zero carbon emissions during use, and its potential to be produced from renewable energy sources. However, the development of effective and efficient hydrogen storage technologies is a critical barrier to the widespread use of hydrogen as an energy carrier. In this paper, we will discuss the design methodology of hydrogen storage options and their suitability for stationary applications, particularly in buildings.

It is also applicable for houses, since the hydrogen related equipment are scalable, so they can serve a family house with 5-6 kW of H_2 production and back conversion to electricity and also more family houses with up to MW scale energy need. Some examples showed that this technology can be used in domestic buildings:

- The Green Village, fieldlab voor duurzame innovatie
- Hydrogen House Project - Hydrogen House Project: Home
- Phi Suea House
- Italian researchers have built the first hydrogen-powered house in Europe | Euronews
- First Hydrogen Homes open to the public | Cadent (cadentgas.com)
- [H_2] Hydrogen Home | SoCalGas

But these are unical and the technology is not popular – so, a technology transfer process is needed.

According to the EU hydrogen strategy (2020), hydrogen will be a key energy carrier by 2030, like now natural gas is, and there will be a supply chain available and even H_2 gas network at some places. Also, now this process has been accelerated as a consequence of the Russian war in Ukraine. The Green Deal 2022 agrees that 45% of renewable energy should be used in EU by 2030, which goal is only reachable when the energy is stored as well, mostly in H_2. Therefore, there’s an aim to have 17,5 GW electrolyser capacity by that year.

For domestic houses there are more possibilities to use hydrogen in the future:

- Use H_2 blended natural gas from the old gas network without any further investment,
- Connect to a new H_2 network or to a bottled supply chain (there are no networks yet and also the bottled H_2 access is limited currently),
- Generate the H_2 on site, store it and convert it back to electricity and heat. (At current maturity of the technology and lack of supply chain capacity this is the only option.)

Local generation and storage is already possible with components on the market - also some integrated solutions are existing in limited sizes. A hydrogen house needs excess energy to be converted and stored in H_2 which can be generated by solar energy - a photovoltaic (PV) system. It is well known, that solar panels produce far more energy in the summer than in winter, due to the suns track and weather conditions.

A PV system can be sized that way, that it generates enough energy in summary for a year, taking also H_2 conversion losses into account. An example system contains the following components (Fig. 1):

- A solar PV system to produce energy and even enough excess energy which will be stored for wintertime.
- An electrolyzer with water supply to produce hydrogen.
- A compressor to pressurize the gas into containers.
- A fuel cell to convert H_2 directly back to electricity and provide heat energy for the heat demand of the house.
- A battery to serve the peaks as the fuel cell needs time to scale up its production.

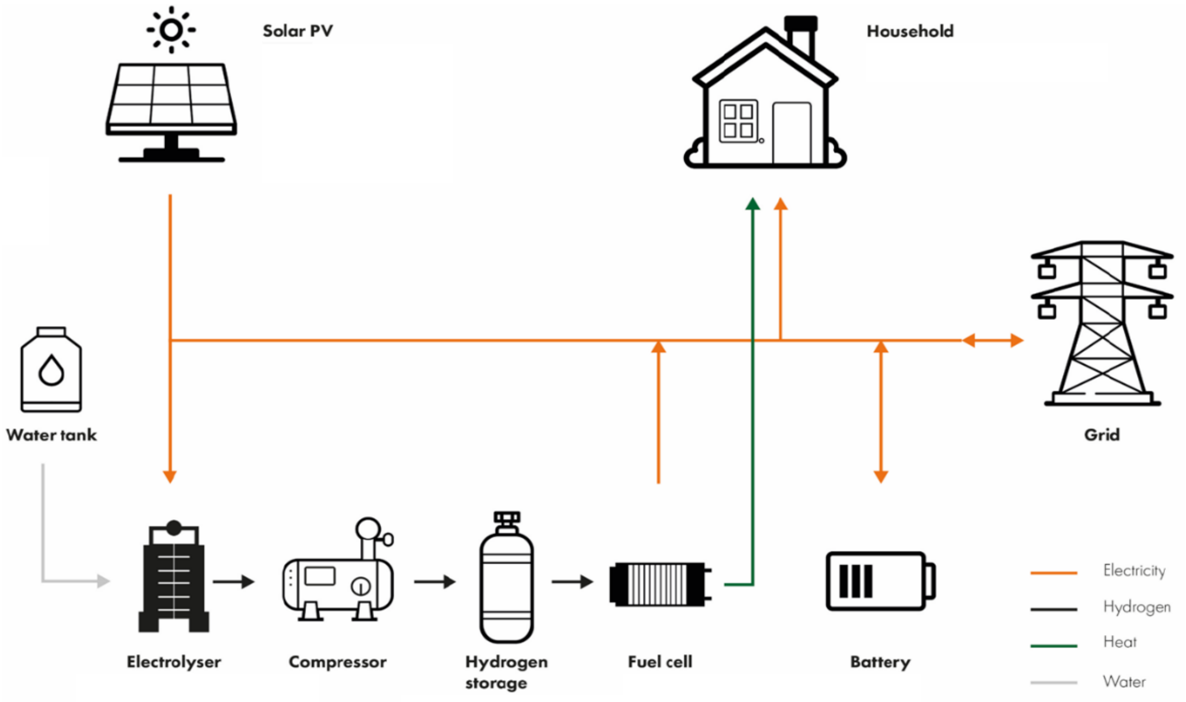

Fig. 1. System components of a household H_2 based storage system

References

Zhao, D., & Schäfer, A. I.: Hydrogen storage for stationary applications: Prospects and challenges. Renewable and Sustainable Energy Reviews, Vol. 104, 2019, pp. 185-196.

Zhu, Q. L., & Xu, Q.: Metal-organic framework composites for hydrogen storage. Journal of Materials Chemistry A, Vol. 3(17), 2015, pp. 8902-8918.

Liu, W., Yan, Y., & Cao, G.: Recent progress in hydrogen storage materials for fuel cell applications. Journal of Materials Chemistry A, Vol. 7(5), 2019, pp. 1975-1992.

MAIN BOTTLENECKS AND OPTIMIZING METHODS OF EXISTING OF SOLAR COOKING METHODS AND TECHNOLOGIES

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Cooking is a fundamental part of human being activity as food is one of the basic necessities for living. Commonly used sources of energy for cooking are firewood, crop residue, cow dung, kerosene, electricity, liquefied petroleum gas (LPG), biogas etc. Half of the world's population is exposed to indoor air pollution, mainly the result of burning solid fuels for cooking and heating. Wood cut for cooking purpose contributes to the 16 million hectares of forest destroyed annually in worldwide.

The World Health Organization (WHO) reports that in 23 countries 10% of deaths are due to just two environmental risk factors: unsafe water, including poor sanitation and hygiene; and indoor air pollution due to solid fuel usage for cooking. In under-developed countries, women have to walk 2 km/h on average and spend significant amount of time for collecting the firewood for cooking. The cooking energy demand in rural areas of developing countries is largely met with biofuels such as fuel wood, charcoal, agricultural residues, and dung cakes, whereas LPG or electricity is predominantly used in urban areas (Prasanna and Umanand, 2011).

Since cooking is integral part of each and every household, cooking with solar energy will reduce the large difference between supply and demand of energy in future. With increasing population and economic growth, utilization of solar energy is a must for sustainable living (Purohit et al., 2002).

Due to exponential raise in the world's population and resulting growth of industrial activities, the energy requirements are such that fossil fuel cannot be the only source on a sustainable basis. This implies that one has to look for alternate sources of energy which are more environmental friendly, cleaner and renewable. Existing cooking fuels are either derived from fossil fuels like LPG, kerosene etc. or air polluting like firewood, crop residue, and cow dung. Heat transport has been one of the most difficult and inefficient tasks in thermal energy management. In solar energy system a transportation of heat energy from storage to cooking place is often viewed as challenge due to lack of an effective heat transfer medium. It often results in costly heat transfer losses and reduced overall efficiencies of the solar cooking application. During the transportation of heat energy in solar cooking system enormous amount of heat is lost because of improper insulation and inadequate heat energy transportation system which is heat pipe. Significant heat lost in transfer over considerable distances.

Therefore, design of efficient solar energy transportation system from the storage to cooker based on numerical modeling and experimental test of high temperature heat pipe development has been attracting interest because using the stored solar energy effectively for cooking application minimizes energy wastage controversy.

In another way, the using of solar energy for cooking application have been alarmingly increased and widely accepted, since the method of solar energy transportation system and cooking efficiency should be updated and simplified.

Heat transport has been one of the most difficult and inefficient tasks in thermal energy management. In solar energy system a transportation of heat energy from storage to cooking place is often viewed as challenge due to lack of an effective heat transfer medium. It often results in costly heat transfer losses and reduced overall efficiencies of the solar cooking application. During the transportation of heat energy in solar cooking system enormous amount of heat is lost because of improper insulation and inadequate heat energy transportation system which is heat pipe. Significant heat lost in transfer over considerable distances.

Major challenge in solar energy transport is to bring heat energy obtained from the sun to the kitchen for cooking application. Energy transferred from solar insolation to the cooking load has to be optimized to maximize the overall efficiency. Here are some existing solar cooking technologies (Figs 1-3).

Fig. 1. Box type solar cooker

Fig. 2. Panel solar cooker

Fig. 3. Parabolic solar cooker

Acknowledgement

This work was supported by the Stipendium Hungaricum Programme and the Doctoral School of Mechanical Engineering, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Prasanna, U.R. and Umanand, L.: Modeling and design of a solar thermal system for hybrid cooking application. Applied Energy, Vol 88 No 5, 2011, 1740–1755.

https://doi.org/10.1016/j.apenergy.2010.11.042

Purohit, P.: Renewable energy technologies for domestic cooking in India: Estimation of CO_2 emissions mitigation potential. International Journal of Ambient Energy, Vol 23 No 3, 2002,127–135. https://doi.org/10.1080/01430750.2002.9674881

ARDUINO-BASED DATA LOGGER FOR SOLAR WATER HEATER SYSTEM

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There are two types of solar water heating systems (SWHS), active and passive SWHS. The difference between active and passive SWHS is how the water circulates between the tank/reservoir and solar collector. In the active SWHS, the pump is used to circulate between them, meanwhile, in the passive SWHS the principle is based on natural convection (Grofu & Cercel, 2019). A useful energy from the solar collector can be expressed as a measure of the amount of heat transferred to the fluid passing through it (Odigwe et al., 2013).

Temperature, pressure requirements, and heat transfer values are the most common parameters of each solar collector for analysis and evaluation (Wassima et al., 2019). The data collection can be quite expensive for the number of sensors and data loggers with their specifications. To get an affordable data logger, the objective of this study is to measure the parameters to be stored in an SD card based on the Arduino platform.

The parameters of SWHS being monitored are the inlet and outlet water temperature of the solar collector, the inlet and outlet water pressure of the solar collector, and the water flow rate throughout the solar collector. The predicted water operating temperature is not more than 80°C, while the predicted water operating pressure is not more than 2 bar. The flow rate is not more than 30 lpm because of the maximum capacity of the pump being used in the active SWHS.

The sensors and components used in this study are shown in the below Table.

Sensors & Components	Specifications	Qty
K-Type Thermocouple with MAX6675 Amplifier	Operating voltage range: 3.0 to 5.5 V Operating temperature range: -20 to 85 °C MAX6675 communicates with a microcontroller using SPI: 3 Digital Input (MISO, CS, CLK)	2
Pressure Tranducer	Working Voltage: 5.0 V DC Output Voltage: 0.5-4.5 V DC Working Current: <=10 mA Working Pressure Range: 0-1 MPa Working Temp. Range: 0-85 °C Communicates with a microcontroller using 1 Analog Input	2
YF-S201 Water Flow Sensor	Sensor Type: Hall effect Working Voltage: 5 to 18 V DC Output Type: 5 V TTL Working Flow Rate: 1 to 30 Liters/minute Working Temperature range: -25 °C to +80 °C Working Humidity Range: 35% - 80% RH Accuracy: 10% Maximum water pressure: 2.0 MPa Communicates with a microcontroller using 1 Interrupt Pin	1

RTC DS3231 Seri SN Real Time Clock I2C	Operating Temperature Ranges: 0 ^oC to +70 ^oC Accuracy 2ppm from 0 ^oC to +40 ^oC Accuracy 3.5ppm from -40 ^oC to +85 ^oC Operating voltage range: 3.3 V and 5 V Communicates with a microcontroller using: 3 Digital Pin (RST, DAT, CLK)	1
MicroSD Card Adapter	Operating voltage range: 4.5 V ~ 5.5 V, built-in 3.3 V Regulator Communicates with a microcontroller using SPI: (MISO, MOSI, SCK, CS)	1
LCD 2004 I2C LCD	Operating voltage: 5 V Communicates with a microcontroller using SCL, SDA	1

All components need 15 Digital I/O, 1 Interrupt Pin and 2 Analog Input. The Arduino UNO meet the needs of microcontroller for this data logger, with using 4 Analog Input as Digital Input.

Acknowledgements

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References

Grofu F. & Cercel C., (2019). Solar water heater system controller. Fiabilitate si Durabilitate - Fiability & Durability No 1/2019. Editura "Academica Brâncuşi", Târgu Jiu, ISSN 1844 – 640X

Odigwe, İ.A., Ologun, O.O., Olatokun, O., Ayokunle, A. A., Agbetuyi, A F. & Isaac, S.A. (2013). A Microcontroller-Based Active Solar Water Heating System for Domestic Applications. International Journal of Renewable Energy Research, 3 (4), 837-845. Retrieved from: https://dergipark.org.tr/en/pub/ijrer/issue/16077/168170

Wassima, Ait & Aggour, Mohammed & Ouhammou, Badr. (2019). Development of an inexpensive data logger for solar water heating system regulators. International Journal of Power Electronics and Drive Systems (IJPEDS). Retrieved from: http://doi.org/10.11591/ijpeds.v10.i2.pp753-767

COMPARATIVE ANALYSIS OF SINGLE PASS AND DOUBLE PASS SOLAR AIR COLLECTORS: AN EFFICIENCY ASSESSMENT

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Solar energy, harnessed from the sun's radiant light and heat, has emerged as a cornerstone in the pursuit of sustainable and renewable energy sources. It represents a clean, inexhaustible, and increasingly cost-effective alternative to fossil fuels (Machi *et al.*, 2022). In the context of growing environmental concerns and the urgent need for reducing greenhouse gas emissions, solar energy offers a viable solution for diverse energy needs (Kabeel *et al.*, 2016). This energy form is versatile, supporting varied applications ranging from residential power generation to large-scale solar farms. Crucially, innovations in solar energy technology are pivotal in addressing the challenges of climate change and energy security.

Among the innovative applications of solar energy is the development of solar air collectors, devices designed to convert solar energy into thermal energy by heating air. These collectors, vital for space heating, drying processes, and even in augmenting traditional heating systems, are a testament to the adaptability of solar technology in everyday applications. They are environmentally friendly, reduce dependence on conventional energy sources, and are increasingly considered cost-effective for heating needs.

This study focuses on conducting a comparative analysis between two types of solar air collectors: single-pass (SPSAC) and double-pass (DPSAC). Both collectors, identical in dimensions and materials, differ only in the number of passes the air makes through the system. The SPSAC allows air to pass once over the absorber plate. In contrast, the DPSAC facilitates a two-stage heating process, with air passing above and underneath the absorber plate. To achieve the research aim, the collectors were compared under several mass flow rates, providing insights into how these rates are influencing the efficiency. A detailed schematic view of the tested rigs, illustrating the differences between the SPSAC and DPSAC systems (see in Fig. 1).

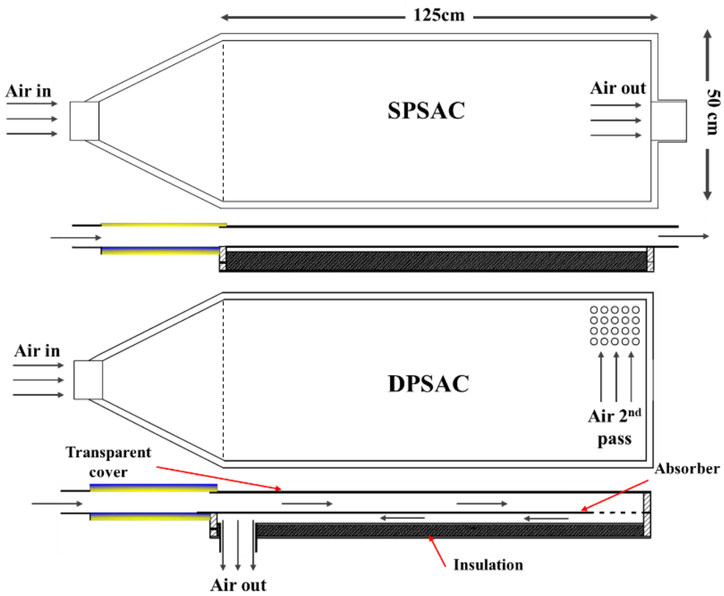

Fig. 1. Schematic view of the test rigs

The findings of the study highlighted distinct performance characteristics between the tested collectors. Notably, the DPSAC consistently achieved a higher outlet temperature than the SPSAC, regardless of the mass flow rate. This points to a more efficient heat transfer process in the double pass system. Additionally, the DPSAC exhibited a lower absorber plate temperature compared to the SPSAC. This observation is indicative of a more effective heat transfer rate in the double pass system. The larger heat exchange area provided by the double pass design allows for more efficient transfer of heat from the absorber plate to the air, resulting in lower plate temperatures and higher overall system efficiency.

In terms of thermal efficiency, the double pass system also surpassed the SPSAC. However, it's important to note that there was a considerable increase in pressure over the fan in the double pass collector compared to the single pass. This higher pressure signifies greater airflow resistance, a factor that needs to be considered in the design and application of these systems.

The obtained results reveal that DPSACs are more efficient than SPSACs. This higher efficiency is mainly due to better heat transfer and a larger area for heat exchange in the double pass design. These findings are important for improving solar air collector technology. They show how design changes can make solar energy use more effective and sustainable.

Acknowledgements

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References

Kabeel, A.E. et al. (2016): Investigation of the thermal performances of flat, finned, and v-corrugated plate solar air heaters, Journal of Solar Energy Engineering, Transactions of the ASME, 138(5), pp. 1–7. Available at: https://doi.org/10.1115/1.4034027

Machi, M.H. et al. (2022): Energy-based performance analysis of a double pass solar air collector integrated to triangular shaped fins’, International Journal of Energy and Environmental Engineering, 13(1), pp. 219–229. Available at: https://doi.org/10.1007/s40095-021-00422-z

RELEVANCE OF THE CHAIN-TYPE SUBSYSTEMS AT INVESTIGATING OF THE MICROSCOPIC STRUCTURE OF LAYER-TYPE SOLAR ELEMENTS

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As it is well-known, the problem of symmetry of incommensurately modulated crystals represents even nowadays one of the most interesting problems, not in the domain of the classical crystallography only, but in the domain of the whole condensed matter physics, too, including liquid crystals.

The basic problem is that the classical crystallographic symmetry descriptions cannot cover the factically existing (i.e. the experimentally proven) structure symmetries of such systems, which are e.g. nevertheless able to scatter X-rays, neutron sor electrons coherently. Some earlier studies about applications of the theory of line groups (which are the exact symmetries of the quasi-one-dimensional (*Q1D*) systems, and which have succesfully been applied in structural investigation of polymers for decades.

There are even nowadays very well-elaborated algorithms belonging to the group representations theory founded decades ago (Elliott and Dawber, 1977), but which are also very effective ones from the point of view of solving of the most accurate problems of the condensed matter physics necessary for treatment of the still unsolved scientific research problems in this area.

Moreover, such types of symmetry analysis methods have successfully demonstrated the usefulness of the finite chain-type systems, if we are interested spectroscopic investigation results in such types of the most complex condensed matter systems containing finite chain-type subsystems e.g. (Kirschner and Mészáros, 2001; Barros et al., 2006; Mészáros et al., 2019).

Finally, in the present study, application of projective representations of line groups will also be demonstrated for obtaining of selection rules relevant for collective elementary excitations at Raman-type scattering processes.

In order to realize this programme in detail, we start here from the basic group-theoretical relation relevant for analysis of possible quantum-mechanical transitions from given initial to allowed final states of atoms, molecules, crystals, because we think, that this seemingly very well-known symmetry method may give us promising absolutely new crucial analytical methods for very effective analyses of results emanating from the most accurate newest group theoretical algorithms.

References

Elliott J.P. - Dawber P.G.: Symmetry in Physics, Vol. I.-II., McMillan, London, 1979. Kirschner, I.; Meszaros, C.: Symmetry analysis of static soliton structures and elementary excitations in incommensurately modulated crystals, J. Phys. - Cond. Mat. 13 5399-5411., 13 (2001)

E.B. Barros, A. Jorio, G.G. Samsonidze, R.B. Capaz, A.G. Souza Filho, J. Mendes Filho, G. Dresselhaus, M.S. Dresselhaus (2006): Phys. Rep. 431 261-304

Meszaros, Cs.; Nikolenyi, I.; Balint, A.: Symmetry Analysis of Some Basic Structural Properties of Incommensurately Modulated Crystals by Projective Representations of Unimodular Groups. Phys. Status Solidi B-Basic Research 257: 3 Paper: 1900403 (2020), 7 p. 1900403

DESIGN OF LOW-SPEED GENERATOR USING PERMANENT MAGNET BONDED NdFeB AS

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Global energy consumption is increasing every year because of the human population growth, and this causes energy needs to also increase (Baratov & Pirmatov, 2020). Unfortunately, we will face a shortage of fossil fuels in the coming decades. The fossil sources, including oil, coal, and natural gas are non-renewable resources that formed when prehistoric plants and animals died and were gradually buried by layers of rock. Therefore, the availability of reserves and renewable energy is an important concern. Renewable energy is referred to as clean energy because comes from natural sources. The most popular renewable energy sources currently are; wind energy, solar energy, hydro energy, geothermal energy, and biomass energy.

Wind is one of the sources of electricity generation and become the cheapest energy source in the world(Vadi et al., 2020). Wind energy turns a turbine's blades, which feeds an electric generator and produces electricity. So that wind can be used as an energy source, it is necessary to design a generator that has optimal performance and is cheap to produce electrical energy (Irfan et al., 2020).

Designing and manufacturing of low-speed permanent magnet generators (PMG) for small-scale electric power plants (Idayanti et al., 2016) have been conducted using NdFeB bonded magnets made using commercial magnequench MQEP 16-7 magnetic powder was manufactured by Magnequench Int. Magnetic powder has been formed using a compaction machine with a pressure of 4 tons and heated at a temperature of 150-200 degrees Celsius for 2 hours. Bonded magnets produced by the compaction process and heated are then carried out axial flux magnetic alignment using the magnetizer machine Magnet Phisyk-Germany with an impulse system of 2500 Volt 20000 amperes which produces a magnetic flux density of 2 Tesla with a fixture coil used to produce a 2-pole magnet. Bonded magnets characterized their magnetic properties with permagraph Magnet Phisyk-Germany and Gauss meter Yokogawa.

The low-speed permanent magnet generator is designed as shown in figure 1 which consists of three rotors and two stators in figure 1(a) and details of one rotor attached to 12 magnets in figure 1(b).

The generator is designed to work at a certain rotation with the induced voltage generated can be calculated by the equation:

$$E_{rms} = \frac{E_{max}}{\sqrt{2}} = \frac{2\pi}{\sqrt{2}}\ x\ N\ x\ f\ x\ \Phi_{max}\ x\ \frac{N_s}{N_{ph}} \quad (1)$$

E_{rms} is the induced voltage (Volt), N Number of windings per coil, f frequency (Hz), ϕ_{max} flux magnet (Wb), N_s number of coil, N_{ph} number of coils per phase.

$$\Phi_{max} = A_{magn}\ x\ B_{max} \quad (2)$$

A_{magn}: magnetic flux area (m^2), B_{max}: maximum magnetic flux density (Wb/m^2).

$$A_{magn} = \frac{\pi\left(r_0^2 - r_i^2\right) - \tau_f\left(r_0 - r_1\right) N_m}{N_m} \quad (3)$$

r_0 = magnetic outer radius (m^2), r_i = magnetic inner radius (m^2), τ_f = distance between magnets (m) and N_m = number of magnets.

$$B_{max} = B_r \frac{L_m}{L_m + \delta} \quad (4)$$

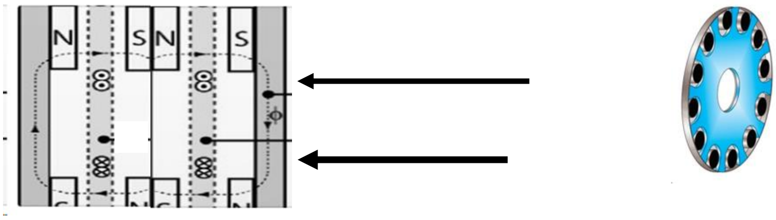
B_r = magnetic flux density (Wb/m^2)., L_m = magnetic length (m) and δ = stator-rotor distance (m).

$$f = \frac{n.p}{120} \quad (5)$$

f = frequency (Hz), n = number of rotations (rpm), and p = number of magnetic poles.

The generator system designed in Fig. 1 (a), on the stator installed 9 coils and each coil has 100 windings, while the rotor consists of 12 magnets facing each other between the 1st rotor, the 2nd rotor and 3rd rotor, the distance between the rotor and stator surface is 1mm.

Surface mounted type is selected as the rotor structure as all flux faces to stator winding and take a role in energy conversion.



(a) Generator system (b) Magnets rotor

Fig. 1. Design of low rpm permanent magnet generator

Acknowledgements

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References

Baratov, R., & Pirmatov, N. (2020). Low - speed generator with permanent magnets and additional windings in the rotor for small power wind plants and micro hydro power plants. *IOP Conference Series: Materials Science and Engineering*, *883*, 12183. https://doi.org/10.1088/1757-899X/883/1/012183

Idayanti, N., Dedi, Nanang, T. K., Sudrajat, Septiani, A., Mulyadi, D., & Irasari, P. (2016). The implementation of hybrid bonded permanent magnet on permanent magnet generator for renewable energy power plants. *2016 International Seminar on Intelligent Technology and Its Applications (ISITIA)*, 557–560. https://doi.org/10.1109/ISITIA.2016.7828720

Irfan, M., Ariyanto, R. F., Syafaah, L., Faruq, A., Nurhadi, & Subeki, N. (2020). Stator slotted design of axial flux permanent magnet generator for low-speed turbine. *IOP Conference Series: Materials Science and Engineering*, *821*(1), 12027. https://doi.org/10.1088/1757-899X/821/1/012027

Vadi, S., Gürbüz, F. B., Bayindir, R., & Hossain, E. (2020). Design and Simulation of a Grid Connected Wind Turbine with Permanent Magnet Synchronous Generator. *2020 8th International Conference on Smart Grid (IcSmartGrid)*, 169–175. https://api.semanticscholar.org/CorpusID:220735243

MAXIMIZING LARGE-SCALE PV INTEGRATION EMPLOYING ENABLING TECHNOLOGIES

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The expansion of large-scale photovoltaic (PV) installations has firmly established renewable energy as a key player in our pursuit of sustainability. However, the integration of PV into the energy landscape presents a multifaceted set of challenges, encompassing issues like intermittency, economic viability, and land requirements, particularly concerning large-scale PV systems. These challenges are rooted from the intermittent nature of solar power, which necessitates storage solutions to mitigate fluctuations and bolster the reliability of the power system. To address this, various enabling technologies have been proposed, including storage, complementarity, and power electronics, to facilitate the integration of large-scale renewables, especially PV.

Enabling technologies encompass both the physical infrastructure and the automation technology needed to support enhanced systems integration, data collection, resource dissemination, and efficient demand response. This holistic approach improves the functionality and efficiency of energy systems, ultimately fostering greater deployment and utilization of renewable energy. While enabling technologies themselves offer novel opportunities for renewable energy, there is a need to delve into additional considerations to promote broader PV system integration. These considerations span various technical, regulatory, and market aspects, all of which can unlock synergies between PV generation and various enabling technologies, leading to more optimized outcomes.

Enabling technologies bring a range of services and benefits to individual consumers, energy providers, and the energy system as a whole. They aid in balancing supply and demand, enhancing power grid stability, and providing backup energy during outages or shortages. Moreover, an important development has been the expansion of product options, increased coupling of storage with solar PV generation, and ongoing advancements in diverse storage technologies. As a result, multiple energy storage technologies, such as pumped storage, Li-ion batteries, flow batteries, flywheels, and hydrogen-based systems, are under development, each with distinct characteristics and control strategies vital for grid-scale implementation (IRENA, 2019).

To address intermittency, the combination of solar PV with wind power has gained prominence due to their capacity to smooth out fluctuations. However, the role of storage and curtailment remains pivotal in maximizing energy utilization and enabling higher penetration (Solomon et al., 2019). Despite the considerable research on large-scale PV integration, power quality aspects have received limited attention. Nevertheless, modern inverters, equipped with more flexible designs, hold potential solutions to various power quality issues and are expected to play a transformative role in meeting ambitious renewable energy targets (Blaabjerg et al., 2023). Notably, there is a gap in the existing literature concerning a comprehensive evaluation connecting large-scale renewable (PV) penetration, storage, curtailment, and power quality.

In light of these considerations, this abstract underscore the significance of addressing large-scale PV integration, with enabling technologies with specific focus on storage, curtailment, and complementarity. The combination of PV with wind power is a valuable strategy for mitigating intermittency, while storage and curtailment are essential for optimizing energy usage and facilitating higher penetration. We have developed a model that optimizes storage size to achieve substantial penetration with reasonable storage and curtailment at reduced balancing needs. Our findings indicate that a 90% penetration rate is attainable with reasonable storage and curtailment strategies, and the possibility of reaching 100% renewable penetration becomes evident based on our comprehensive data. In our future work, we will explore predictive analytics to enhance power quality and reliability by forecasting power generation characteristics.

Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

References

Blaabjerg, F. Yang, Y. Kim, K.A. and Rodriguez, J.: Power electronics technology for large-scale renewable energy generation, Proceedings of the IEEE, Vol. 111, No. 4, pp. 335–355, April 2023, doi: 10.1109/JPROC.2023.3253165.

International Renewable Energy Agency (IRENA), Enabling technologies: Innovation landscape. September 2019. https://www.irena.org/publications/2019/Sep/Enabling-Technologies

Solomon, A.A., Bogdanov, D. and Breyer, C.: Curtailment-storage-penetration nexus in the energy transition, Applied Energy, Vol. 235, No. November 2019, pp. 1351–1368, doi: 10.1016/j.apenergy.2018.11.069.

DESIGN AND MANUFACTURING OF A BIOMASS PYROLYSIS REACTOR TOBACCO STICKS CAPACITY 25-65 kg

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Using chemical pesticides to control plant pests causes many adverse effects, including environmental pollution and being dangerous for humans if pesticides attached to plants are consumed (Heri Wibowo, 2016).

Tobacco stems are part of the tobacco plant that are used as waste. However, tobacco stem waste has the potential as a pest exterminator in plants because it contains nicotine, saponins, flavonoids, and pyridine, all of which can be toxic to insects (Aswantini, 2008), (Abdi R, 2010) (Gondodiputro, 2017). Biomass in tobacco stems can be used as a pesticide by pyrolysis using a biomass reactor. Pyrolysis is a process of thermal decomposition of biomass involving rapid heating above 200 ℃ - 600 ℃ with conditions of minimal oxygen or no oxygen at all into gas, liquid, and solid, where hydrocarbon molecules from biomass are broken down into smaller hydrocarbon molecules (Chitti Y, 2013).

This research aims to design and manufacture a pyrolysis reactor to produce liquid smoke raw materials from tobacco stems with a tobacco stem capacity of 25-65 kg, and target pyrolysis reactor temperature range of 200 ℃ - 450 ℃. The description of Fig. 1 components are as follows: 1. Reactor Cover, 2. Reactor Tank, 3. Reactor Furnace, 4. Thermocouple, 5. Isolator.

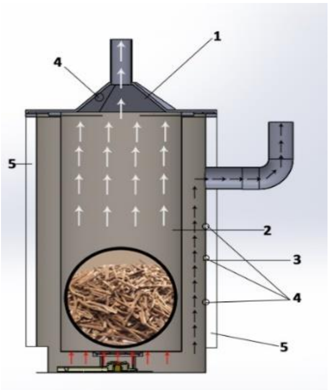

Fig. 1. Pyrolysis Reactor Schematic

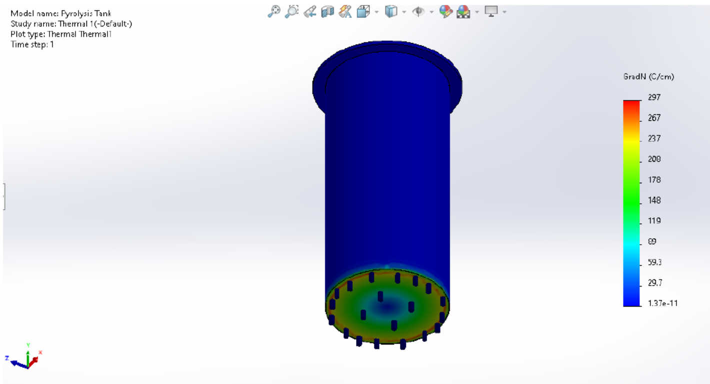

Fig. 2. Reactor Temperature Simulation

The type of reactor designed and made is a batch-type reactor because its operation is not continuous. The reactor designed and made has three main parts: the reactor lid, reactor tube, reactor furnace equipped with a combustion chimney, and a burner holder.

The reactor dimensions are 700 mm in diameter and 1200 mm high, using mild steel plate material with a thickness of 1.5 mm. This reactor tube has a diameter of 500 mm and a reactor height of 1110 mm, using mild steel plate material with a thickness of 1.5 mm. The reactor tube is the most crucial component, which functions as a place for the pyrolysis process of tobacco stems. Fig. 2. shows the results of the temperature simulation design, the maximum temperature is 499 ℃.

In the process of testing the function of the pyrolysis reactor, the tobacco stems are first chopped 5-8 cm before being put into the pyrolysis reactor and then heated in a closed reactor for a maximum of 6 hours.

The results of functional testing of the tobacco biomass pyrolysis reactor are that liquid smoke can be produced at pyrolysis temperatures around 200 ℃. At 30 to 60 minutes of reactor heating, the liquid smoke produced is white to brass. At 90-150 minutes of heating, it produces greenish liquid smoke; above 180 minutes, it produces brownish to blackish liquid smoke. The maximum temperature after heating for up to 6 hours is 224.8℃.

Acknowledgements

The short synopsis of this research is released as an outcome of a multidisciplinary international partnership between ITENAS Bandung, Indonesia, and MATE Gödöllő, Hungary.

References

Aswatini, Noveria Mita, Fitranita. (2008). Consumption of Vegetables and Fruit in the Community in the Context of Fulfilling Balanced Nutrition. Indonesian Population Journal, 3 (2), pp. 97-119.

Abdi. R. (2010). Flavonoids: Structure, Antioxidative Properties and Role in Biological Systems. Belian Journal, pp. 196-202.

Gondodiputro. (2017). Dangers of Tobacco and Forms of Tobacco Preparations. Bandung: Public Health Sciences, Faculty of Medicine, Padjadjaran University.

Heri Wibowo. (2016). The Activity of Liquid Smoke of Tobacco Stem Waste As An Insecticide on Spodoptera Litura Fabricius Larvae. Indonesian Journal of Plant Protection. Vol 20 no 1, pp. 22-27.

Chitti. Y., Kemiha. M. (2013). Thermal Conversation of Biomass Pyrolysis and Gasification: Review: International of Engineering Science (2), pp. 75-85

APPLICATION OF AGRIVOLTAIC: INITIAL DESIGN IMPLEMENTATION

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Indonesia is a tropical country that has 2 seasons, i.e., the rainy season and the dry season. Apart from that, Indonesia is a country that crosses the equator which makes Indonesia special compared to countries that are far from the equator, therefore the animals and plants can live well throughout the year because the sun continues to shine over the year.

Seasonal changes between the dry season and the rainy season will have an impact on soil moisture which will vary, therefore the plants can grow well throughout the year. It is necessary to regulate/control watering based on soil moisture. Based on the statement above, it is necessary to utilize unlimited solar energy (4.5 kW/m^2) by photovoltaic which is used to create a smart garden so that if the soil moisture is below the value expected by the plants, then the irrigation system for watering the plants can be controlled with input over time, such as morning, afternoon or evening. The schematic diagram of the photovoltaic support directly the plants is shown in Fig. 1. The soil moisture value sensed by the soil moisture sensor will be controlled using an Arduino or Programmable Logic Controller.

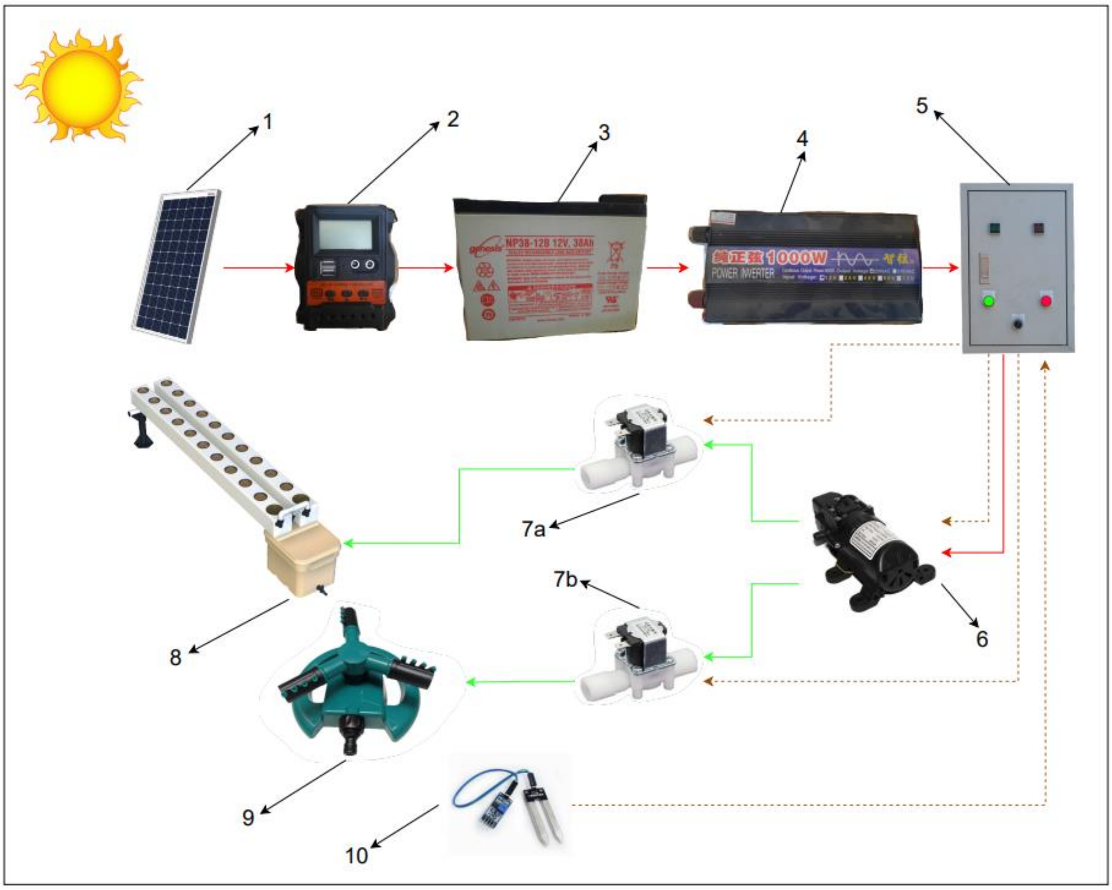

Fig. 1. The concept of agrivoltaic components

The schematic diagram of the soil moisture controller is shown in Fig. 2.

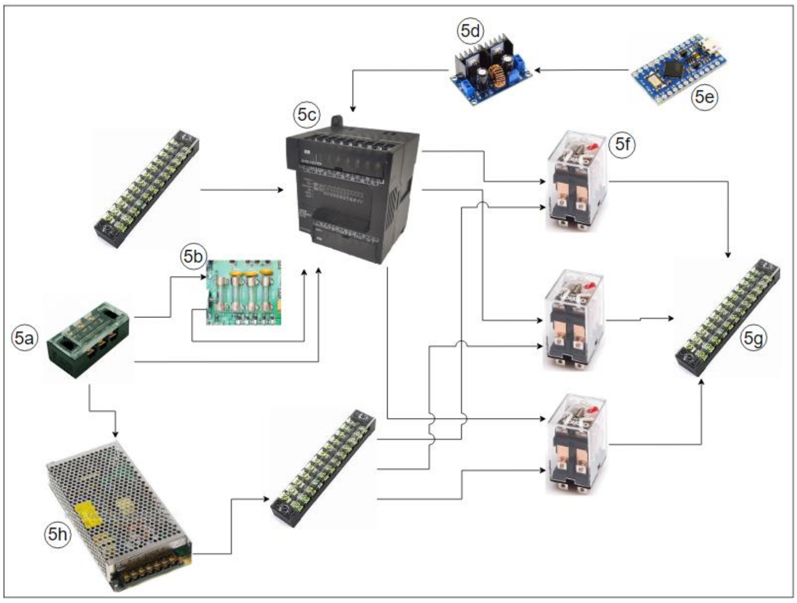

Fig 2. Soil moisture controller concept schematic

Figs. 1 and 2 image descriptions:

1. Photovoltaic
2. Solar Charge Controller
3. Battery
4. Inverter
5. Panel Box
    a. Terminal Block 3 Pole
    b. Fuse
    c. Programmable Logic Controller
    d. Transformer Step Down
    e. Arduino
    f. Relay
    g. Terminal Block 12 Pole
    h. Power Supply
6. Pump
7. Valve
8. Hydroponic
9. Sprinkler
10. Moisture Sensor

By utilizing the controls above, farmers' work will be easier and they will get the expected harvest results.

Acknowledgments

The short synopsis of this research is released as an outcome of a multidisciplinary international partnership between ITENAS Bandung, Indonesia and MATE Gödöllő, Hungary.

References

Özdemir, Cem. (2022), Agrivoltaics: Opportunities for Agriculture and the Energy Transition. Fraunhofer Institute for Solar Energy System ISE, Freiburg, Germany.

ORGANIC RANKINE CYCLE POWERED BY SOLAR COLLECTOR: EXPERIMENTAL SETUP PROGRESS

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The Organic Rankine Cycle (ORC) is the same as the conventional steam but uses the low boiling temperature of organic fluids instead of water. Various advantages of the ORC system are high efficiency, low turbine cost, compact size and the most important one is the environmental-friendly.

The main disadvantage of the ORC system is that a separate precaution to prevent the leakage and contamination of the organic fluid. Although ORC can generate electricity in low-range temperatures, it still needs heat resources from another system. There is a lot of heat resource in Hungary that can be combined with ORC among others is used solar thermal as a heat source.

Solar Thermal is one of many heat sources that can support the ORC system. The advantage of using solar thermal as a heat source when combine with an ORC system, it can provide affordable energy supplies in remote areas and is suitable in disaster territory. The amount of annual global horizontal irradiation for Indonesia is between 1314 to 2191 kWh/m^2, which makes it a relatively good site for installing solar thermal collectors (GHI, 2020). This makes it an ideal place for putting solar thermal collectors in conjunction with an ORC system.

Solar collectors and heat storage are the two primary subsystem components in solar thermal applications. A solar collector is the component in solar thermal applications that converts solar irradiation energy to heat energy via a working fluid; a good optical performance is required to absorb as much heat as feasible.

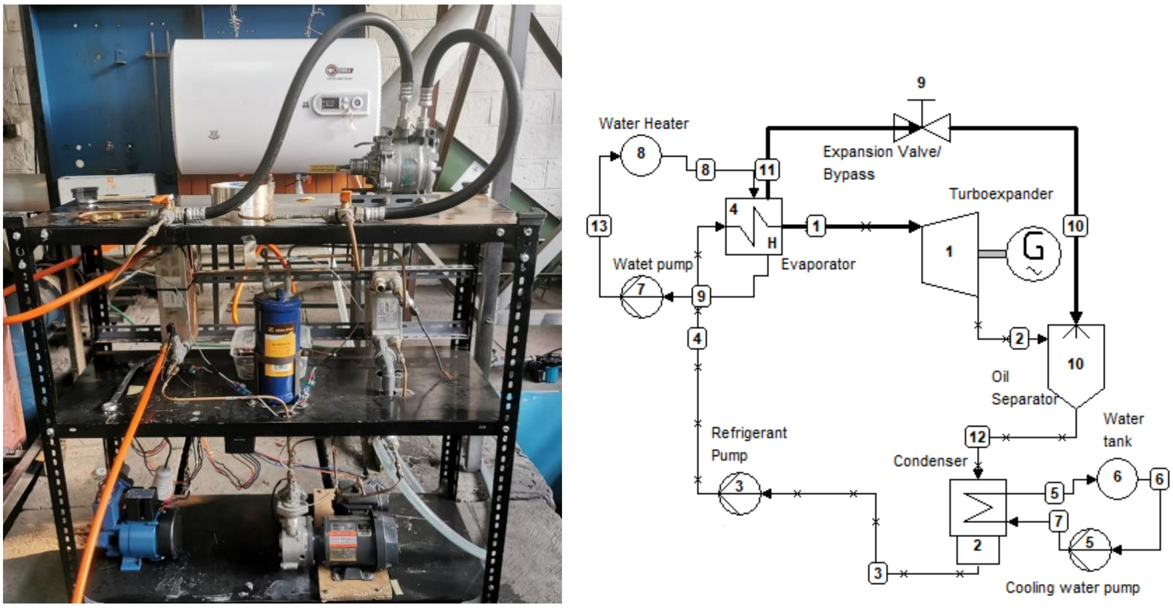

Fig. 1. Organic Rankine cycle: experimental setup (left), schematic setup (right)

The study reports the extent of the progress of solar-ORC research that has been carried out. Fig. 1 (left) is a prototype of the ORC experimental setup using a water heater as a heat source with a maximum temperature of up to 65-70 °C. Meanwhile, Fig. 1 (right) is a schematic of the ORC setup where there is the addition of a bypass and expansion valve to channel the working fluid without going through the turboexpander with the aim that the working fluid that will enter the turboexpander has reached the desired phase and properties.

Acknowledgements

This work was supported by the Stipendium Hungaricum Programme and by the Mechanical Engineering Doctoral School, Hungarian University of Agriculture and Life Science, Gödöllő, Hungary and the Department of Mechanical Engineering, Itenas Bandung, Indonesia.

References

Solargis. No Title. https://solargis.com/maps-and-gis-data/download/Indonesia. (Accessed 20 April 2022).

DESIGN AND REALIZATION OF A DUAL-AXIS SOLAR TRACKER FOR A GENERATOR SOLAR POWER PLANT BASED ON ARDUINO MICROCONTROLLER

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Dual axis Solar Tracker System (STS) is a tool used to control the angle of incidence of sunlight, and it should be perpendicular to the surface of the photovoltaic (PV). The STS uses 2 (two) axes in order to ensure that the incidence of sunlight is perpendicular to the PV's Surfaces, in terms of tilt and azimuth angles.

The purpose of this research is to design and realize a rig, that will be controlled by Arduino and is driven by a DC Low-Speed Gear Worm Box Motor, and the sensor is an amorphous solar cell. There are 4 (four) amorphous solar cells with specifications of 18.75 μW, and 2.4 Volt for 2 axes (Azimuth or Tilt Sensor) and each axis has 2 units amorphous or one pair. Other references informed that STS can improve the efficiency at a range of 24-39%, whereas the previous efficiency for fixed systems is at a range of 16% – 24%, especially for monocrystalline technology.

Referring to these efficiencies, it is found that when using STS, we just need 4.09% (maximum) of the total energy motor to drive a PV.

The challenges are to make a rigid rig, reliable mechanical system, reliable control system, and low cost of production. These issues can be solved using the equipment as illustrated in Fig. 1.

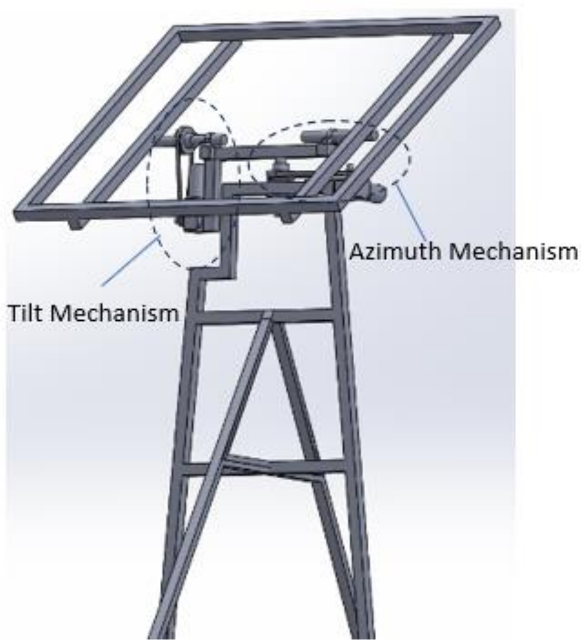

Fig. 1. The concept of rig of STS system

Mechanical Rig must use hollow with anti-corrosive paint protection and have good welding quality.

Mechanical systems must use gear transmission from stainless material or minimal transmission for Azimuth and Tilt from metal that is protected from corrosive environments or must be contained in a protective case that ensures that water does not enter when it rains.

Power control (solar charge controller), battery, inverter, and other electric equipment, the control system especially control component, motor driver, and other control equipment must be placed in a room with low humidity to protect them from the corrosive, as an effect of environment contact and its long-time operation. Moreover, the rig and control equipment should have a distance maximum of 4 meters, because their cables are resistant caused of the speed of the motor's problem.

Specifically for Arduino, the pin connection must have an interface between the male and female pin to protect it from bad contact, so the cable may not direct contact with the male/female Arduino’s pin.

For rural home power applications up to 4.000 Wp of photovoltaic, it can be installed in several rigs, the output electric power can be installed in parallel to maintain the output voltage, so that still use standard equipment on the market for easy spare parts and easy maintenance, so housing in rural areas has an independent electricity source without having to depend on the state electricity company (Off Grid).

Acknowledgments

The short synopsis of this research is released as an outcome of a multidisciplinary international partnership between ITENAS Bandung, Indonesia, and MATE Gödöllő, Hungary.

References

Albayumi, Usep. Thesis of Mechanical Engineering, Graduate Program, ITENAS 2023.

REVIEW ON UTILIZATION OF SOLAR ENERGY IN INDONESIA: NATIONAL TARGET, CURRENT STATUS AND RESEARCH ACTIVITIES

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Referring to the Indonesian government's renewable energy mix target, as stipulated in the National Electricity General Planning Document 2018-2037, the target share of renewable energy in Indonesia is 23% in 2025, and it can be supplied by available renewable energy resources in Indonesia: hydro, solar, wind, bioenergy, and geothermal energies. However, by the end of 2019, Indonesia's share of renewable energy was achieved only 9.2%.

The potential and realization of all the Indonesia's renewable energy resources can be found in Table 1.

Table 1. Indonesia renewable energy potential and realization

Renewable energy resource	Potential (GWp or GW)	Realization (GWp or GW)
Solar energy	207	0.1 (0.02%)
Geothermal	11	1,9 (0.4%)
Hydro, mini hydro, kacro hydro	75	5.8 (1.3%)
Wind energy	60	0.2 (0.03)
Bioenergy	32	1.9 (0.04%)

A lot of implementation and applied research activities are needed in order to accelerate the utilization of renewable energy, including solar energy utilization, especially in solar power plants (SPP).

Regarding the National program of SPP, the Cirata floating photovoltaic power plant located in Cirata Reservoir, West Java, with a capacity of 145 MW or 195 MW(p), was inaugurated on November 9, 2023, and actually this is a milestone for Indonesia, as furthermore this plant can be said as the largest floating solar power plant in Southeast Asia (previously the largest is the Tengeh floating solar power plant in Singapore (IESR, 2023). The situation of the Cirata floating photovoltaic power plant shows in Fig. 1. (NS Energy, 2023)

Fig. 1. Cirata floating photovoltaic power plant

Cirata floating photovoltaic power plant need a land area of 200 hectare. The system totally uses a smart grid concept, which combines smart power plant, smart transmission, smart distribution, and smart control system.

In the other side, research activities of solar energy at research institutes or universities, like Institut Teknologi Nasional Bandung (ITENAS Bandung) simultaneous was carried out, as a response to the global challenges in the environmental issue and depletion of conventional (fossil) energy (Rusirawan and Farkas, 2023)

At the ITENAS Bandung, research intensively in this field was enlarged since the collaboration with the Hungarian University of Agriculture and Life Sciences (MATE), Godollo campus. By 2018, ITENAS Bandung has operated a 1 kWp solar power plant (SPP), as a research facility for the PV thematic field. Until the present, some research work activities, for BSc & MSC students in ITENAS Bandung and PhD student in Gödöllő campus of MATE, have been implemented and can be summarized as follow:

- Modelling of the PV modules of the SPP by single and double diode model using Visual Basic for Application (VBA) Microsoft Excel and SIMULINK;
- Modelling of the PV modules characteristics using Fuzzy Time Series (FTS) Algorithm;
- Modelling of the PV modules using Seasonal Autoregressive Integrated Moving Average (SARIMA) Algorithm;
- Development of an SPP cooling system to increase the SPP performance;
- Modelling of the PV energy production using Machine Learning (Naive Bayes and Support Vector Machine Algorithms);
- Realization of a prototype Security System Based on IoT for village protection;
- Application of the PV and the Internet of Things (IoT) in the farming field;
- Application of solar energy in the Organic Rankine System;
- Development microprocessor-based of prototype solar tracker system;
- The feasibility study of substitution of the steam power plant to the solar power plant;
- Study and realization of agrivoltaics for the tropical climates.

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References

Institute for Essential Services Reform (IESR). Cirata Floating Solar PV Plant Ready to Operate: Important Milestone for Accelerating Solar Energy Development to Decarbonize Electricity in Indonesia. Available at: https://iesr.or.id/en/cirata-floating-solar-pv-plant-ready-to-operate-important-milestone-for-accelerating-solar-energy-development-to-decarbonize-electricity-in-indonesia, accessed on November 16, 2023.

D. Rusirawan, I. Farkas, Solar energy research activities at ITENAS Bandung. Book of abstract of BioPhys Spring 2023 – the 22nd International workshop for young scientist, Godollo, June 15-16, 2023, p. 59.

NS Energy. Masdar, PLN inaugurate Cirata floating solar plant in Indonesia. Availabale at: https://www.nsenergybusiness.com/news/masdar-pln-inaugurate-cirata-floating-solar-plant-in-indonesia/, accessed on November 16, 2023.

PERFORMANCE ANALYSIS OF HELICAL BAFFLE OF SHELL AND TUBE HEAT EXCHANGER USING HEAT TRANSFER RESEARCH INC WITH VARIATION ANGLE

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According to the Downstream Oil and Gas Regulatory Agency, national fuel consumption in Indonesia in 2018 increased from the previous year, 55 million kiloliters to 75 million kiloliters. The increase in fuel oil needs requires the petroleum processing industry to increase production so that fuel oil is sufficient. The increase in oil demands every year must be anticipated by taking appropriate efficiency in petroleum processing.

In this research, the problem occurs is the existing heat exchanger in the Catalytic Condensation Unit (CCU) in the petroleum processing industry does not work optimally where the temperature does not comply with industry process standards of 150 ^oC-180 ^oC. This will affect the subsequent process in the reactor, it does not react completely and the product results in the Catalytic Condensation Unit (CCU) will not be in accordance with production needs and affect the effectiveness of the entire unit.

The performance of the heat exchanger can be seen from the coefficient heat transfer and is characterized by an inappropriate output temperature, this may occur because the pressure drop and fouling are too high (Salahudin et al, 2015). Baffles are one of the basic components of shell and tube type heat exchangers (Fig. 1) which is a very important role in regulating the fluid in the shell (Ahmed et al, 2017). The type of baffle used can influence the pressure drop, fouling and heat transfer coefficient of a heat exchanger so that it can be one of the improvements (Jayachandriah et al, 2015).

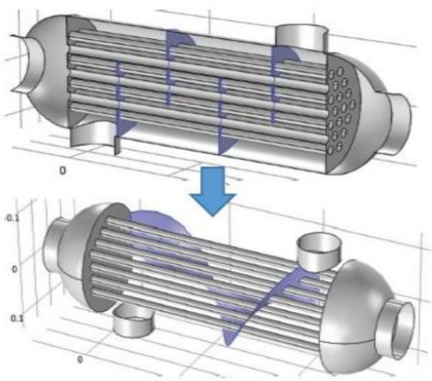

Fig. 1. Illustration of segmental baffles to helical baffle

Heat Transfer Research Inc (HTRI) software helps to see the performance of replacing segmental baffles with helical baffles with the aim of obtaining optimal heat transfer so that the output temperature can be achieved.

The use of helical baffles requires selecting the angle to get optimal results. The angle variations chosen include 3^o, 6^o, 9^o, 12^o, 15^o 18^o, and 21^o. Giving an angle depends on design needs, want to reduce pressure drop or increase effectiveness. The design required heat exchanger for the heating process is to increase effectiveness so that the problem of temperatures that do not comply with operating standards can be resolved, around 150 ^{o}C – 180 ^{o}C. This design can increase effectiveness, but still with the design requirements, that is shell pressure drop <2 psi or <13.7895 kPa so that the effectiveness value remains high and the shell pressure drop meets the requirements, and the most appropriate angle of 6^{o} is chosen. The values of the parameters are summarized in Fig.2.

No.	Parameter	*Segmental*	*Helical*	Satuan
1.	Laju Alir *Steam*	1.384	1.384	kg/s
2.	Temperatur Keluaran Butana	132.53	178.95	°C
3.	Temperatur Keluaran *Steam*	225	156.63	°C
4.	Sudut *helical*	0	6	Derajat
5.	Koefisien Perpindahan Panas Bersih Keseluruhan (Uc)	227.83	314.16	W/m^2K
6.	Koefisien Perpindahan Panas Desain keseluruhan (Ud)	78.92	305.78	W/m^2K
7.	Faktor Kekotoran (Rd)	0.0083	0.000087	m^2K/W
8.	ϵ (bersih tanpa *fouling*)	0.68	0.74	-
9.	ϵ (dengan *fouling*)	0.42	0.72	-
10.	*Pressure Drop shell*	4.91/33.9	1.38/9.53	psi/kPa
11.	*Pressure Drop tube*	1.7/11.75	0.73/5.03	psi/kPa

Fig. 2. Comparison simulation segmental baffles and helical baffle

The use of a helical baffle with an angle of 6^{o} produces a temperature output of 178.95 ^{o}C, an effectiveness value that increases from 0.68 to 0.74, an overall heat transfer coefficient of 314.16 W/m^2K and a shell pressure drop of 1.38 psi or 9.53 kPa.

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References

U. Salahuddin et al. A review of the advancements made in helical baffles used in shell and tube heat exchangers. International Communications in Heat and Mass Transfer 67 (2015) 104–108, https://doi.org/10.1016/j.icheatmasstransfer.2015.07.005

Jayachandriah, D.B. and V. Vinay Kumar, Design of Helical Baffle in Shell and Tube Heat Exchanger and Comparing with Segmental Baffle Using Kern Method. International Journal of Emerging Technology in Computer Science and Electronics (IJETCSE) ISSN: 0976-1353 Volume 13 Issue 2 – MARCH 2015.

Ahmed, Asif, Iman Ul Ferdous, Sumon Saha, Comparison of Performance of Shell- and - Tube Heat Exchangers with Conventional Segmental Baffles and Continuous Helical Baffle AIP Conference Proceedings 1851, 020066 (2017), DOI:10.1063/1.4984695

USE OF PV FOR DOMESTIC PURPOSES, GARDENING AND AGRICULTURE

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A huge amount of PV systems have been installed during the last years also in relation with the observed climate change. Small private households with some kWp up to larger PV plants with up to 100 kWp or more have emerged during the last years.

The present study deals with the use of PV systems in private households up to larger farms. We first look at the energy consumption of several different electrical devices and the suitable PV systems for operation. In a second step the combination between PV system installation and agriculture is investigated.

Table 1 and 2 show the consumption of different devices and what is possible as a function of energy yield.

Table 1: Rough estimation of possible operation of different electrical devices as a function of the PV system (clear sky day, summer around noon). (X = Total coverage of energy requirements possible at midday, summer, without clouds)

Electrical device with typical power consumption in W	Balcony power plant 0.8 kWp	Roof PV 5 kWp	Agri_PV 100 kWp
LED lamp (1-9 W)	X	X	X
Normal light bulb (75 W)	X	X	X
Personal computer (70 W)	X	X	X
Hedge trimmer (70 W)	X	X	X
Electrical irrigation system with pump (20-70 W)	X	X	X
TV set (100 W)	X	X	X
Lawnmover (144 W)	X	X	X
Refrigerator (80-150 W)	X	X	X
e-heating (300 – 2000 W)		X	X
Hair blower (2300 W)		X	X
Washing machine (1500 – 3000 W)		X	X

Table 2: Possible operation of electrical device as a function of PV system for devices with battery

Electrical device with typical power consumption in W	Balcony power plant 0.8 kWp	Roof PV 5 kWp	Agri PV 100 kWp
Lights for garden (5-150 W)	X	X	X
Motor 12 V with max 18 (approx. 200 W)	X	X	X
e-scooter (250 W)	X	X	X
E tractor (1000000 W)			X

Table 1 shows the electrical devices that may be operated using the yield of the various PV systems. We see that a balcony power plant may be used to operate most of the instruments used for gardening. Devices with battery up to e scooters may be fed with the self-produced electricity. Charging may take longer for PV systems with a smaller energy yield.

Balcony power plants will have their limits with larger devices like washing machine or even hair blowers.

Whereas larger PV plants may even be used to feed larger machines, at the same time the surface below the panels may be used for growing plants.

The agri PV power plants have much more potential regarding the production of electricity and supply and operation of agricultural machinery.

Different geometrical configurations of the PV plants were simulated for 3 crops in order to analyse the impact on incident solar radiation and the resulting decrease in crop yield. We found for maize and spring barley the largest decrease in yield which was on average for a 10-year period between 5 and 30%. For winter wheat the reduction in yield was much lower with reduction between 2 and 13% as a function of the respective geometrical configurations of the PV systems

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EVALUATING INDIRECT SOLAR DRYING SYSTEM COMPONENT PERFORMANCE USING CFD MODELLING METHODS

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Solar drying system is a system that uses solar energy to evaporate water from high humidity items, thereby drying them. The systems typically include solar collectors, chimney, fans or ventilation systems, and drying chambers.

Solar air collector, drying chamber and chimney are important components of the drying system. Solar air collector absorbs solar radiation energy and supplies it to the system to dry items. Different absorbing plates have different abilities to absorb solar radiation. The amount of energy absorbed and its efficiency will affect the efficiency of the drying system.

Drying chamber is used to place the items to be dried. The number and shape of the drying chamber will affect the efficiency of drying the items. The chimney is used to discharge gas, accelerate the flow rate of gas in the system, the length of the chimney height and internal structure will affect the flow rate and thus the efficiency of the system.

Computational fluid dynamics (CFD) is a powerful and state-of-the-art numerical method for solving controlled partial differential equations for conservation of mass, momentum and energy in fluid flow and heat and mass transfer problems. In drying systems, the use of CFD analysis methods is gradually increasing in the evaluation of drying performance, the analysis of wind speed and humidity distribution, the evaluation of heat and mass transfer values in the drying process, and the design of drying systems (Daş et al., 2021).

CFD analysis methods generally have three processes, pre-processing, processing and post-processing. Pre-processing is mainly a series of preparation work and preprocessing steps that need to be carried out before numerical simulation. The main purpose of these steps is to ensure the accuracy, stability and validity of the numerical simulation. The main role of the processing stage is to simulate fluid flow and heat transfer phenomena using numerical methods to obtain information about the behavior and properties of the fluid system. Post-processing is the process of analyzing and visualizing simulation results. The main steps as shown in Fig. 1.

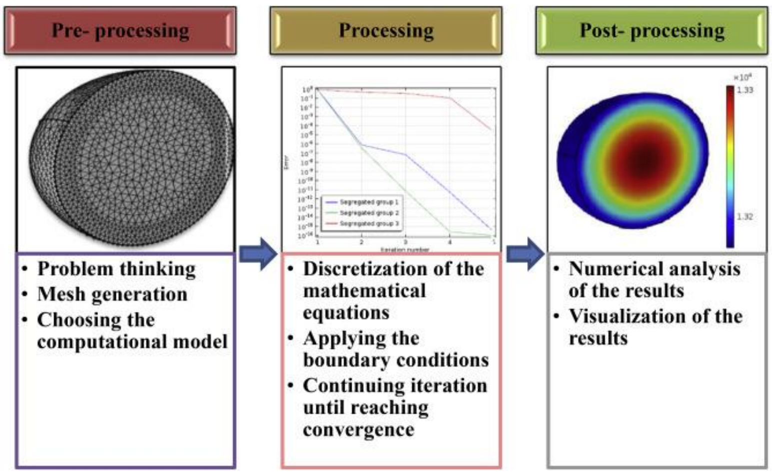

Fig. 1. Main steps of CFD analysis (Malekjani and Jafari, 2018)

In CFD simulation, the general basic steps are set up the geometry, meshing, choose material properties and apply the boundary conditions, solve fluid and heat transfer equations and grid independence test. The impact of changes in solar air collectors, chambers and chimney on the drying efficiency of the system is studied through air flow analysis, heat transfer analysis, mass transfer analysis and multi-physics coupling analysis of the drying system (Avargani et al., 2023).

Relevant literature shows that solar air collectors, drying chambers and chimney all affect the efficiency of the drying system to a certain extent. The purpose of this study is to study the impact of solar collector absorption surface, cavity shape, chimney length and internal structural changes on the efficiency of the entire drying system through CFD simulation. Confirm the impact of each component on the efficiency of the entire drying system, and maximize the efficiency of the solar drying system by adjusting the component combination.

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References

Daş, M., Alıç, E. Akpinar, E.K. (2021). Numerical and experimental analysis of heat and mass transfer in the drying process of the solar drying system. Engineering Science and Technology, an International Journal, 24(1), 236-246.

Malekjani, N., Jafari, S.M. (2018). Simulation of food drying processes by Computational Fluid Dynamics (CFD); recent advances and approaches. Trends in food science & technology, 78, 206-223.

Avargani, V.M., Maarof, H.A., Zendehboudi, S. (2023). Multiphysics CFD modeling to assess performance of a perforated multi-plate indirect solar dryer with a V-corrugated absorber surface. Applied Thermal Engineering, 227, 120387.

THE LIMITATIONS OF THE APPLICATION OF RESIDENTIAL BALCONY SOLAR MODULES IN AUSTRIA AND HUNGARY

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In the 21st century, growing interest in sustainable energy sources and the challenges of global climate change are driving the international community to transform the energy sector. The European Union (EU) is committed to promoting renewable energy sources in order to reduce environmental pressures and diversify energy production. The EU's efforts to reduce its dependence on countries exporting energy have created additional incentives for the research, development and deployment of renewable energy sources. Among renewable energy sources, solar energy is of paramount importance due to its highly diverse radiation potential in the EU. The exploitation of solar energy has become more efficient in recent years due to the development of solar cell technology (Costoya et al., 2022; Yang et al., 2022).

Among photovoltaic (PV) systems, balcony solar modules represent another step in integrating renewable energy sources and increasing energy efficiency, especially in urbanized areas. A balcony PV system consists of a photovoltaic module or modules with a rated power of up to 800 W today. The essence of the concept is that the photovoltaic utilization of solar energy can be achieved with the help of easy-to-install PV modules installed on the balconies or facades of city apartments and buildings. The advantages of using balcony solar modules are twofold:

- First, due to the lack of free space in urban areas, building surfaces, including balconies and facades, have significant potential for solar energy generation. The design and sizing of balcony PV modules allow urban buildings to be widely involved the utilization of renewable energy sources, thus contributing to achieving the EU's sustainable energy production targets.
- Secondly, the practicality and easy mounting of balcony solar modules to existing buildings leads to significant cost savings. The need to renovate or transform buildings is minimal, as balcony PV modules utilize the external structures of buildings to collect solar energy. This modular solution not only reduces installation costs, but also increases the decentralized nature of energy production, which contributes to the stability of the energy sector (Behmann et al., 2023; Bögel et al., 2023; Zsiborács et al., 2023).

This research focuses on balcony solar cell technology, with special regard to the Austrian and Hungarian populations. This work examines balcony PV systems with a nominal output of 640 W. There is currently no comparative scientific research available for the two countries that determines the annual potential of balcony PV systems in terms of direct PV energy use, therefore this type of research is of great importance for understanding the optimal energy application of balcony PV systems.

Based on the research results, it can be concluded that the use of balcony solar modules can achieve significant electricity savings, which is of paramount importance for the spread of the use of sustainable energy sources and the reduction of environmental loads.

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References

Behmann, R., Phan, J., Root, A., Schmidt, M., & Bessler, W. G. (2023). Integration of a lithium-ion battery in a micro-photovoltaic system: Passive versus active coupling architectures. Solar Energy, 262, 111748. https://doi.org/10.1016/J.SOLENER.2023.05.025

Bögel, P.M., Trenks, H., Upham, P., Sauter, H., Albiez, M., Stelzer, V., & Laborgne, P. (2023). Diversifying power in action: A socio-psychological approach to inclusive energy transition experiments. Energy Research & Social Science, 100, 103070. https://doi.org/10.1016/J.ERSS.2023.103070

Costoya, X., deCastro, M., Carvalho, D., Arguilé-Pérez, B., & Gómez-Gesteira, M. (2022). Combining offshore wind and solar photovoltaic energy to stabilize energy supply under climate change scenarios: A case study on the western Iberian Peninsula. Renewable and Sustainable Energy Reviews, 157, 112037. https://doi.org/10.1016/J.RSER.2021.112037

Yang, Y., Javanroodi, K., & Nik, V.M. (2022). Climate Change and Renewable Energy Generation in Europe—Long-Term Impact Assessment on Solar and Wind Energy Using High-Resolution Future Climate Data and Considering Climate Uncertainties. Energies 2022, Vol. 15, Page 302, 15(1), 302. https://doi.org/10.3390/EN15010302

Zsiborács, H., Vincze, A., Pintér, G., & Hegedűsné Baranyai, N. (2023). A Comparative Examination of the Electricity Saving Potentials of Direct Residential PV Energy Use in European Countries. Sustainability 2023, Vol. 15, Page 6490, 15(8), 6490. https://doi.org/10.3390/SU15086490

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