HUNGARIAN UNIVERSITY OF
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31st Workshop on Energy and Environment

December 11-12, 2025, Gödöllő, Hungary

Book of Abstracts

Editors: István Farkas
Piroska Víg

Gödöllő, 2025

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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.

The deadline of the two pages abstract submission: November 7, 2025

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PASSIVE GEOTHERMAL COOLING OF UNDERGROUND GARAGES: FIELD STUDY AND THERMAL ANALYSIS

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In hot-climate cities like Baghdad, the growing demand for vertical housing developments has intensified pressure on land availability and increased the need for efficient building solutions. Traditional open parking areas expose vehicles and users to extreme temperatures, reaching up to 60 °C during summer months, which leads to increased fuel consumption, faster material degradation, and thermal discomfort (Ali et al., 2016).

Embedding parking structures underground represents an innovative architectural and environmental solution that not only optimizes land use but also exploits the natural thermal stability of the soil. This approach aligns with sustainable design strategies by reducing energy demand, improving microclimatic comfort, and enhancing urban aesthetics (Ali et al., 2024) (Alshibil et al., 2025).

The study was conducted on a recently implemented underground parking system beneath a high-rise residential complex in Baghdad. The garage was fully enclosed beneath the ground level, with natural soil acting as a thermal buffer.

Field temperature measurements were recorded monthly throughout one full year, capturing both outdoor ambient temperature and underground garage air temperature. Data were analysed to assess the magnitude of thermal moderation provided by the subsurface environment.

A comparative analysis was then performed to evaluate the potential reduction in vehicle-related energy consumption, maintenance needs, and the overall contribution to sustainable building performance.

The measurements revealed a consistent difference between outdoor and underground temperatures throughout the year (Fig. 1). While outdoor air temperature fluctuated widely between 8 °C and 41 °C, the underground garage maintained a relatively stable range between 20 °C and 31 °C, demonstrating strong thermal damping due to soil–air heat exchange.

These findings confirm that underground parking spaces can maintain indoor conditions up to 15–20 °C cooler than outdoor levels during peak summer, which directly reduces vehicle cooling load and indirectly lowers fuel consumption.

Moreover, this approach enables efficient land utilization – critical in high-cost areas where land prices reach approximately 22,000 USD/m² – and provides 2,992 parking spaces that would otherwise require substantial surface area. Despite a construction cost of around 1,000 USD per parking unit, the economic advantage is evident compared to the high land value and the long-term energy savings achieved.

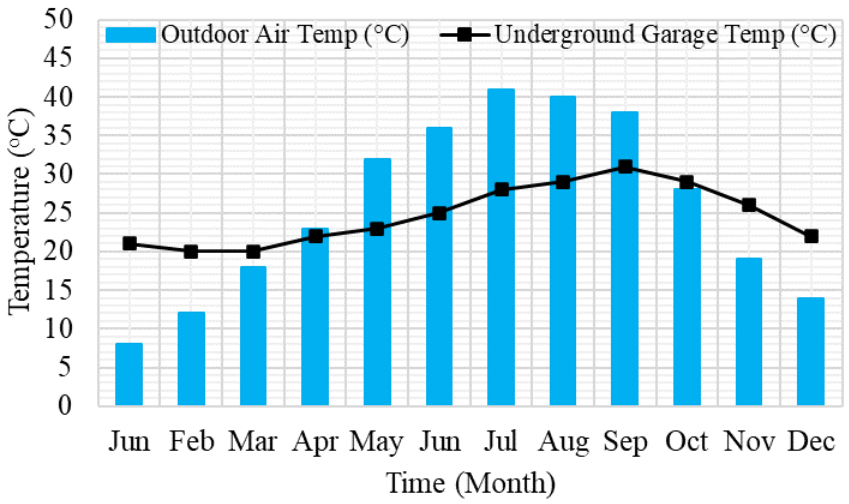

Fig. 1. The soil temperature at various depths at Al-Najaf location.

The study demonstrates that integrating underground parking beneath residential buildings represents a viable passive geothermal cooling solution in hot-arid regions. It contributes to sustainability by:

- Reducing surface heat exposure and vehicle energy demand.
- Enhancing user comfort and microclimate conditions.
- Maximizing land efficiency in dense urban developments.
- Supporting energy conservation goals through natural thermal regulation.

Future work will involve computational modelling of soil–air heat transfer mechanisms and parametric optimization to explore the influence of soil type, depth, and ventilation design on overall cooling performance.

This approach offers a promising direction for architects and engineers seeking low-energy, climate-adaptive solutions in urban environments of the Middle East and similar climatic regions.

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THERMAL EFFECT OF PASSIVE COMPONENTS ON THE PHOTOVOLTAIC MODULE

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Solar energy is a renewable energy source that can be converted into electricity through photovoltaic (PV) technology. Photovoltaic modules (PV module) serve as the main devices that convert solar radiation into electrical energy and are a key component in solar power generation systems. Indonesia's strategic location near the equator provides high and relatively stable solar irradiance throughout the year, making PV utilization highly potential. However, PV modules often experience performance degradation, one of which is caused by excessive thermal effects on passive components.

This study aims to analyze the thermal effects occurring in passive components of the PV modules (included the PV module structure) and their impact on photovoltaic efficiency. To conduct this analysis, DHT22 sensors, temperature sensors, and type-K thermocouples are used to measure temperature variations on passive components. The results of this study are expected to determine the maximum thermal threshold that can influence PV module performance and support efforts to minimize thermal effects in passive components. The structure of the PV module is shown in Fig. 1.

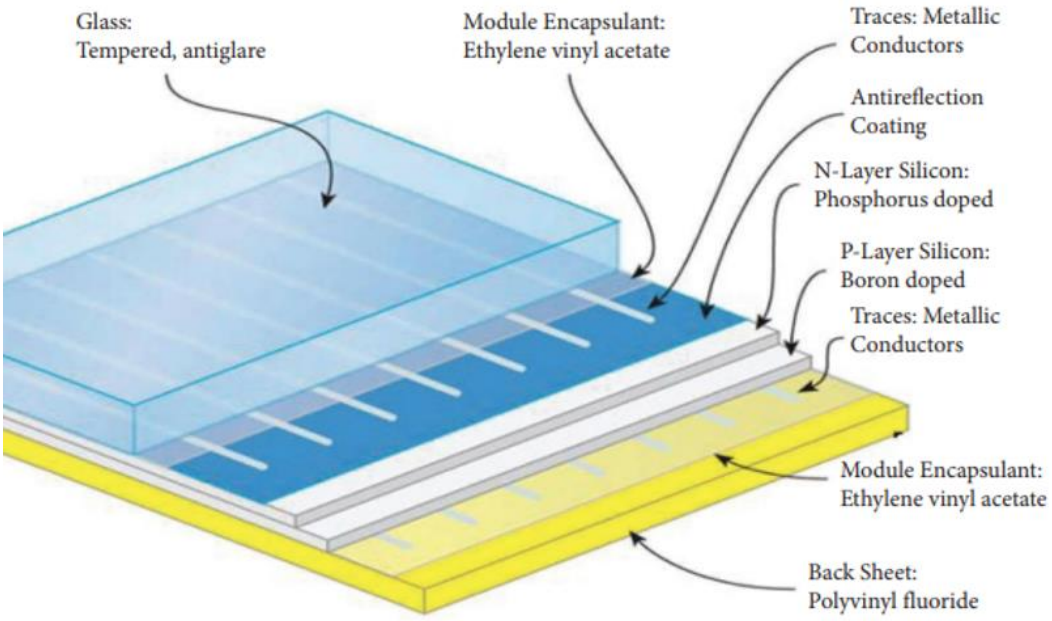

Fig. 1. Basic sturcture of PV module

The basic structure of a photovoltaic module (solar module) consists of several layers that function to protect and support the solar cells to work optimally. There is only 1 active layer, namely the P-N silicon layer (photovoltaic cell) which produces electricity through the photovoltaic effect. While the other layers are passive (Wenham et al., 2007).

In other side, the frame/structure PV module typically made of anodized steel, is a crucial component of a photovoltaic module. Despite its apparent simplicity, the frame serves many crucial technical functions. While seemingly simple, the frame serves many crucial technical functions. The frame is a passive component that can conduct heat to other components.

A 1 kWp PV module at ITENAS Bandung will be used as an object of this research, and the actual installation of the PV module can be seen at Fig. 2.

Fig. 1. The frame structure of PV module at ITENAS Bandung

Acknowledgments

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THERMAL MANAGEMENT INSIGHTS INTO HYBRID SOLAR MODULES TOWARD ENHANCED SUSTAINABILITY

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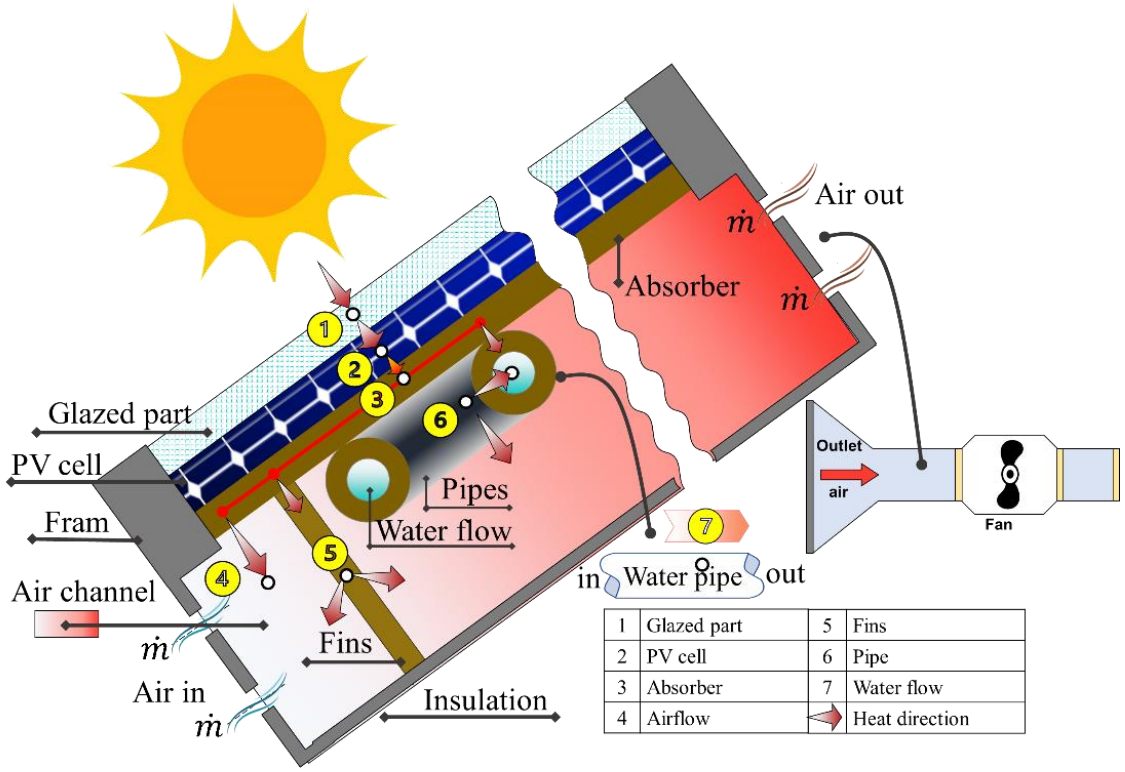
Sustainability is a critical factor in the design of net-zero energy buildings, where energy efficiency and environmental impact are key indicators. Conventional photovoltaic (PV) modules convert only 15-20% of incident solar energy into electricity, with the remaining 80-85% released as an emitted heat to the surroundings (Ali et al., 2023). This excess heat not only reduces electrical efficiency but also negatively influences environmental sustainability by contributing to local warming (Alshibil et al., 2021, 2024).

Hybrid photovoltaic/thermal (PV/T) modules offer a practical solution to improve sustainability by harnessing the otherwise emitted heat for useful applications, such as space heating and hot water production (Ali et al., 2025; Ashibil et al., 2024). This study experimentally assessed a bi-fluid PV/T module using water and air as simultaneous working fluids to extract and utilize generated heat, comparing it with a standalone PV module.

The experimental setup included two polycrystalline PV modules: a conventional PV module and the other was equipped with a finned copper absorber, serpentine water tubing, and an air duct. Data on solar cell surface temperature, emitted heat, thermal and electrical outputs, were collected over a clear summer day at the Hungarian University of Agriculture and Life Sciences solar lab.



Results indicated a substantial improvement in sustainability metrics for the bi-fluid PV/T module. The surface temperature of PV cells decreased by 30%, directly reducing heat loss to the environment. Consequently, the amount of emitted heat dropped by 77% compared to the conventional PV module.

The Sustainability Index (SI), derived from PV/T efficiencies to quantify environmental performance, further highlighted the advantages of the hybrid system. The bi-fluid PV/T module achieved an SI value of about 1.6, indicating a higher contribution to sustainable energy use, while the PV module recorded values of about 1.06.

In conclusion, the experimental findings confirm that the bi-fluid PV/T module significantly enhances sustainability compared with conventional PV systems. By reducing emitted heat, improving efficiency, and providing usable thermal energy, hybrid PV/T collectors can play a pivotal role in promoting environmentally responsible and energy-efficient solutions. Future studies should explore integrating these modules into building designs and assessing economic feasibility to support widespread adoption.

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COMPARATIVE EVALUATION OF ANN, CNN, AND ANFIS MODELS FOR SHORT-TERM PHOTOVOLTAIC POWER FORECASTING

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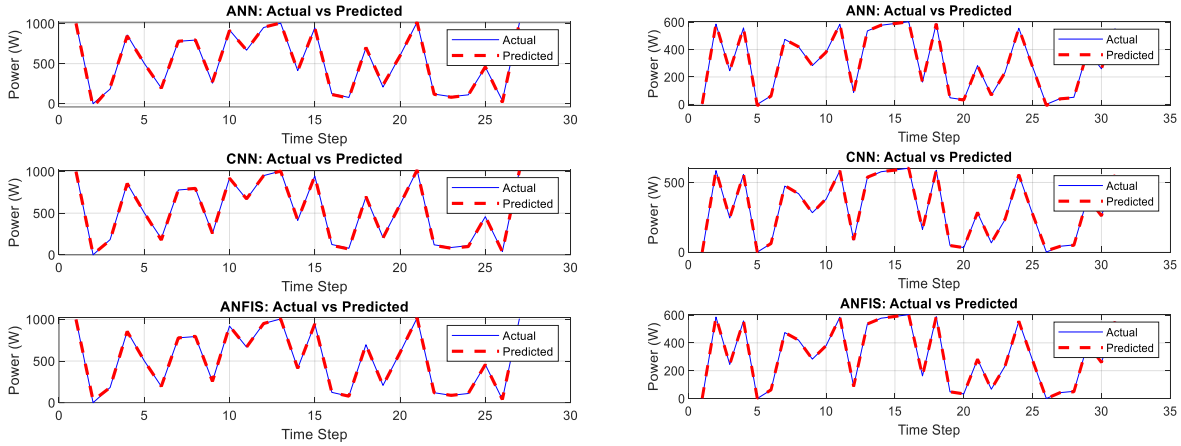
Artificial Neural Networks (ANNs), particularly MLP and LSTM variants, are recognized for their flexibility and effectiveness in time-series forecasting of PV/irradiance, especially when provided with tabular meteorological data. LSTM networks are adept at handling temporal dependencies. However, ANNs have limitations in capturing spatial features (Assaf et al., 2023). Convolutional Neural Networks (CNNs) excel at extracting spatial information from images, making them suitable for short-term irradiance/PV output nowcasting, and are often integrated with LSTMs to capture both spatial and temporal structures. CNNs require substantial data and computational resources, and are most effective in cloud-driven climates (Salameh et al., 2025). Adaptive Neuro-Fuzzy Inference Systems (ANFIS) combine fuzzy logic with neural learning, performing well in nonlinear relationships and noisy environments. ANFIS can outperform ANNs in small-data scenarios but face challenges in scaling and hyperparameter tuning (Akiner & Ghasri, 2024).

The aim of this research is to is to identify the best deep learning model for photovoltaic power prediction. Two tropical regions Stuttgart (cold) and Kabul (hot), are examined for photovoltaic (PV) power output predictions using ANN, CNN, and ANFIS models. The following figure shows that predicted values closely match actual measurements, reflecting strong model accuracy.

High overlap between predicted and actual curves indicates effective capture of short-term variability and nonlinear behaviours. All models provide stable predictions across all regions.



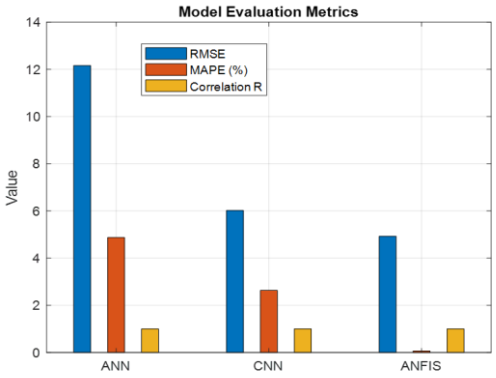
Hot climate Cold climate

The figure presents performance metrics Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and correlation coefficient (R) for the ANN, CNN, and ANFIS models. All three models demonstrate high predictive accuracy, though their precision and generalization abilities differ.

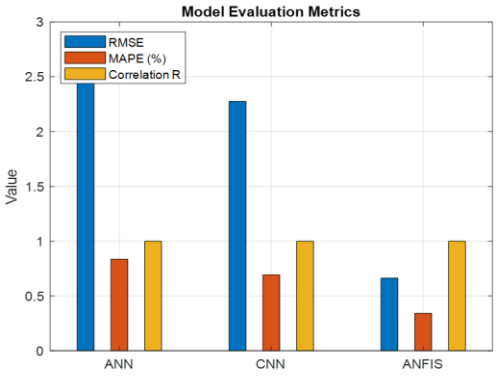
The ANN model shows moderate RMSE and MAPE for Kabul and Stuttgart, indicating good predictive capability but sensitivity to short-term fluctuations. CNN model, which achieves

lower RMSE and MAPE for Kabul and Stuttgart, reflecting its strength in capturing nonlinear dependencies than ANN model. The ANFIS model excels, achieving the lowest RMSE and MAPE with the highest correlation coefficient (R ≈ 1). This indicates a superior match between predicted and actual PV outputs, as ANFIS effectively manages nonlinearities and environmental uncertainties, resulting in smoother predictions.

Hot climate



Cold climate



In conclusion, power predictions for two climatic regions were evaluated using ANN, CNN, and ANFIS models. The analysis shows that ANFIS outperforms the others across all regions. Overall, visual comparisons confirm that all two models provide reliable short-term PV power estimates, with minor deviations at peak points likely caused by transient environmental fluctuations or measurement noise not fully captured by the models.

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THEMATIC EVOLUTION OF SEMI-TRANSPARENT PHOTOVOLTAIC RESEARCH IN BIBLIOMETRIC APPROACH

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Semi-transparent photovoltaic (STPV) systems enable power generation while maintaining daylight, supporting their use as façade-integrated BIPV. Research has progressively shifted from system integration toward advanced materials.

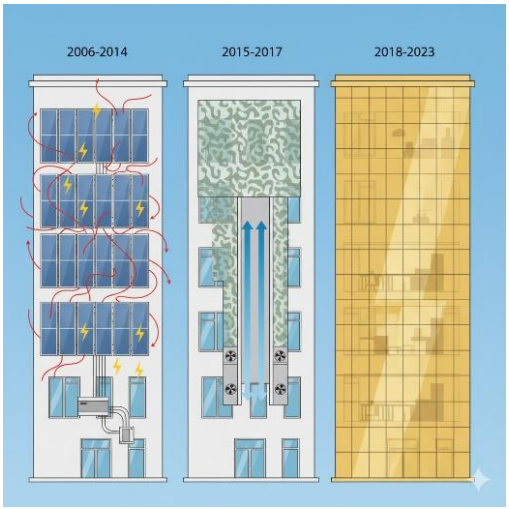
Using Biblioshiny (2024), authors' keywords were analysed across three periods – up to 2014, 2015–2017, and 2018–2023 – showing a clear transition from system development to hybrid performance evaluation and, most recently, material-focused innovation.

The initial phase (2006–2014) focused on exploring BIPVT systems, highlighting early attempts to combine photovoltaic generation with thermal recovery within building envelopes. This period focused on research related to system prototypes, thermal performance, and feasibility assessments, in alignment with broader building energy research. The studies highlighted the capability of STPV to enhance building energy autonomy, acting as a precursor to more sophisticated envelope-integrated functionalities as it was mentioned by Romani et al., 2022).

The second thematic period (2015–2017) marks a transition toward system optimisation, incorporating exergy assessment, dual-channel design configurations, and simulation tools such as EnergyPlus. The emphasis shifted from solely energy production to thermodynamic analysis, underscoring opportunities for optimising heat extraction while preserving electrical yield. The emergence of topics such as organic photovoltaics (OPV) and double-skin façades indicates an increasing interest in integrating architectural concepts with material technology. The advancements facilitated the integration of STPV for multifunctional applications in façade design, particularly in scenarios requiring a balance of thermal, optical, and visual properties (Vats & Tiwari, 2012).

The latest phase (2018–2023) indicates a significant shift towards material-centric innovation. Thematic clusters indicate a significant focus on semi-transparent perovskite, dye-sensitised, and kesterite solar cells, each providing adjustable transparency and improved conversion efficiency. The terms "daylighting quality," "energy consumption," and "shading" indicate a convergence between performance engineering and indoor environmental quality. The research trend indicates a comprehensive approach to STPV adoption, emphasising equal importance on energy production, architectural usability, and occupant well-being (Khalifeeh et al., 2021). This phase emphasises the increasing significance of balancing transparency and efficiency, a fundamental trade-off that continues to influence new research directions.

The three different phases are shown on the figure below.



The transition to advanced materials has significant implications for design. Higher transparency decreases generation efficiency, whereas increased efficiency limits daylight penetration; thus, simulation-guided design is essential for optimising envelope performance. The integration of optical analysis tools with photovoltaic simulation allows architects and engineers to assess trade-offs and minimise uncertainty before installation. This additionally facilitates preliminary design choices for BIPV applications in diverse climate zones.

Thematic evolution in STPV research indicates a progression from initial system prototypes to advancements in materials, alongside a growing focus on architectural integration. The shift towards perovskite and organic photovoltaic technologies indicates a growing practicality for extensive façade implementation. The thematic focus on visual performance, shading, and indoor comfort reflects an expanding viewpoint on practical application. Future research will likely focus on the transparency–efficiency trade-off, advancing material development, and enhancing performance modelling in real building conditions.

This bibliometric mapping identifies STPV as a significant technology that facilitates energy-efficient, occupant-centred architecture. Analysing its thematic trajectory provides essential insights for directing future research priorities, promoting interdisciplinary collaboration, and enhancing the integration of BIPV markets.

Acknowledgements

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

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LOCAL-SCALE ASSESSMENT OF AIRBORNE HEAVY METAL DEPOSITION ON SZENTENDRE ISLAND (HUNGARY) USING MOSS BIOMONITORING

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This study focuses on the airborne deposition of heavy metals on Szentendre Island, located north of Budapest, Hungary. Five elements—cadmium (Cd), cobalt (Co), nickel (Ni), copper (Cu), and lead (Pb)—were analysed in moss samples collected from three forested sites along the island. The results were compared with data from a nationwide survey conducted in 2003 (Ötvös et al., 2003), enabling assessment of changes in atmospheric deposition over the past 15 years.

Mosses are widely used as natural bioindicators for monitoring airborne heavy metal deposition due to their high accumulation capacity and lack of a root system (Steinnes et al., 1992; Harmens et al., 2015). We hypothesised that the southern part of the island would exhibit higher contamination due to its proximity to Budapest and the environmental impact of the construction of the Megyeri Bridge approximately a decade earlier. In addition, we expected overall concentrations to be lower than those previously recorded, reflecting improved air quality and stricter emission controls in Hungary.

Sampling was performed at three locations representing the southern, central, and northern parts of the island:

1. Between Szigetmonostor and the Megyeri Bridge,
2. South of Tahitótfalu, and
3. Southeast of Kisoroszi.

At each site, five subsamples were collected following the ICP Vegetation manual for moss biomonitoring (UNECE ICP Vegetation, 2020). The sampling took place on a single autumn day under stable weather conditions to minimise short-term variability.

The moss samples were dried at 70 °C for 24 hours, weighed before and after drying, then ground and digested using a microwave-assisted acid digestion method. Heavy metal concentrations were measured instrumentally, and the results were compared with the 2003 national dataset (Ötvös et al., 2003) to reveal spatial variability and long-term trends in air deposition.

Contrary to expectations, the southern site showed the lowest overall concentrations of most metals. With the exception of cadmium, the highest values were detected near Kisoroszi, in the northern part of the island. Cadmium, cobalt, and nickel concentrations were lowest in the southern area, suggesting minimal local emissions despite its closeness to urban influences.

Compared with the 2003 survey, lead and copper concentrations decreased markedly, indicating a general improvement in air quality, consistent with broader European trends (Harmens et al., 2010). Cadmium showed only a slight decline, while nickel concentrations nearly doubled, representing a notable increase.

As there are no major industrial activities on or near Szentendre Island that could account for elevated nickel levels, the increase is likely due to regional atmospheric transport or long-range air deposition (Schröder et al., 2016). This highlights the need for further research into potential external sources and deposition pathways.

The findings indicate that Szentendre Island remains relatively unpolluted and that concentrations of most airborne heavy metals have decreased over the past fifteen years. However, the rising nickel levels require further investigation.

We recommend establishing permanent air-monitoring stations in the northern, central, and southern parts of the island, along with annual moss biomonitoring surveys. This integrated approach would provide valuable data on airborne deposition dynamics, help identify pollution sources, and support the long-term protection of the environmental integrity of Szentendre Island.

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ENVIRONMENTAL INFLUENCE OF THE SEAWEEDS GROWING IN BLACK SEA ROMANIAN COASTAL AREA AND THE POSIBILITY TO USE THE BIOMASS AS FEEDSTOCK IN BIOREFINERY TECHNOLOGY

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Every year, especially in the summer, the coastal zone of the Black Sea is covered by a thick layer of seaweed, which causes discomfort for tourists. Some of this plant material is collected and stored at local landfill sites, especially from tourist areas, while the rest degrades naturally. In both cases, this has a negative impact on the environment and on tourism, which peaks in the summer in the northern Romanian coastal zone. In the summer of 2025, more than 2,700 tonnes of seaweed were collected and stored from legally registered beaches. This biomass was degraded naturally at the local landfill sites, producing air pollution (Borcea, S., 2025). This problem occurs yearly and, once the tourist season is over, it is resolved naturally. During the rest of the year, the algae bloom is low and stops in the cold period. In biorefinery technology, many procedures can be found to use biomass as a raw material for extracting added-value products and producing useful biogas from technological remains for local use in the treatment plant. In our experiments with this biomass, ulvan – a sulfonated polysaccharide – was extracted. The extraction yield in this case ranged from 9.5 to 18% (dry basis), and the remaining solids were used for biogas production via anaerobic digestion technology. The methane yield was estimated at 250 l/kg of treated biomass, with a minimum content of 50–51% methane (Bartha et al., 2023). The studied biomass was collected at Golful Pescarilor near Eforie Nord*. This phenomenon, the blooming of algae, is caused by the Black Sea's high sensitivity to the dynamics of nutrients, particularly nitrogen (N) and phosphorus (P), which originate from the Danube, Dniester and Dnieper rivers. The quantity in the summer period is higher than at any other time of the year, which is caused by tourist activity and the pollution of the inflowing rivers. Based on the literature on this phenomenon, a model was presented that evaluates the relative growth rate (RGR, d^{-1}) as a function of the region's climate conditions and the nutrient availability in the marine environment. Based on these data, a graph of this parameter was created with a monthly breakdown (Figure 1). The value ranges from 0.3 to 15 g DW /m².day. The highest values are in the summer period, are in accordance with the increase in nutrient concentration and the optimal climate conditions, temperature and light, which favour the natural growth process of seaweed. These growth rate data indicate high marine biomass quantities, which in some cases reached 3,300–3,800 g /m².year (Marin, 2024).

A thorough study of this phenomenon requires an evaluation of water quality parameters, generally by *in situ* methods. For this purpose, we tested a HI97105 Marine Master Photometer kit, which can be used to evaluate the pH, alkalinity, calcium, nitrate, nitrite and phosphate content of the water under study. These parameters are all important for studying the nutrients that cause seaweed blooms on the Black Sea coast. In this study, we conducted a pH evaluation using a non-conventional method with this photometer based on the colorimetric adaptation of the phenol red method. Based on published studies of the coastal zone, the salinity values range

from 1.72 to 18.91 PSU (Practical Salinity Units), the phosphate concentration ranges from 0.14 to 7.3 µM and the nitrate concentration (NO_3^-) ranges from 1.08 to 70.97 µM. These values are modified seasonally in function of the region's climatological conditions and the quality of the inflowing rivers' water. The photometer kit can be used to evaluate the pH, alkalinity, calcium, nitrate, nitrite and phosphate content of the studied water. All these parameters are important for studying the nutrients that cause seaweed blooms on the Black Sea coast. In this study, we evaluated pH in a non-conventional way using a photometer and a colorimetric adaptation of the phenol red method. According to a published study of the coastal zone, salinity values range from 1.72 to 18.91 Practical Salinity Units (PSU), phosphate concentrations range from 0.14 to 7.3 µM, and nitrate concentrations (NO_3^-) range from 1.08 to 70.97 µM. These values fluctuate seasonally in accordance with the region's climatological conditions and the quality of the inflowing river water (Dragomir et al., 2014).

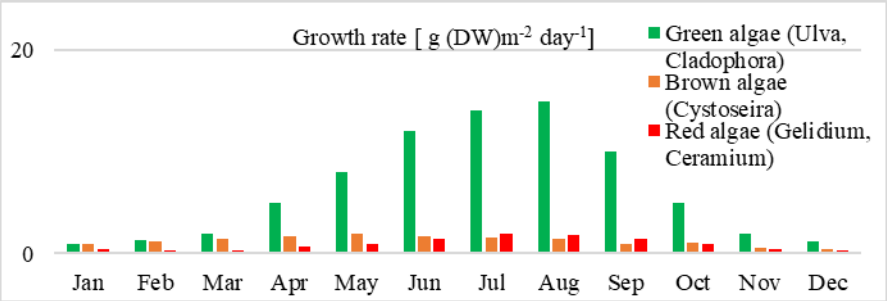

Figure 1. Seaweeds growth rate in the Romanian Costal area

The Black Sea is the world's largest semi-enclosed anoxic basin. The most significant pollution problem in this sea has been identified as eutrophication. One of the main sources of this problem in the Black Sea is agricultural activity in the catchment areas of the inflowing rivers, which are the main sources of nitrogen (N) and phosphorus (P). This can cause a high growth rate of seaweed in the coastal area, especially during the tourist season from June to September. In 2008–2009, around 25,000–38,000 tonnes of plant material were collected from the coastal tourist zones and stored in local landfill sites. This marine biomass can be integrated into a biorefinery platform, where classical extraction techniques can be used to obtain added-value products for the cosmetics and pharmaceutical industries. The remaining biomass can then be used to produce biogas with a good yield.

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PRODUCTION OF HUMINS FROM LIGNOCELLULOSIC BIOMASS

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Lignocellulosic biomass is a promising feedstock for biorefineries aimed at producing biofuels and green chemicals. These can be achieved by two main platforms, the (Bio) Chemical platform and the Thermochemical platform, which can be distinguished by the type of technologies involved. In the (bio) chemical platform, it is necessary to first obtain a sugar stream, typically in the monomeric form, since most of the biochemical processes (fermentative/enzymatic) cannot use polysaccharides directly. This implies the need to use biomass deconstruction or pre-treatment processes and polysaccharide hydrolysis steps. Biomass pre-treatments or fractionation processes are classified into chemical, physico-chemical, physical, and biological methods.

Briefly, physical pretreatments act by reducing biomass size, chemical methods use acids, bases, and or (advanced) solvents to break down lignin and hemicellulose, and biological methods use microorganisms and/or enzymes to degrade the biomass. Typically, the most common and efficient processes are acid-based aqueous processes. During the acid-catalysed conversion of the polysaccharides present in the lignocellulosic materials, namely into chemicals such as 5-hydroxymethylfurfural (HMF), furfural, and levulinic acid, a plethora of chemical by-products altogether known as humins are invariably generated.

By general definition, humins are carbonaceous, furan-based polymeric solids formed during the acid-catalyzed conversion of carbohydrates such as cellulose, hemicellulose, and their degradation products (HMF, furfural). Typically, they are insoluble or partially soluble polymeric materials, often dark in colour, formed through side reactions such as polymerization, condensation, aldol reactions, and dehydration. These compounds are generally heterogeneous and polydisperse, and their structure depends strongly on the type of biomass and on the nature of the carbohydrate used as feedstock, as well as on the reaction conditions used. Structurally, humins may contain furanic rings (derived from HMF and furfural) and various functional groups such as aldehydes, ketones, hydroxyls, and carboxyls, presenting a high diversity of chemical formulae. Based on elemental analysis, humins derived from lignocellulosic biomass can be represented by an empirical formula of approximately ($C_6H_{4-7}O_{2-3}$) per monomer unit. The structural formula is shown in Fig. 1.

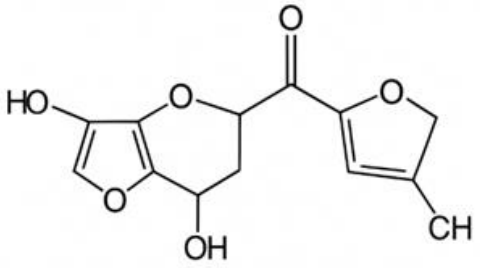

Fig. 1. Basic structural element of humins containing furanic rings

These materials can be utilized in various ways—for example, as sorbents for supercapacitors or Li-ion battery anodes, or as bio-based cross linkers or monomeric precursors in resin synthesis (Ed de Jong, et al., 2025). An important parameter for assessing humin structure is the aromaticity index (fa), a dimensionless parameter used to estimate the fraction of carbon atoms that are aromatic in complex organic materials such as humin, humic acid, or biochar. This index can be evaluated from the elemental composition of the studied biomass, using an empirical formula (Kaal et al., 2012):

$$fa = 1 - \frac{0.5 \times (\frac{H}{C})}{1 + 0.5 \times (\frac{O}{C})}$$

Where H/C and O/C are the molar atomic ratios of hydrogen and oxygen to carbon, respectively. Fo instances, according to literature data, humins derived from corn stalks have an aromaticity index of f_a = 0.74, compared to f_a = 0.67 for those derived from corn cobs. This difference correlates with the higher lignin content of stalk biomass and the greater proportion of aromatic C=C and C=O groups. Generally, f_a > 0.7 indicates a structurally highly condensed compound. In the case of wood-based lignocellulosic biomass, that index value is in the range 0.6-0.9, depending on treatment severity and the origin of the biomass (Hoang et all, 2015). All biorefinery processes are evaluated by the resulting product yields. That value is a function of the structural composition of the biomass in generally that is in function of the cellulose and hemicellulose content. The wood base biomass produces less humins than the biomass resulted from agriculture residues like corn cobs, or corn stalks. That is caused by the lower pentose content and slower sugar degradation in case of the wood base biomass. In this case the typical humin yields is in range 5- 18 % and in case of the agricultural residues is 15-30 % to corn stover and 20-35 % to the corn cob. (Siwei, Liu, et all, 2022). this parameter is also influenced by the used treatment technology.

Humins are inevitable side-products in acid-catalyzed biomass processing, especially when converting lignocellulosic material to furanics or levulinic acid. While they present challenges, recent research is turning them from waste streams into potentially useful materials. The humin fractions are enriched in aromatic, hydrophobic, and thermally stable carbon, making them good candidates for soil carbon sequestration and amendments, with agricultural residues presenting a high potential to be converted into humin-base componds.

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HYBRID OPTICAL-THERMAL LINEAR FRESNEL RECEIVERS WITH SINGLE AND DUAL NON-VACUUM TUBES: SIMULATION AND EXPERIMENTAL ASSESSMENT

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Linear non-vacuum secondary-reflector Fresnel receivers are inherently prone to considerable convective and radiative heat losses. However, comprehensive experimental assessments of these receivers remain both expensive and time intensive. To overcome this limitation, a hybrid numerical modelling strategy has been developed, integrating Monte Carlo Raytracing (MCRT) for optical simulation with Computational Fluid Dynamics (CFD) for thermal and flow analysis. This coupled approach enables accurate prediction of the receiver's thermal and optical performance while significantly reducing the reliance on costly experimental trials.

The hybrid model was validated using experimental data obtained from a single-tube Fresnel receiver tested at operating temperatures up to approximately 320 °C. The comparison between numerical and experimental results demonstrated strong agreement, with predicted global heat losses deviating less than 5 %. This high level consistency confirms the model's reliability in reproducing the overall heat balance and justifies its use for extended design optimization.

Following validation, the method was applied to compare single- and dual-absorber tube configurations incorporated within a compound parabolic concentrator (CPC)-type cavity. Both receiver designs achieved similar optical efficiencies of approximately 65 %, as shown in Fig. 1. However, the dual-tube configuration exhibited lower overall heat-loss coefficients (ranging from 4.6–10.3 W m^{-2} K^{-1}) compared to the single-tube design (4.9–10.8 W m^{-2} K^{-1}) across the absorber temperature range of 173–473 °C (Figure 2). This improvement is primarily attributed to the larger spacing between the glass cover and the smaller-diameter absorber tubes, which effectively reduces convective and radiative heat transfer to the environment. Consequently, the dual-tube design enhances thermal performance without compromising optical effectiveness.

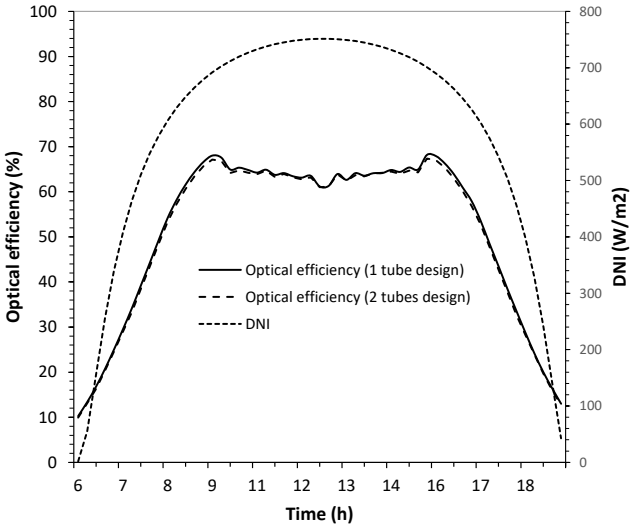

Fig. 1. Overall optical efficiency comparison between single tube and dual tube designs

Beyond these results, several additional insights emerge from the study. The influence of ambient wind, receiver inclination, and aperture orientation has been identified as critical for assessing convective heat losses. Previous research confirms that natural and forced convection

patterns significantly alter the cavity heat-transfer characteristics under varying wind conditions and orientations (Ko et al., 2022), Santos et al., 2024). Incorporating these parameters into future simulations would enable a more realistic representation of outdoor operation. Fig. 2. shows a comparison of heat losses between different tube designs.

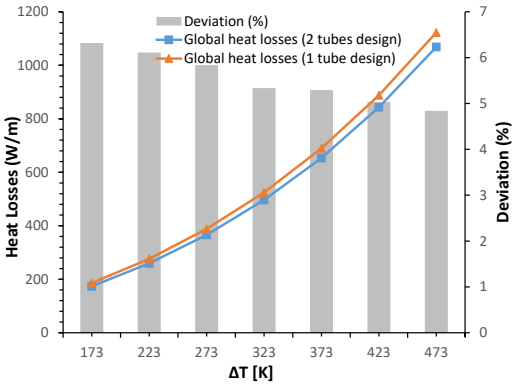

Fig. 2. Comparison of global heat losses between the dual-tube and single-tube designs

Furthermore, geometric optimization such as varying tube diameters, cavity depths, and secondary reflector shapes can play a major role in further minimizing losses. As reported by (Montanet et al., 2023), small modifications to cavity geometry can lead to notable efficiency gains in linear Fresnel systems. Similarly, surface coatings with high solar absorptance and low emissivity can mitigate radiative losses, particularly under non-vacuum conditions where thermal radiation dominates at higher temperatures (Alcalde-Morales et al., 2023, Sánchez-Mora et al., 2025).

While the current work focuses on steady-state conditions, extending the hybrid model to transient analysis could provide valuable insights into system performance under fluctuating solar irradiance, start-up and shut-down cycles, and thermal inertia effects. Such developments would be essential for integrating these receivers into large-scale solar thermal plants equipped with thermal energy storage systems. Additionally, implementing uncertainty quantification (UQ) techniques and multi-objective optimization algorithms would allow the framework to evaluate design robustness and trade-offs between efficiency, cost, and manufacturability.

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ENHANCING HYBRID PV/T SYSTEM EFFICIENCY THROUGH INTELLIGENT AI-BASED OPTIMIZATION

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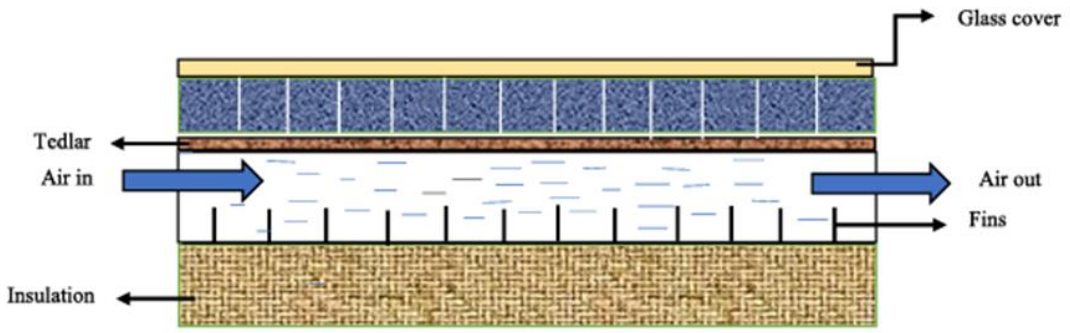
Hybrid photovoltaic–thermal (PV/T) systems offer a sustainable solution for combined electricity and heat generation from solar energy. However, their performance is highly dependent on the control strategy, as rapid variations in irradiance and temperature cause significant efficiency losses.

This resent work aims is to show based on the literature how it is possible to improve the total energy conversion efficiency of PV/T systems through an intelligent control framework based on Particle Swarm Optimization (PSO).

Near the traditional optimization methods, integrating intelligent optimization with real PV/T experimentation to achieve superior performance, adaptability, and reliability under variable environmental conditions. As highlighted by Tiwari et al. (2023), hybrid photovoltaic–thermal (PV/T) systems offer a unique pathway for simultaneous electrical and thermal energy generation; however, their efficiency remains strongly dependent on temperature regulation, heat extraction, and accurate Maximum Power Point Tracking (MPPT).

Excessive heating of photovoltaic cells leads to notable electrical efficiency losses, while poor heat management limits the recovery of usable thermal energy. Therefore, integrating artificial intelligence (AI)-based optimization frameworks into PV/T systems has become an essential strategy to overcome these interdependent challenges. The Figure shows a Flat-plate PV/T air collector with a glass cover and internal fins for improved air turbulence and heat transfer (Tiwari et al., 2023)



The advanced intelligent optimization methods are employed to establish an adaptive control mechanism capable of learning, predicting, and responding dynamically to fluctuating solar irradiance, ambient temperature, and airflow conditions. Unlike conventional control approaches, which rely on static parameter tuning, AI-based techniques—such as Particle Swarm Optimization (PSO), Genetic Algorithms (GA), Artificial Neural Networks (ANNs), and Fuzzy Logic Controllers (FLC) offer the capability to perform self-adaptive, real-time decision-making. These methods are designed to continuously track the global optimum operating point of the system, ensuring maximum energy conversion under diverse weather conditions.

Among these optimization strategies, PSO stands out due to its mathematical simplicity, strong global search capability, and rapid convergence toward optimal solutions. Inspired by the collective behavior of bird flocks and fish schools, PSO enables the control algorithm to locate the best combination of operating parameters—such as voltage, current, and flow rate—that maximize both electrical and thermal outputs simultaneously. This swarm-intelligence-based approach minimizes computational complexity while maintaining high robustness and precision, making it well-suited for real-time PV/T system optimization.

This approach minimizes the temperature difference induced degradation, stabilizes system operation, and improves overall solar energy utilization. According to the literatures experimental results indicate that the AI-optimized system effectively adapts to rapid irradiance fluctuations, maintaining stable performance even under partially cloudy conditions.

So, the PSO approach integrates advanced MPPT tracking with thermal optimization and real-time monitoring to achieve a more stable and efficient hybrid operation. My research work long-term goal is the development of the efficient PSO model for a real PV/T system.

Acknowledgements

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FMECA AND FTA OF A CENTRIFUGAL AIR COMPRESSOR AT THE NITRIC ACID PLANT

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In the chemical industry, particularly in companies that operate plants producing nitric acid, the reliability of equipment operating in the plant environment is extremely important, especially the centrifugal air compressor. This compressor plays a crucial role in supplying high-pressure air, which is one of the essential requirements for the nitric acid production process. Therefore, any damage or issues in the components of the centrifugal air compressor can result in a reduction of production volume and even potentially halt nitric acid production.

However, a centrifugal air compressor is a piece of equipment with components that are prone to performance degradation, which can be caused by component wear, continuous operating conditions, or insufficient maintenance. Therefore, the reliability of the centrifugal air compressor is very important to maintain its performance, as this compressor serves as the "lungs" of the nitric acid production process.

The aim of this study is to identify and analyze potential failure modes in the main components of the centrifugal air compressor using the FMECA method, determine the components with the highest criticality to system reliability, analyze the root causes of major failures using the FTA method to understand the most significant causal pathways, and provide recommendations for maintenance strategies and system reliability improvements based on the results of FMECA and FTA analyses.

No	Risk	Reason	*Occurance* (O)	*Severity* (S)	*Detection* (D)	RPN (OxSxD)
1	Fertilizer Planning					
	Fertilizer recommendation late	Sampling and analysis of old leaves	2	2	3	12
	The type of fertilizer used for a long time is determined	Need consideration from cross section	2	3	2	12
	Availability of funds/budget is not in accordance with fertilizer recommendations	Fertilizer prices according to high recommendations	3	3	3	27
	The volume of fertilizer needed by the garden was received late	The garden is late in calculating needs	3	2	2	12
2	Supplier Selection Process					
	Determination of old HPS	Price surveys are hard to come by	2	2	3	12
	Announcement of the old tender carried out	Procurement packages enter at the same time	3	2	3	18
	Supplier bids on HPS	The price on HPS does not match the price conditions	2	2	3	12

Fig. 1. Example of creating a Risk Priority Number (RPN) table

The FMEA method functions to evaluate various risks that arise from the potential occurrence of problems by using several approaches or techniques. One commonly used method is the calculation of the Risk Priority Number (Rahman, 2021).

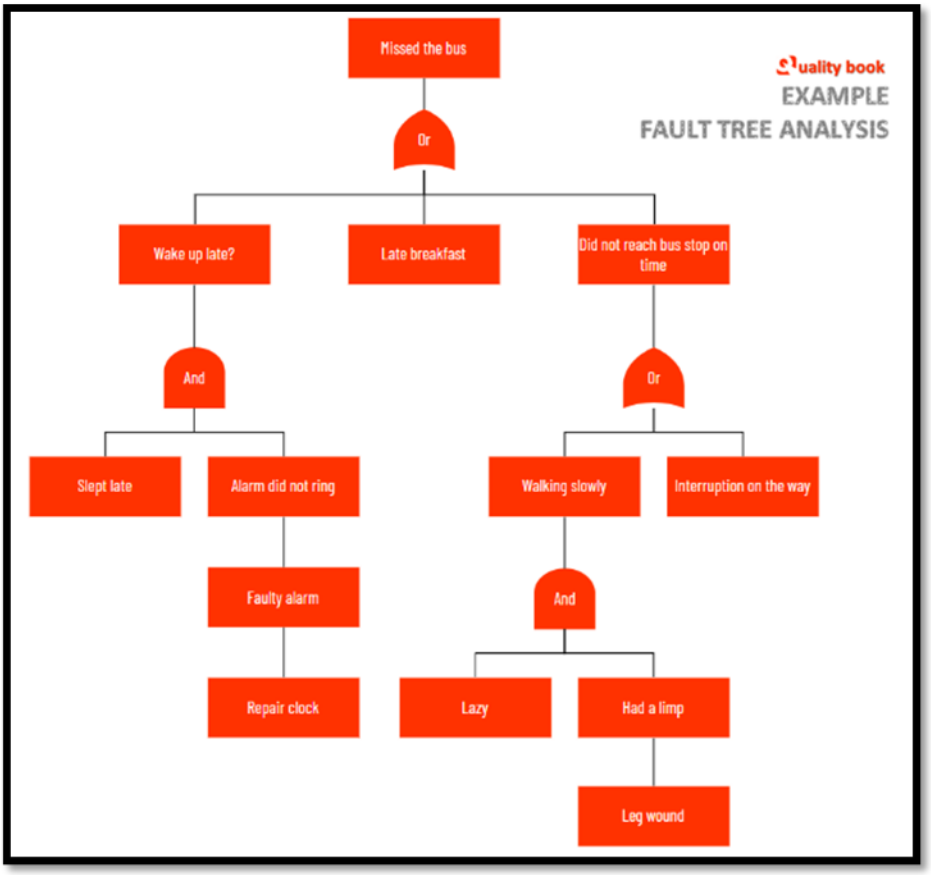

Fig. 2. Example of creating a Fault Tree Analysis (FTA) table

Fault Tree Analysis (FTA) is defined as a process of identifying and analyzing the conditions and factors that can cause, potentially cause, or contribute to a condition defined as the top event (such as system failure). Fault Tree Analysis is an organized graphical representation of the conditions or other factors that cause or contribute to the occurrence of the state referred to as the top event (Yafi, 2024).

After identifying the components with the most critical failure modes and determining the root causes of system failures, the results of this analysis can be used by anyone operating a centrifugal air compressor to help improve reliability and reduce downtime of the equipment.

Acknowledgements

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GROWTH AND TECHNOLOGICAL INNOVATION IN SOLAR PHOTOVOLTAIC SECTOR

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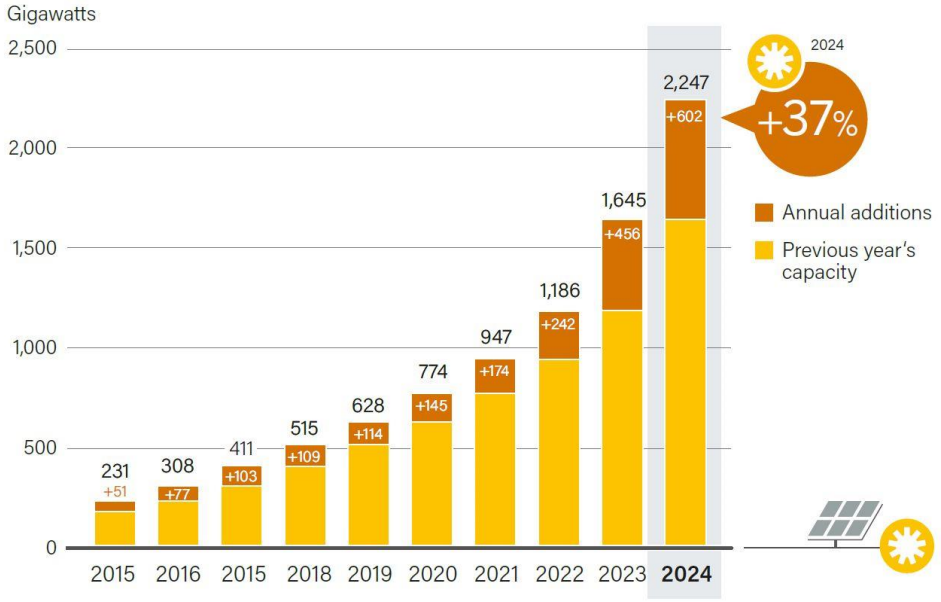
This paper is dealing with the recent advances and future scenarios of the very rapidly developing field of solar photovoltaic technologies. The worldwide situation is analysed based on the topics discussed intensively at the EuroSun 2024 Solar Conference organised in Limassol, Cyprus and at the Solar World Congress (SWC 2025) organised by the International Solar Energy Society in Fortaleza, Brasil.

The solar photovoltaic (PV) sector experienced another record-breaking year in 2024. Global cumulative installed capacity surpassed the 2 terawatt (TW) milestone, reaching 2.25 TW – up from 1.65 TW in 2023 and nearly twice the installed capacity of 2022. Annual installations attained an unprecedented 602 GW, equivalent to the total global PV capacity installed by the end of 2019, representing a 32% year-on-year increase (Renewables 2025; IEA PVPS, 2025).



Solar PV capacity (in GW) and annual additions in 2024

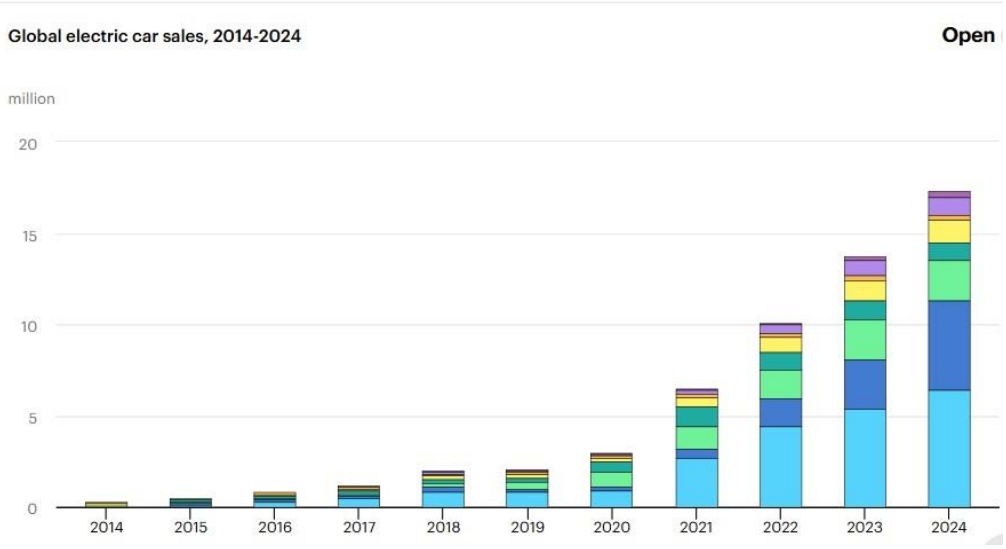
Market expansion continued to be driven primarily by long-term leaders, with China accounting for approximately 60% of new capacity additions, followed by the United States (8%) and India (5%). Meanwhile, emerging markets demonstrated notable acceleration fr example in Pakistan, United Kingdom and Poland. By 2024, a total of 23 countries had achieved solar PV shares exceeding 10% of their electricity generation mix, up from 18 countries the previous year. Five countries surpassed or approached 20% shares: Hungary (25%), Luxembourg (22%), Chile (22%), Greece (21%), and Spain (21%).

By the end of 2023, the global solar PV industry employed an estimated 7.2 million people. China remained the dominant employer, accounting for approximately 4.6 million jobs, nearly half of which were in manufacturing. In the United States, solar PV employment reached approximately 280,000, with manufacturing showing the strongest growth. As of mid-2025, more than 250 clean energy manufacturing facilities – many dedicated to producing solar

modules, inverters, and cells – were under construction, supporting roughly 122,000 manufacturing jobs. Projections indicate up to 575,000 positions may be created by 2030. Within the European Union, around 720,000 people were employed in the solar PV sector in 2023, with notable job growth in manufacturing driven by efforts to re-establish domestic supply chains (IRENA, 2024).

Beyond conventional rooftop, building-integrated, and ground-mounted systems, innovative PV applications are gaining momentum. These include agrivoltaics, floating PV systems, and vehicle-integrated PV. Such technologies enhance the versatility of solar energy while addressing land-use constraints and expanding deployment opportunities.

The global distribution of electric vehicle (EV) registrations remains uneven, dominated by key markets. China (depicted in blue), Europe (purple), and the United States (green) continue to lead, while other regions (yellow) represent smaller but growing markets. In the accompanying figure, lighter color intensity denotes the market share of battery electric vehicles, whereas higher intensity indicates plug-in hybrid models.



Global electric car sales (in million), 2014-2024

PV module prices now stand at approximately €3/Wp, though they vary depending on system size and location. Regarding technological performance, state-of-the-art laboratory cells based on monocrystalline silicon have achieved efficiencies of 27.8%. High-concentration multi-junction solar cells have reached 47.6% efficiency, and concentrator modules 38.9% (NREL Report, 2025). Perovskite cells have set a new record at 26.9% efficiency (Fraunhofer ISE, 2025). At the module level, research and development efforts focus on next-generation high-power modules exceeding 750 W of output, particularly for building applications.

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ENVIRONMENTAL MONITORING SYSTEM OF THE RADNANO INFINITY ASTRONAUT DOSIMETER

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Environmental parameters can vary widely during spaceflights and missions. Some of these changes are completely unfamiliar on Earth, such as the hypergravity experienced during rocket launches and the microgravity experienced in stable orbit.

Space radiation is also a complex and pervasive phenomenon that poses significant challenges to space exploration and the long-term health of astronauts (Hart, 2023), consist of various types of energetic particles originating from different astrophysical sources, it constantly bombards spacecraft and celestial bodies. Understanding its composition, origins and effects is crucial for mitigating the risks it poses and enabling future human missions beyond Earth's protective magnetosphere.

Dosimeters worn by astronauts and sensors on spacecraft provide real-time data on radiation doses, which is essential for assessing exposure and making informed decisions about mission operations.

Space missions can basically be divided into two categories: satellite missions and crewed spaceflights. Satellite missions operate in a vacuum after leaving the atmosphere, while crewed space flights – with the exception of spacewalks – typically take place at normal atmospheric pressure, as spacecraft and space stations strive to maintain normal atmospheric pressure inside their interiors. Sudden pressure changes can occur when spacecraft dock or undock with each other, as well as due to external impacts, damage, or aging and leaking seals.

During orbit, extreme temperatures can occur on spacecraft and space stations, so temperature control is often necessary to keep onboard equipment and instruments operating within the proper temperature range. Appropriate temperature control is also critical for the comfort of astronauts working on board space stations and spacecraft, as well as for living organisms participating in biological or medical experiments.

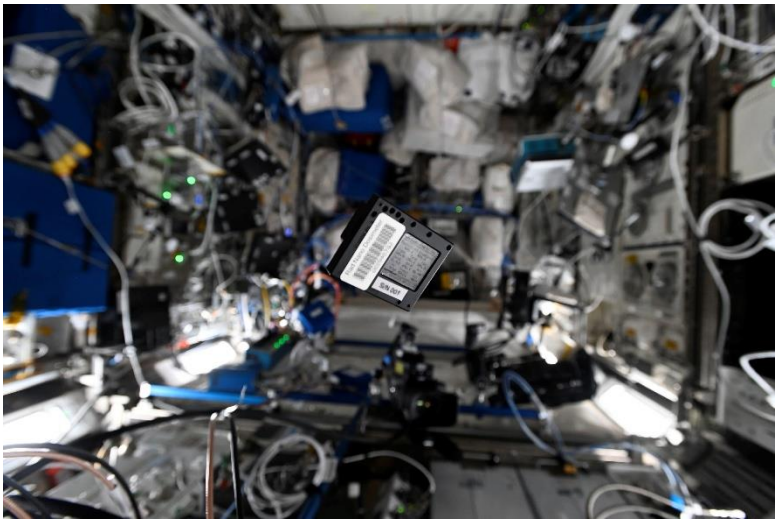
Air purification and humidity control are also critical during crewed space flights, as the carbon dioxide and humidity content of exhaled air can quickly reduce air quality to unacceptable levels for astronauts, biological and medical experiments in enclosed spaces. Light intensity and spectral composition are also important parameters for astronauts and biological experiments.

The aim of the presentation is to present the RadNano Infinity Astronaut Dosimeter environmental monitoring system. The goal of developing this dosimeter was to create a device that is more compact, lighter, and more energy-efficient than previous models. It can be used to monitor the environment of astronauts and scientific experiments during space missions, with a particular focus on the environmental parameters described above. The dosimeters are equipped with environmental sensors to monitor conditions for astronauts, modules of the International Space Station, and other biological, medical, or material science experiments.

These instruments measure temperature, humidity, pressure, and carbon dioxide and air quality levels, as well as light intensity and magnetic fields. Thanks to the dosimeters' advantageous technical parameters, such as their small size and advanced energy efficiency, a lightweight, portable, handheld device has been designed that can operate for months using its integrated battery without any external charging. The device's current status and the measured environmental parameters can be viewed by the user on a small LCD display. The device can

alert the crew to potential dangers and save timestamped measurement results to a memory that can be accessed after the mission to create a database for further scientific analysis (27G-Technology, 2025).

The Axiom-4 space mission recently took place, during which ten RadNano Infinity prototypes were used on board the SpaceX Dragon spacecraft and the International Space Station (Axiom Space, 2025; NASA, 2025). Four units were used by the astronauts, while the remaining six were deployed by the crew to monitor experiments for the HUNOR (Hungarian to Orbit) Astronaut Program.



The devices travelled approximately 12 million kilometers in space over a period of 20 days, continuously collecting scientific data from the days before the rocket launch until the spacecraft's return to Earth. The recorded scientific data provides a comprehensive picture of the astronauts' working environment. The results will soon be published in scientific journals.

Acknowledgements

This research was supported by 27G-Technology Ltd., the manufacturer of the RadNano Infinity Astronaut Dosimeters, the Doctoral School of Engineering Sciences, Hungarian University of Agriculture and Life Sciences – MATE and the HUNOR Astronaut Program. The author would also like to acknowledge the support provided by NASA, Axiom Space, the European Space Agency (ESA) and SpaceX.

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GAS ENGINE VIBRATION: AN INTRODUCTION

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A gas engine is one of the most widely used types of internal combustion engines in industrial applications such as power generation, transportation, and gas compression systems. Its main advantages include high efficiency, cleaner combustion, and the ability to use natural gas as a more environmentally friendly fuel compared to diesel engines (Taylor, 1985).

The working principle of a gas engine is based on converting the chemical energy of fuel into mechanical energy through combustion inside the cylinder, driving the crankshaft to produce rotational motion. However, during operation, gas engines often experience vibration problems caused by mechanical imbalance, misalignment, combustion pressure fluctuations, and structural resonance (Hoffman, 1999). Excessive vibration can reduce performance, accelerate component wear, and even cause system failure if not properly monitored. To overcome this issue, vibration analysis is implemented as a predictive maintenance technique that continuously monitors vibration signals to identify early signs of mechanical faults. Through this method, the sources and severity of engine faults can be identified based on the frequency spectrum and time-domain characteristics, allowing early fault detection and improving the reliability and efficiency of gas engine operations (Mobley, 1999). The Schematic Diagram usage of gas engine generator is shown in Fig. 1.

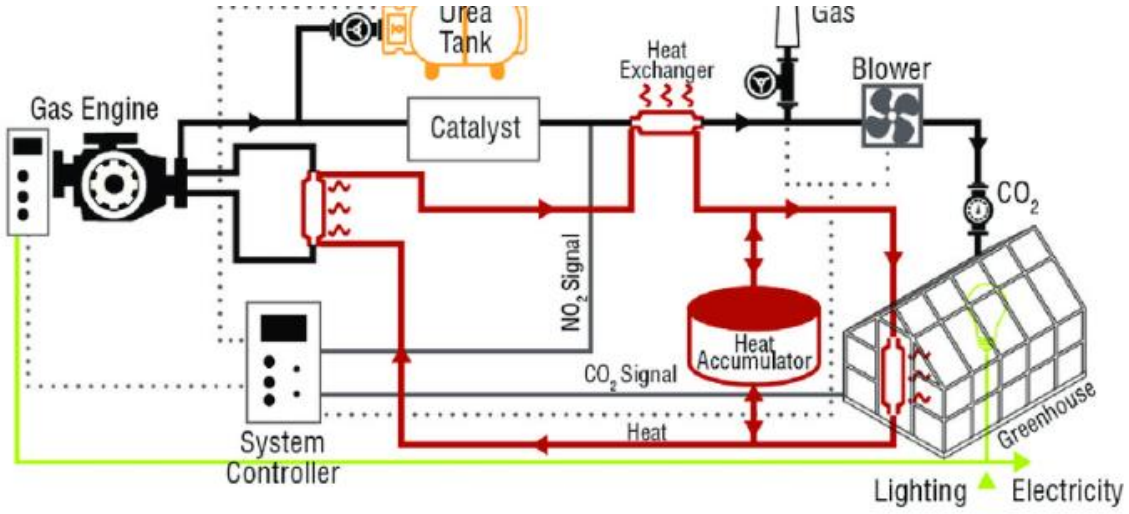

Fig. 1. Schematic Diagram usage of gas engine generator

There are several methods can be implemented to analyse the vibration phenomena. In this research, vibration analysis will be performed by measurement directly, using the CSI 2130 Machinery Health Analyzer vibration analyser, and furthermore processed with the assistance of AMS Machinery Manager software. The mechanism of this process is to convert vibration data from the time domain into the frequency domain, which can be used to identify the problem/fault location of gas engine component.

The initial data obtained are vibration graphs in the time domain, which are then converted into graphs in the frequency domain. The results of this transformation are subsequently analysed and compared with the ISO 10816-3 standard to assess the level of component damage based on the measured vibration levels, as shown in Fig. 2 (Putra et al., 2012). The effective value of vibration velocity is used to assess the condition of the machine. ISO 10816-3 specifically applies to machinery with a power rating above 15 kW and an operating speed between 120 and 15,000 RPM, with power ranging from 15 to 75 kW, or medium-sized engines. After the data analysis process is completed, the results are used to make maintenance decisions for the gas engine.

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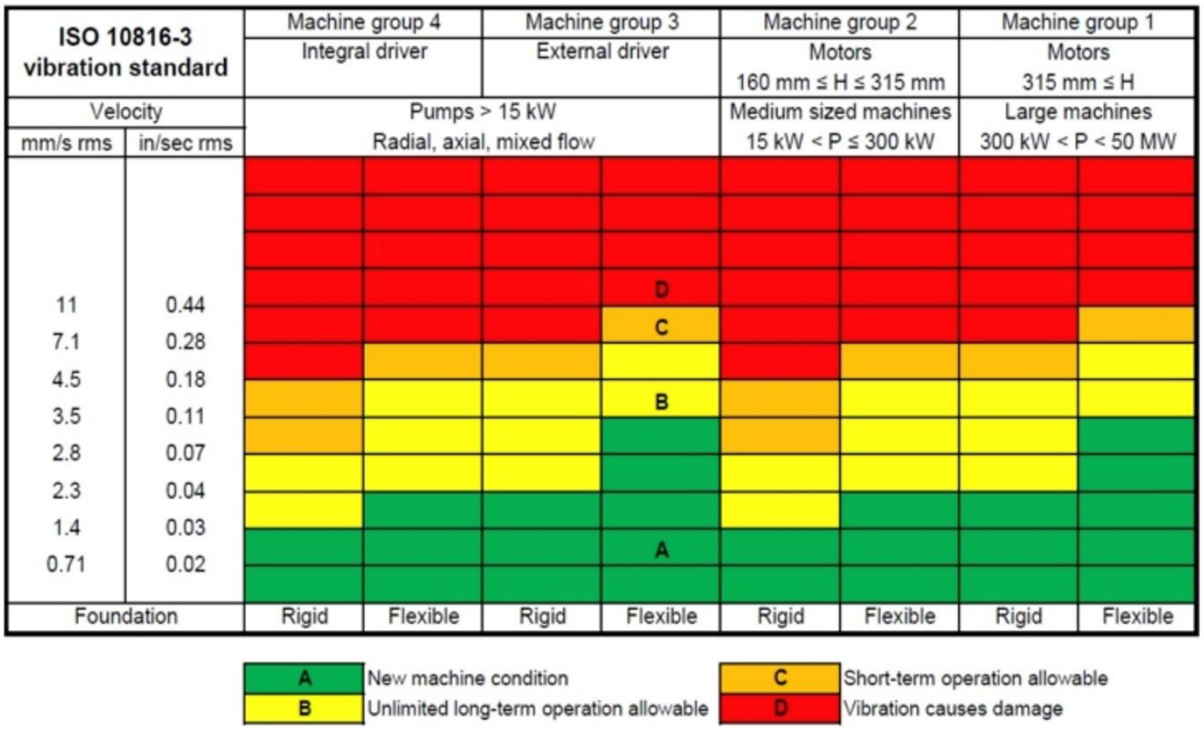

Fig 2. ISO 10816-3 Vibration table

Acknowledgments

The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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COMPARISON OF COMMUNICATION FOR WIRELESS SENSOR NETWORK IN SMART FARMING APPLICATIONS

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Wireless Sensor Network (WSN) technology has been widely used in smart farming applications to monitor and collect environmental data on agricultural land. However, wireless technology is affected by transmission signal strength, especially for the large agricultural land.

Wireless communication modules and technologies that can be used today, like nRF24L01, LoRa RFM95W, and ESP-NOW. The nRF24L01 and LoRa RFM95W are a module for wireless communication which can connected with microcontroller like Arduino or ESP by Espressif. Meanwhile, ESP-NOW is an embedded wireless communication system between ESP microcontrollers. This means that the system is installed on an ESP microcontroller with Wi-Fi features that can communicate to another ESP based microcontrollers, like ESP8266 and ESP32.

The aim of this research is to compare wireless communication on three smart agricultural devices that use nRF24L01, LoRa RFM95W, and ESP-NOW technologies. Furthermore, it remains to be studied how type and angle of the antenna would be affected to transmission range. Because the ESP and the module nRF24L01 in this study using on-board antena, meanwhile LoRa RFM95 using external antenna.

The first device (Fig. 1) using Arduino UNO and nRF24L01 in transmitter side, which contain soil moisture sensor, DHT11 sensor for air temperature and humidity, and solenoid valve. While in receiver side using WEMOS D1 mini and nRF24L01. The data transferred via nRF24L01 then uploaded to the Wi-Fi router from WEMOS D1 which ESP8266 based microcontroller (Hartawan et al., 2025). The second device (Fig. 2) using Arduino UNO and LoRa RFM95W in transmitter side, which contain soil moisture sensor, DHT11 sensor for air and temperature humidity, and solenoid valve. While in receiver side using ESP32 and LoRa RFM95W. The data transferred via LoRa RFM95W then uploaded to the Wi-Fi router from ESP32 microcontroller (Sujana, Hartawan, 2024). The third device (Fig. 3) using WEMOS D1 mini in transmitter side, which contain DHT11 sensor for air and temperature humidity. While in receiver side using two pieces of ESP32. The data transferred between WEMOS D1 mini then finally collected to ESP32 near Wi-Fi router. The collected data transferred to another ESP32 microcontroller via serial communication then uploaded to the Wi-Fi router, so the Wi-Fi feature in ESP32 only use for sending data to the Wi-Fi router (Iqbal et al., 2024).

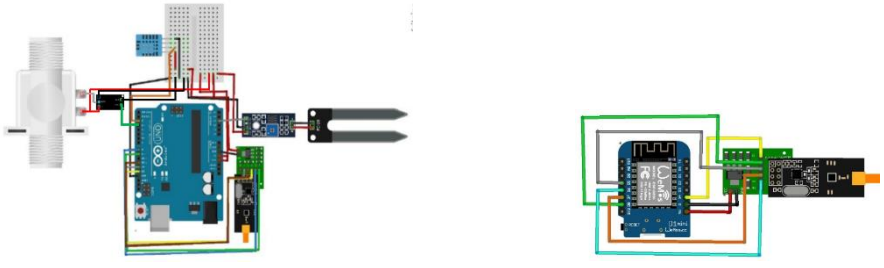

Fig. 1. Wiring diagram of the device with nRF24L01 module, Transmitter & Receiver

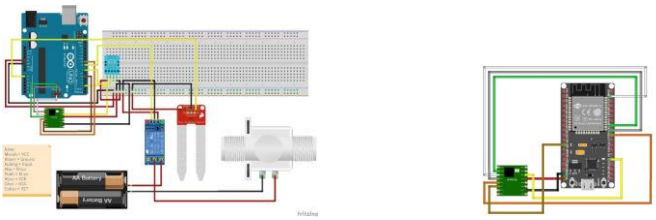

Fig. 2. Wiring diagram of the device with LoRa RFM95W mod., transmitter & receiver

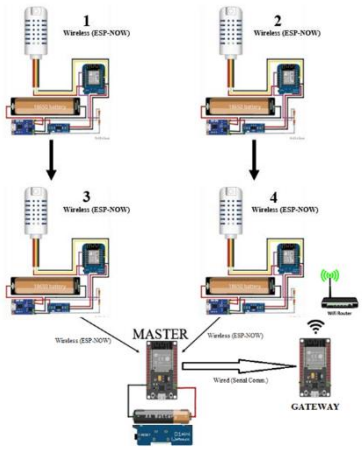

Fig. 3. Wiring diagram and schematic data transfer for the device with ESP-NOW technology

The functional test results show that the transmission range for each technology is: the first device (nRF24L01) is about 20 meters, the second device (LoRa RFM95W) is about 140 meters, and the third device (ESP-NOW) is about 45 meters. The environmental conditions (such as trees) extremely affects this distance. However, devices with LoRa modules are the most expensive, costing up to 3 times more than others.

ESP-NOW technology in ESP based microcontroller is suitable for use as a Wireless Sensor Network (WSN) in smart farming devices to collect environmental data in agricultural land, due to the limited sensor sensing area.

Furthermore, sleep feature in ESP based microcontroller can be used to reduce power consumption. Therefore, adjusting sleep time to the interval data requirements for further analysis needs to be explored to maximize device operating time.

Acknowledgements

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RELIABILITY CENTERED MAINTENANCE PLAN: CASE STUDY ON CENTRIFUGAL PUMP

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Reliability Centered Maintenance (RCM) is a proactive maintenance management approach aimed at preventing functional failures of a system. This approach ensures that equipment can continue to operate optimally according to operational requirements (Moubray, 1997).

This research evaluates the reliability of centrifugal pump components in Water Injection Pump (WIP) applications by identifying existing failure modes and analysing risks using OREDA (Offshore Reliability Data).

In general, the pump block functional diagram can be described such Fig. 1, and its valid for all the pump types (OREDA, 2009; Taufik, 2009).

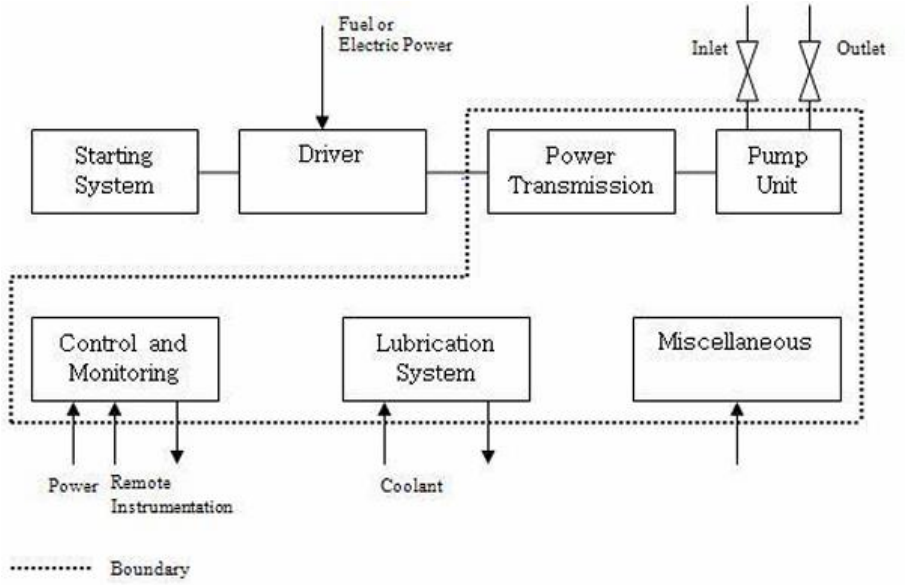

Fig. 1. Pump block functional diagram

Based on above block functional diagram, list maintainable item/equipment (sub system) can be identified and determined, as prerequisite to evaluate a system reliability.

The complete activities to create the RCM plan of the system, is illustrated by Fig. 2. The evaluation is dependent on the several data: failure rate, reliability, and Mean Time Between Failure (MTBF) for each selected component, which are then used as the basis for calculating the Risk Priority Number (RPN) by considering severity, occurrence, detectability, and repair time parameters. The RPN analysis determines the maintenance priority for the most critical components, allowing the development of a maintenance strategy consisting of visual inspection, condition monitoring, and preventive maintenance. This study concludes that implementing the RCM approach can improve the reliability of centrifugal pump operations, reduce the risk of failure, and extend the service life of components.

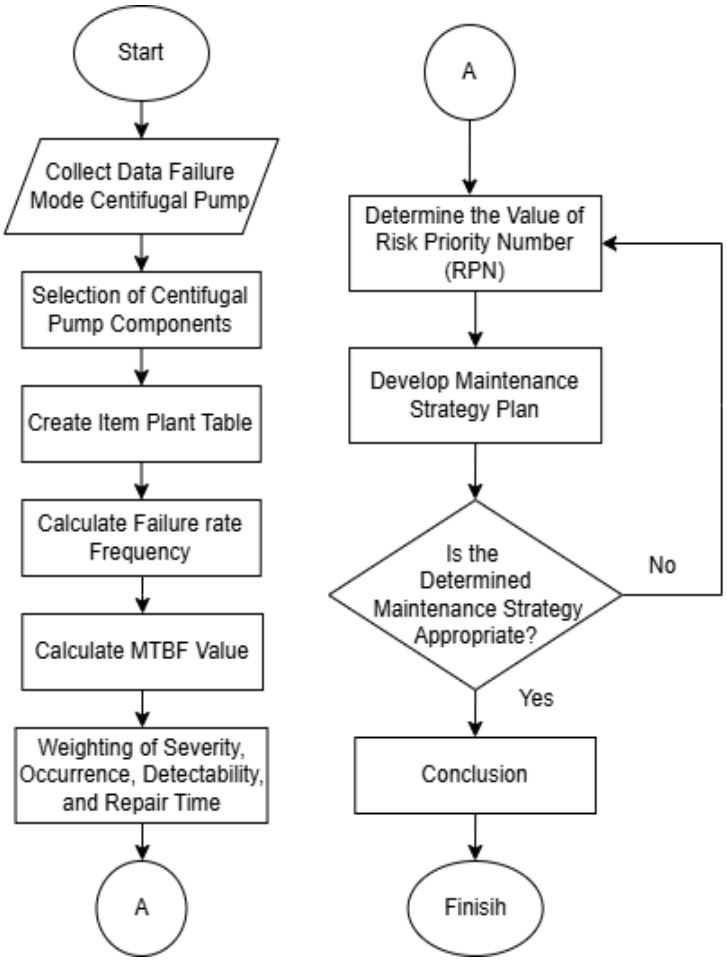

Fig. 2. Decision logic diagram

Acknowledgments

The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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SOME NOTES ON THE DISTRIBUTION OF WIND SPEED OVER TRUNCATED PYRAMID SHAPED LANDFILL HILLS WITH SHORT GRASS – APPLICATION OF BERNOULLI THEOREM

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Electric island networks based on renewable energy sources include - in almost all cases - an electric generator unit based on fossil fuel (diesel engine) and an energy storage. The more diverse the energy source of renewables (e.g. photo-electric cells + wind power plant), the lower the performance of the mentioned auxiliary units can be (Imre, 2004, Tóth 2014). In the energy hills this is possible, using landfill gas as a source for the production of electricity together with solar and wind energy units. In this part of the ongoing (student) research (Imre et al. 2012 and 2024, Kasparek 2020, Ulsbold 2023, Tanui, 2023), a truncated pyramid-shaped artificial hill with short grass cover – new meteorological concept, a modified flat field – was examined with preliminary way for designing solar and wind energy power plants on the landfill hill.

Methods implied Open Foam simulations with standard wind profile load and handheld measurements. The size of the hill is varied from a basic geometry related to the Pusztazámor landfill hill, using smaller, narrower, wider and higher ones. The qualitative OpenFoam software simulation indicated (Figs 1-2) that the hill effect is more complicated than expected.

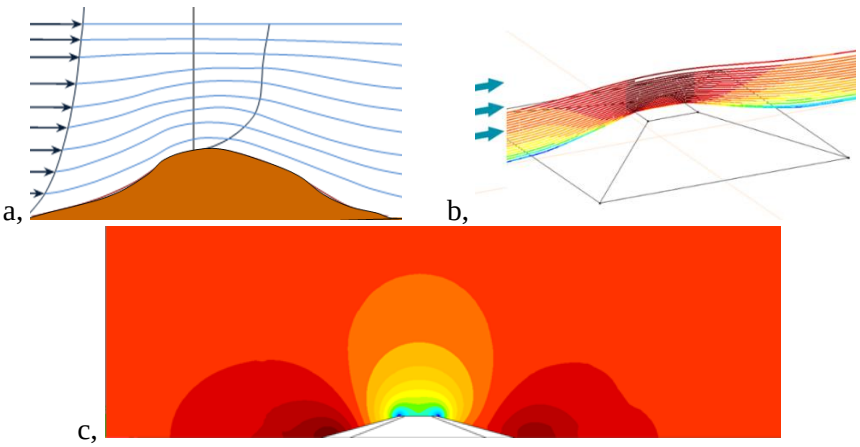

Fig. 1. (a) Velocity field expected, (b) H= 55 m, simulated speed field with start of "bulb" above plateau, (c) H= 55 m. Pressures. Note: darker colour means larger velocity and pressure

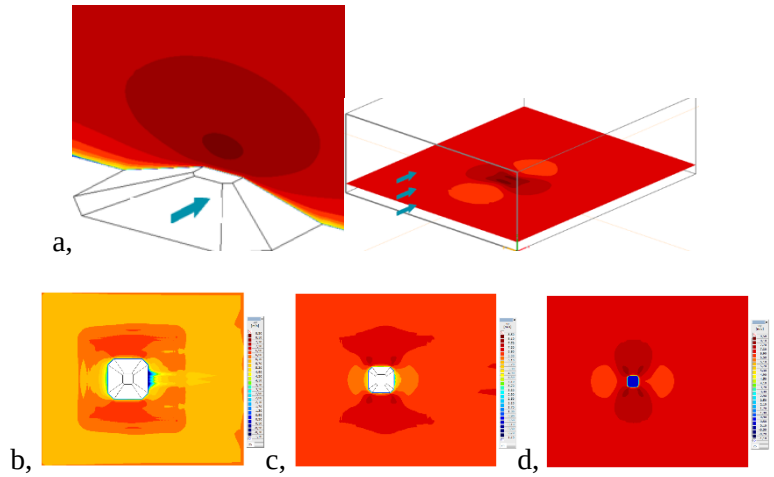

Fig. 2. Horizontal velocity component over hillsides in the following levels: 0H, 1/3H, 2/3H, H

The horizontal component of the wind speed increases nearly discontinuously above the hill if it is high enough, resulting in an area with speed inversion. This is explained as follows. Due to the decrease in cross-section in the wind direction, the speed increases above and the sides of the slope, and the air mass from the sides of the section may be sucked, similarly to a Pitot tube (perfume spray principle). Results are confirmed by the first handheld wind seepd measurements on the slopes (Imre et al. 2024).

Acknowledgements

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EFFICIENCY ANALYSIS OF A 300 W_p PUBLIC ELECTRIC VEHICLE CHARGING STATION AND A 5 kW/220V ELECTRIC GENERATOR FOR RECHARGING ELECTRIC MOTOR VEHICLES

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Public Electric Vehicle Charging Stations (PEVCS) are Electric vehicle charging stations (EVCS) locations where electric vehicles are charged with appropriate security, monitoring, and conversion systems, as well as maximum current and voltage for fast charging (Kannan, 2022). These stations generally obtain their energy sources from various types of electricity sources, and for the 1st case, used Solar Power Plants (SPP) system, which the main component is photovoltaic (PV) module. The specifications of the EVCS PV module are 1110 mm x 1134 mm, and used technology monocrystalline. Meanwhile, for another case, EVCS is electric diesel generators whose main function is to generate electricity, and do as a charging station, as well, but the main energy source, used fossil fuels. The purpose of this study is to compare the performance and efficiency of electric vehicle charging systems using 300 Wp solar panels and 5 kW/220 V diesel generators in charging batteries for electric motors. The schematic wiring diagram is shown in Fig. 1.

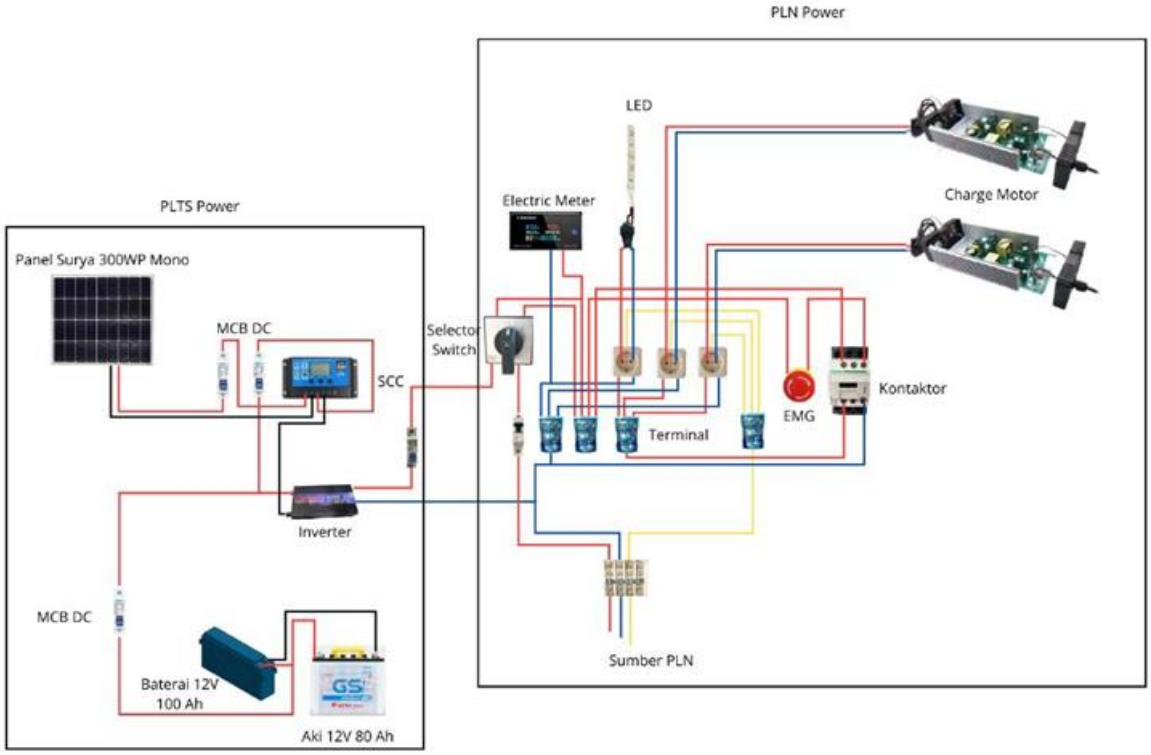

Fig 1. Wiring diagram of an electric vehicle charging systems

The data collection of the SPP charging station was carried out for 9 consecutive days with a data collection duration of 6 hours per day, from 08.00 to 14.00 WIB. Data was recorded every hour. The SPKLU (PEVCS) system consisted of PV module, a solar charge controller (SCC), a 100 Ah battery, and additional measuring tools such as the Windy App, a multimeter,

and a manual recording tool. The PV module were positioned facing North at a 10-15 Degree Inclination. Testing parameters included sunlight irradiation, current, voltage, and input power to the battery. The efficiency can be calculated using the following equation:

$$\eta = \frac{Pout}{Pin}\ x\ 100\ \%$$

P_{out} is the output power of the PV module (W), and calculated using the formula P = V × I, while P_{in} is the solar radiation power received by the PV module (W), and calculated using P_{in} = Ir × A, where V = voltage (V), I = current (A), Ir = radiation intensity (W/m^2), and A = PV module surface area (m^2).

For the diesel generator, the amount of fuel consumed was measured in relation to the output power used for charging the electric motorcycle.

$$\eta_{genset} = \frac{E_{output\ listrik}\ (kWh)}{E_{input\ BBM}\ (kWh)}\ x\ 100\ \%$$

The fuel used by the diesel generator was Pertamina Dex with a cetane number of 53 and a density of 0.84 kg/L, according to Pertamina's specifications. Based on data from the Ministry of Energy and Mineral Resources (ESDM RI), the lower heating value (LHV) of diesel fuel ranges from 41.4 to 43.3 MJ/kg, with an assumed value of 43 MJ/kg for this study. The test results were analysed to calculate and compare the efficiency of both systems, determining which energy source provides a more effective and sustainable charging method for electric motorcycles. The results showed that the solar power system (PLTS) had higher efficiency (22.53%) but limited energy capacity and high weather dependence, while the diesel generator had lower efficiency (16.87%) but greater environmental stability. Construction and operational costs of the PLTS were lower, and the cost per full charge was also significantly cheaper (Rp 6,609) compared to the diesel generator (Rp 11,560).

Acknowledgements

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OPTIMIZATION OF RENEWABLE ENERGY INTEGRATION USING REINFORCEMENT LEARNING

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The need for renewable energy is rapidly increasing due to escalating global warming and the continued rise in demand linked to population growth (Mellit & Pavan, 2010). Thus, the share of renewables in global energy demand is rapidly growing. However, integrating large-scale intermittent renewables presents challenges and opportunities for the power grid, as their increased penetration causes various technical issues. To harness the vast potential of variable renewables while minimizing related challenges, it is essential to understand the availability of different renewables and their complementary operational requirements. Spatially distributed solar PV and wind energy are widely used to address the instability caused by higher renewable integration. Additionally, their optimized combination reduces the need for energy storage and curtailment while improving overall system flexibility (Solomon et.al 2020).

In our previous work, a new methodological framework for integrating large-scale PV systems was introduced, centred around the 'System Use Index (SUI)', a newly developed metric designed to identify optimal and near-optimal parameter configurations that enhance overall system performance. While the results using this index demonstrated promising outcomes, establishing the credibility and robustness of the framework requires rigorous validation against widely recognized and proven modelling approaches. To this end, the current section employs a well-established machine learning technique-Deep Reinforcement Learning (DRL), to optimize system performance using one full year of PV generation and demand data.

Reinforcement learning is based on the Markov decision process, a mathematical modeling of decision-making that uses discrete time steps (Cardo-Miota et al., 2025). At every step, the agent takes a new action that results in a new environment state. Similarly, the current state is attributed to the sequence of previous actions. In this work, an RL-based battery dispatch model using the Proximal Policy Optimization (PPO) algorithm was implemented. To train the RL agent, we used Stablebaseline3, a popular library of RL algorithms. The RL agent is trained for 100,000 time steps. The agent interacts with a custom environment simulating hourly renewable generation and load demand. The action space is continuous, representing charge/discharge decisions, and the reward function penalizes curtailment and unmet demand while incentivizing energy delivery (served load). The model was trained over a one-year horizon using PV and load data, with battery parameters reflecting realistic operational constraints.

The simulations were conducted using consistent input parameters as in the rule-based approach, with diurnal storage capacities below 0.5 times the average daily demand, a fixed storage duration of 6 hours, and a renewable-to-load ratio of 1.04. Notably, at a diurnal storage level of 0.3 times the average daily demand, the RL-based model achieved a renewable energy penetration of 89.33% with only 12.65% curtailment. With the same input parameters, the newly proposed approach yields 90% penetration and 16% curtailment, but at a higher RE-to-load ratio of 1.1 as optimized by the newly introduced system use index. The negligible disparity between the results of the two models shows that the newly proposed approach is reliable in determining optimum system parameters. Fig. 1 shows the energy flow balance as optimized using the RL approach.

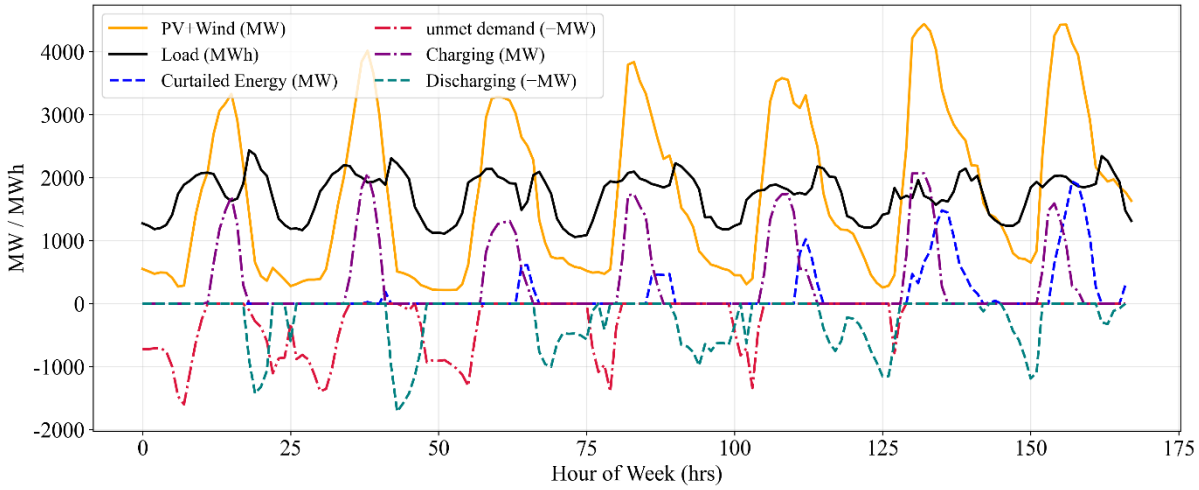

Fig. 1. Hourly dynamics of energy flow balance for the RL-optimized configuration over the one week of May

Acknowledgment

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ACTIVATION OF 1 kW$_P$ SOLAR POWER SYSTEMAT THE ITENAS BANDUNG: IDENTIFICATION AND PROBLEM SOLVING

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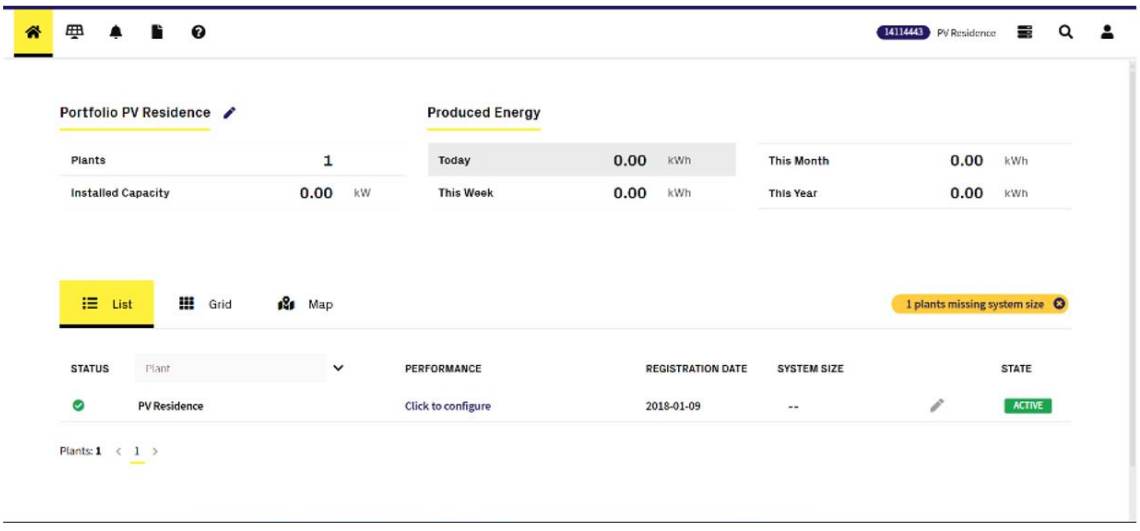
The increasing demand for renewable energy has encouraged the utilization of solar photovoltaic (PV) systems as an alternative to conventional power generation. At ITENAS Bandung, a 1 kWp solar power system has been installed to support research and educational activities in the field of sustainable energy, which can be monitored through an online platform.

The system used the ABB UNO inverter equipped with a VSN300 WiFi Logger Card, enabling real-time data transmission to the internet. The ABB UNO series is a single-phase string inverter commonly used in small-scale PV systems, known for its high conversion efficiency, built-in protection features, and compatibility with remote monitoring solutions. The addition of the VSN300 WiFi Logger allows performance data – such as voltage, current, energy production, and system status - to be uploaded automatically to ABB's online monitoring portal. The inverter system actual is shown in Fig. 1.

However, currently, the system has experienced issues with internet-based monitoring, resulting in inverter data disconnection and limited access to real-time performance information, as shown in Fig. 2.

Fir. 1. The existing inverter ABB UNO



Fir. 2. The dashboard feature of the PV system performance

This study aims to identify the causes of the inverter's data disconnection from the internet in the 1-kWp solar power system at ITENAS Bandung. The research methods include field observation, system configuration inspections, network connectivity testing, and data analysis from both the inverter and the monitoring platform.

The results show that the main cause of the inverter's data disconnection is damage to the VSN300 WiFi Logger Card, which serves as the communication interface between the inverter and the cloud server. The malfunction of this component prevents power generation data from being transmitted and displayed on the online monitoring system. Based on this finding, it is recommended to replace or repair the WiFi Logger module and conduct regular inspections of the communication and network systems. By these corrective actions, the monitoring of the solar power system's performance can be restored to optimal condition, supporting research and educational activities in renewable energy at ITENAS Bandung. The WiFi logger is presented in Fig. 3.

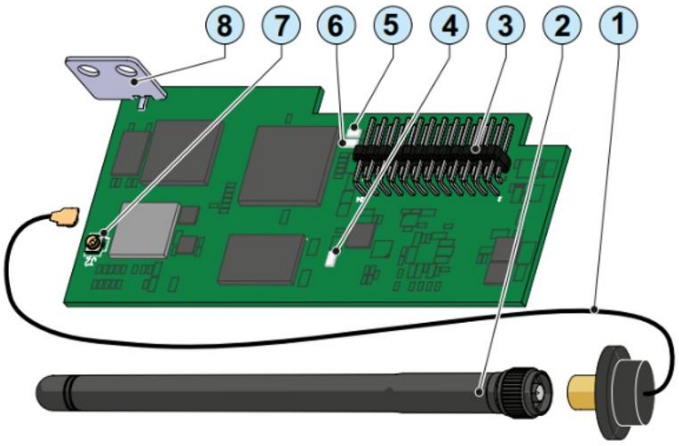


Fig. 3. WiFi logger card

Acknowledgments

This research synopsis is released as an outcome of multidisciplinary international partnership between ITENAS Bandung, Indonesia and Hungarian University of Agriculture and Life Sciences, Hungary.

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PROPOSING USER-FRIENDLY MATHEMATICAL MODELS FOR A RECENTLY INVENTED SOLAR POT

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Creating user-friendly mathematical models to forecast temperatures in solar cookers is essential, as solar cooking represents an important method of harnessing renewable energy (Getnet et al., 2023) and lowering emissions (Saini et al., 2023).This research concentrates on the solar pot (Géczi, Kicsiny, 2021), a novel device registered with the Hungarian Intellectual Property Office as a utility model (patent no. 5489).

The pot is designed for heating or cooking food, drinks, and other liquids, and its structure is similar to a double-pipe heat exchanger, consisting of an outer mantle and an inner cooking tank. A prototype of the pot has been developed and investigated, but its performance had not yet been analysed through modelling, simulation, or experimental testing thoroughly. The current research is focusing on filling this gap and providing the latest results.

The purpose of this study is to formulate mathematical models capable of predicting the temperatures in both the pot's mantle and cooking tank. The research presents the modelling and simulation outcomes, offering valuable insights into the system's efficiency and possible uses.

Additionally, an experimental setup combining the solar pot with a solar collector was constructed (see Fig. 1.) to carry out measurements under different conditions. These experiments were used to assess the pot's performance and to verify the accuracy of the proposed models.

The findings confirm the solar pot's practicality and demonstrate that the developed models can predict temperatures with remarkable precision.

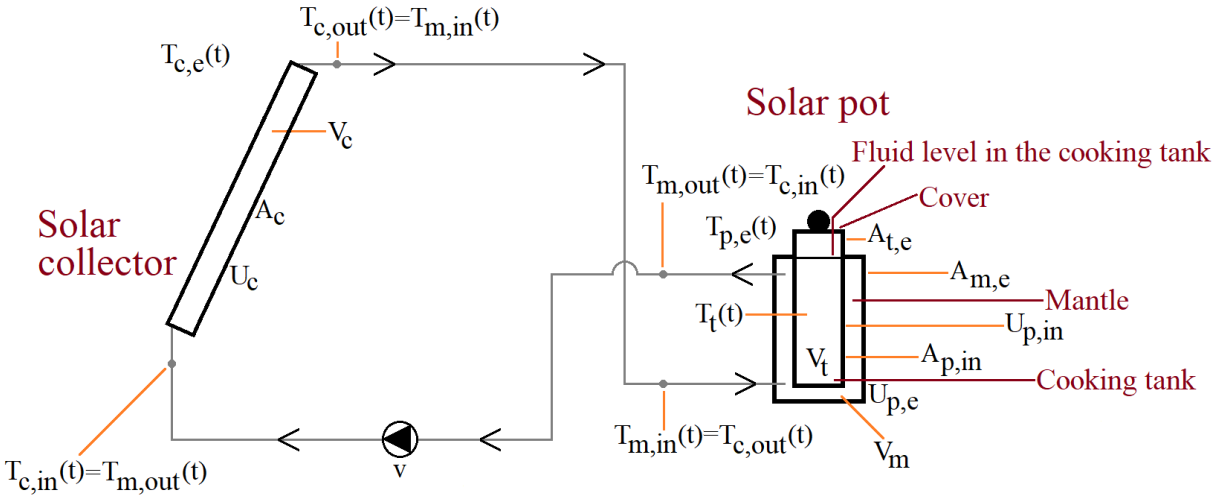

Fig. 1. Experimental system of the solar pot and the solar collector

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DEVELOPMENT OF SOLAR ENERGY COURSE IN VIEW OF "THE 4TH GENERATION UNIVERSITY": A PRELIMINARY DISCUSSION

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The university transformation was moving tremendously at the moment, in line with trends digitalization and automation of industrial processes through the integration of advanced technologies like the internet of things (IoT), artificial intelligence (AI) and machine learning, big data, cloud computing and analytics, etc. Furthermore, the word called it as the fourth industrial revolution (industry 4.0).

The "4th generation university" is an emerging concept that integrated approach to education, research and innovation, with a strong focus on societal impact and regional development. The idea is that these global universities embrace local innovation with the aim of tackling societal challenges and driving regional economic growth (TU/e, 2025).

Generally, in implementation level the term of the 4th generation university combined some aspects such as teaching, research, knowledge exchange, and entrepreneurial activities, directly under the same an umbrella, rather than as separate umbrellas. In this term, collaborative partnerships to drive sustainable growth and having impact to the societal/environments, are really important.

Summary of some characteristics of the university generation (1st-4th generations) are shown in the below table (Steinbuch, 2025; TU/e, 2025).

	1st generation	2nd generation	3rd generation	4th generation
Objective	Education	Education and Research	Education, research & know how exploitation (knowledge transfer)	Education, open innovation (research and valorization)
Role	Defending the truth	Discovering nature	Creating value	Enabling value creation (enable societal value creation)
Method	Scholastic	Mono-disciplinary science	Inter-disciplinary science	Multi-actor innovation (transdisciplinary research and multi-actor innovation)
Human capital development	Professionals & scientists	Professionals, scientists	Professionals, scientists & entrepreneurs	Professionals, scientists, entrepreneurs, artists, customers, ecosystem participants
Orientation	Universal	National	Global	Ecosystem
Language	Latin	National language	English	English
Organization	Colleges	Faculties	Institutes & centers	Innovation spaces
Management	Rector and Chancellor	Part-time academics	Professional management	Disruptors

In addition, the feature of the 4th generation university is enriching by integration in global and local ecosystem (in view of interaction) and powerful in advanced technology and AI integration (in view of technology integration).

The successful of the university level in implementing the 4th generation university concept is dependent on the readiness level of all academic communities (study program and lecturer) in that university, especially in understanding of the characteristic the 4th generation university concept and expected outcome.

For a small case study, we focussed on the field of solar energy. The topic of solar energy mostly is a part of the renewable energy technology course subject, both as mandatory or elective course, in a relevant curriculum of the study program. However, in some study program of some universities, the solar energy is the course subject itself, for 1 semester (minimal).

Refer to the characteristic university table (previously), it shows that in case of toward the 4th generation university, some of improvements should be addresses to the solar energy course. As a further outcome should integrate of the advance technology and also drive sustainable growth and having impact to the societal, and also directly driving regional economic growth, detail activities/learning achievement of this subject should be considered.

In this paper, a discussion about how to improve the content curriculum of solar energy subject will be elaborated, and some education method and research activities (previously) will be used as first step to update/improve the outcome the course, in line toward "the 4th generation university" (Rusirawan, 2023; Rusirawan, 2025).

Acknowledgements

The synopsis of this scientific work is presented as one of the partnership implementations between Institut Teknologi Nasional Bandung (Indonesia), Slovak University of Agriculture in Nitra (Slovakia), Czech University of Life Sciences Prague (Czech Republic), and Hungarian University of Agriculture and Life Sciences, Gödöllő (Hungary).

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PERFORMANCE EVALUATION OF CENTRIFUGAL PUMP USING INFRARED THERMOGRAPHY: AN INITIAL STUDY

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Before the infrared thermography arise, heat identification was done using contact sensors such as thermometers or thermocouples, which only measured temperature at a single point and posed risks when used on high-temperature objects. Today, infrared thermography technology enables temperature measurement without direct contact and displays temperature distribution in thermal images. In industry, this technology is used for early detection of component failures, identifying hot spots, and maintaining equipment reliability and efficiency (Usamentiaga et al., 2014). Infrared Thermography functions to detect surface temperature distribution without contact by measuring infrared radiation. When a pump experiences performance decline or failure, the recorded thermal patterns can provide information about the cause of the problem, such as misalignment, bearing damage, cavitation, or hydraulic inefficiency. Temperature anomalies at specific locations can be diagnosed, allowing the root cause of the issue to be identified (Gaussorgues, G.1994). The illustration of Infrared thermography utilization is shown in Fig. 1.

Fig. 1. Thermography infrared

A centrifugal pump functions to move fluid through a rotating impeller to generate a stable and efficient flow. Optimal pump performance is crucial to ensure the overall process system operates properly and achieves maximum work efficiency (Dietzel, 1988). A schematic diagram of a centrifugal pump can be seen in Fig. 2.

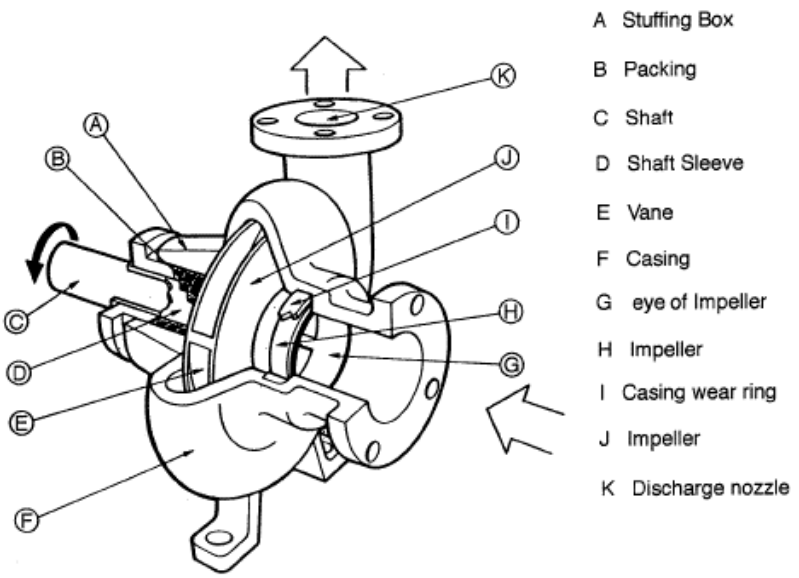

Fig. 2. Schematic diagram of the centrifugal pump

The method used in this research to evaluate the performance of the centrifugal pump is thermal measurement using the FLIR TG165-X thermal camera. The measurement data is then processed with the help of FLIR Tools software. This process aims to convert the infrared radiation from the pump's surface into a two-dimensional thermal map, which can be used to identify temperature anomalies and overheating locations on critical pump components. The initial data obtained are pseudo-color thermal images (thermograms) showing the temperature distribution on the pump surface. These thermal images are then analyzed qualitatively (based on heat distribution patterns) and quantitatively (based on numerical temperature values). The analysis results are subsequently compared with the ISO 18434 standard, which is the standard for condition monitoring and diagnostics of machines using thermography, to assess the thermal condition of the pump based on the measured temperature anomalies.

The effective surface temperature value is used to evaluate the machine's condition. The ISO 18434 standard specifically provides guidelines for the application of infrared thermography in condition monitoring and machine diagnostics, with a focus on temperature-based fault detection (ISO, 2008).

Once the data analysis process is complete, the results are used to determine the performance condition of the centrifugal pump and to support predictive maintenance decision-making.

Acknowledgments:

The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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CENTRIFUGAL PUMP VIBRATION: AN OVERVIEW

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A centrifugal pump is one of the most widely used types of pumps across various industrial sectors, such as oil and gas, chemical industries, and distribution systems. The main advantage of this pump lies in its ability to transfer fluids continuously with a stable flow (Adji, 2006). The working principle of a centrifugal pump is to convert the mechanical energy from the impeller's rotation into kinetic energy and pressure energy in the fluid. However, during operation, this pump often experiences vibration issues caused by factors such as imbalance, misalignment, bearing damage, or cavitation. Excessive vibration can reduce performance, accelerate component wear, and even lead to system (Dietzel, 1988).

To overcome this issue, vibration analysis is used as a predictive maintenance method, which involves monitoring the condition of the machine periodically. Through vibration analysis, the sources and types of mechanical faults can be identified based on the generated frequency spectrum patterns which is capable of early detection of machine conditions (Ebara, 2022). By measuring vibration parameters such as displacement and frequency spectrum using the CSI Emerson 2130 Machinery Health Analyzer, the pump condition can be evaluated based on the ISO 10816-3 standard. The results of this analysis are expected to help identify the sources of faults, determine the actual condition of the pump, and improve the reliability and efficiency of centrifugal pump operations. The schematic diagram of centrifugal pump can be seen in Fig. 1.

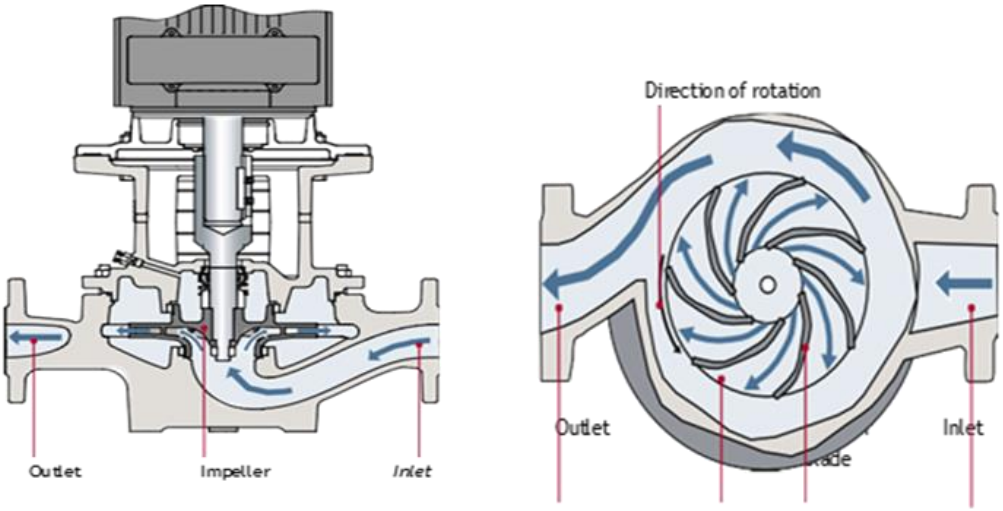

Fig. 1. Schematic diagram of a centrifugal pump

The method used to analyze vibration in this thesis is measurement using the CSI 2130 Machinery Health Analyzer vibration analyzer, processed with the assistance of AMS Machinery Manager software. This process aims to convert vibration data from the time domain into the frequency domain, which can be used to identify the location of pump component faults.

The initial data obtained are vibration graphs in the time domain, which are then converted

into graphs in the frequency domain. The results of this transformation are subsequently analyzed and compared with the ISO 10816-3 standard to assess the level of component damage based on the measured vibration levels, as shown in Fig. 2. (Putra et al., 2012). The effective value of vibration velocity is used to assess the condition of the machine. ISO 10816-3 specifically applies to machinery with a power rating above 15 kW and an operating speed between 120 and 15,000 RPM, with power ranging from 15 to 75 kW, or medium-sized engines.

After the data analysis process is completed, the results are used to make maintenance decisions for the centrifugal pump. After the data analysis process is completed, the results are used to make maintenance decisions for the centrifugal pump.

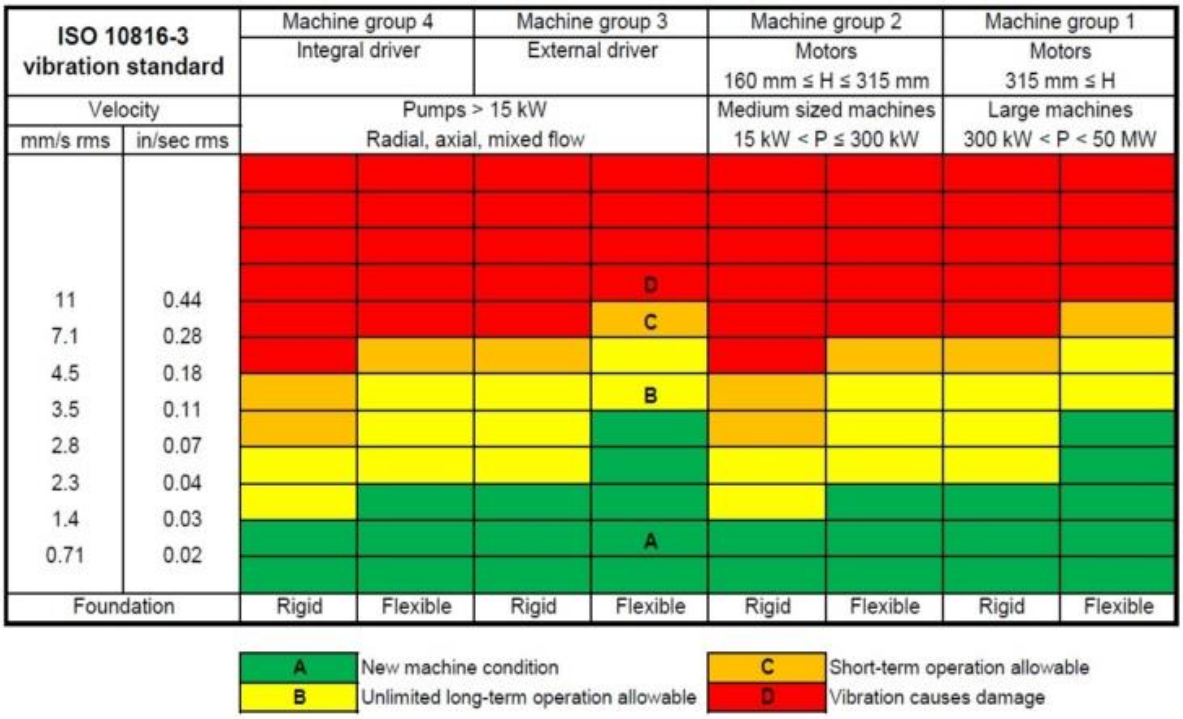

Fig. 2. ISO 10816-3 Vibration table

Acknowledgments

The synopsis of this scientific work is released as an outcome of the partnership between ITENAS Bandung, Indonesia, and PT Performa Integritas Indonesia (Fortasindo), Indonesia, an engineering consulting company specializing in risk and integrity management.

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SMART IOT-BASED THERMAL AND SURFACE MANAGEMENT SYSTEM FOR PV MODULES WITH CYLINDRO-PARABOLIC COLLECTOR

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This work presents a smart hybrid photovoltaic-cylindro-parabolic collector (PV-CPC) desalination system that combines renewable electricity generation, thermal water distillation, and intelligent surface management (Touaref et al., 2025). The novelty lies in a fully automated IoT-based three-dimensional cleaning and cooling mechanism designed in *SOLIDWORKS* and controlled by an ESP32 microcontroller.

Real-time environmental data trigger self-cleaning and thermal regulation, ensuring continuous high efficiency without manual maintenance, as shown in the Fig. 1.a,b. Field experiments performed in Gödöllő, Hungary, showed 8-15 % higher irradiance capture and 12% more daily energy yield compared with unmaintained panels. Peak irradiance reached 950 W/m², and predictive modelling achieved R^2 = 97.5-98.8% with a MAPE ≈ 7-13%, validating high reliability. The hybrid CPC produced up to 160 L day^{-1} of distilled water (≈ 64 L m^{-2} day^{-1}) with a thermal efficiency of 70% and salt rejection > 99.9% (TDS < 5 ppm), suitable for PCM, fuel-cell and many applications. The setup integrates a 50 W PV panel (17.4 V, 2.93 A), 12 V battery, CPC receiver, and IoT control board (ESP32 + Wi-Fi). The control logic activates: Cooling when $T_{pv} > T_{th}$, Cleaning when dust sensor value $D > D_{th}$. Data from temperature, irradiance, and dust sensors are transmitted to a Blynk IoT dashboard for remote monitoring. The cooling fans and mechanical brush consume less than 3 W combined, ensuring energy autonomy. The CPC subsystem reaches receiver temperatures of ≈ 350 °C, driving a compact distillation unit. The specific energy consumption is **1.8-2.2 kWh/m³**, notably below conventional MED or MD systems (2.5-6 kWh/m³).

Fig 1. Intelligent solar energy systems: (a) System implementation (b) 3D design of IoT-Enabled hybrid PV-CPC

Performance results, seasonal experiments showed consistent improvements: spring: +7% irradiance (≈740 → 790 W/m²)**,** summer: +10% (≈870 → 950 W/m²), Autumn: +8% (≈660 → 720 W/m²), Winter: +10% (≈400 → 440 W/m²), as shown in the Fig. 2. Predictive models achieved R^2 = 97.5-98.8%, confirming reliability. The specific energy consumption was only 1.8-2.2 kWh/m³, much lower than conventional desalination systems.

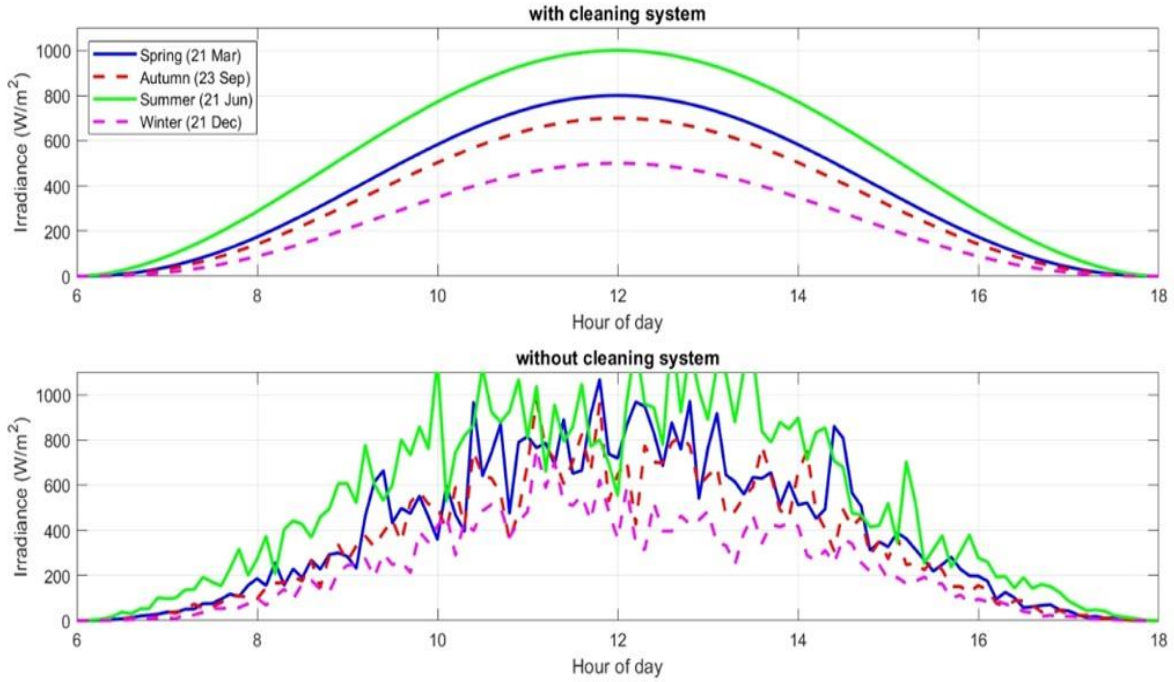

Fig 2. Effect of cleaning system on solar irradiance across different seasons

The developed IoT-enabled hybrid PV-CPC delivers simultaneous electricity generation, thermal desalination, and self-maintenance. Key outcomes: Irradiance gain = 8-15%, Energy yield ↑ 12%, Thermal efficiency ≈ 70%, TDS <5 ppm, Predictive model R^2 ≈ 0.98, Autonomous 24 h operation. This prototype establishes a scalable benchmark for sustainable solar water and energy production in remote or coastal zones.

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PERFORMANCE ANALYSIS OF SOLAR ORGANIC RANKINE CYCLES USING ISOBUTANE, R134a AND R245fa AS WORKING FLUIDS

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The organic Rankine cycle (ORC) has emerged as a sustainable method for converting low - medium grade temperature heat sources into electricity or useful heat (Permana et al., 2025, Alla et al., 2020). ORC has been effectively applied to utilize various renewable and alternative energy sources, including geothermal, solar, waste heat, biomass, and ocean thermal energy (Tartière & Astolfi, 2017). An ORC system driven by solar thermal energy, such as a solar collector, has attracted interest due to its potential to bolster renewable energy utilization and mitigate climate change. Solar thermal energy is abundant, reliable, cost-effective, versatile, and easy to use (Goel et al., 2022).

This results in its integration with ORC being very crucial. Selection of the right working fluids is essential in ORC operation as it influences the overall performance of the systems, power output, efficiency, safety, and environmental footprint of the cycle (Megaprastio et al., 2023, Dai et al., 2019). This study presents a thermo-environmental analysis of a small-scale solar-assisted organic Rankine cycle system using R245fa, R134a, and Isobutane as carefully selected working fluids.

Fig. 1 shows a schematic configuration of the proposed solar ORC model. The model consists of a solar collector (flat plate), evaporator, turbine, condenser, fluids, and circulation pumps. Solar energy heats and vaporizes the fluids in the evaporator. The vapor is expanded in the turbine to generate electricity, and the outlet vapor condenses and pump again for a new cirle (Alkahli et al., 2012).

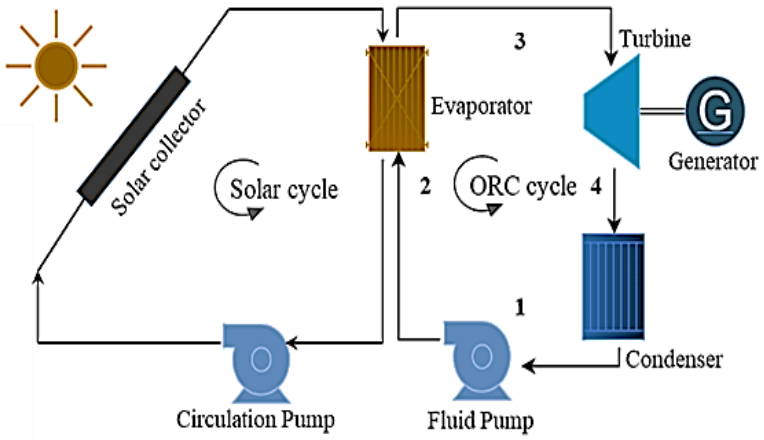

Fig. 1. Schematic diagram of solar-assisted ORC

A steady-state model was developed to investigate the influence of the working fluids on the thermodynamic performance of the system at different operating conditions, including a constant turbine inlet temperature of 110 °C with varying pressure of 10 to 20 bar, and a constant pressure of 10 bars with varying turbine inlet temperature of 90 °C to 110 °C. Net power output, heat input, cycle efficiency, and environmental metrics, such as Global Warming Potential (GWP) and Ozone Depletion Potential (ODP), were evaluated and compared.

The results show that a rise in turbine inlet pressure generally increases the net power output and efficiency, while an increase in the turbine inlet temperature increases the net power output but decreases thermal efficiency.

The study also found that under both operating conditions, Isobutane yielded maximum net power output, thermal efficiency of 61 kW and 13.9% respectively, R245fa achieved maximum efficiency of 14.36 and net power output of 31.3 kW, while R134a achieved maximum efficiency and net power output of 23.7 kW and 9.6% respectively. Compared to R245fa and R134a, isobutane is considered an environmentally friendly working fluid for running solar ORC. Therefore, solar ORC performance can be enhanced by optimization of operating conditions and selection of the right working fluids, thereby promoting sustainable energy goals.

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APPLICATION OF SOLDER RESIST COATING MEASUREMENT IN ELECTRONICS MANUFACTURING

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Electronics manufacturers most commonly use data matrix codes for product identification, which are created using a laser beam in the solder mask layer of the printed circuit board. Two marking methods are known: either by discolouring the solder mask, the laser beam penetrates the layer only to a depth of a few microns, or by completely removing the solder mask down to the surface of the copper layer in accordance with the code design (Brewin et al., 2007; Peterson 2017).

In both cases, the choice of exact laser processing parameters can only be determined by preliminary testing. However, it is often a problem during production if the raw material, in this case the circuit board, changes. The change should be understood as a change in the thickness and/or material of the solder resist layer.

Different materials do not absorb laser beams of the same wavelength equally. The result of the marking process is greatly influenced by the optical properties of the solder resist, which have not been studied so far and depend on the material composition.

In the electronics industry, different industrial marking laser sources are used to mark the solder resist layer:

1. Pulsed CO_2 laser sources are most often used to colour the solder mask layer, the wavelength of the laser beam emitted by this device is 10600 nm.

2. A laser beam with a wavelength of 1064 nm is suitable for layer removal, which is most often implemented by equipment operating with a fibre laser source. Fiber laser machines are very productive, have low investment costs and their laser sources are characterized by a long service life.

Printed Circuit Board (PCB): a basic electronic component made of 1 to 16 layers of bakelite or fiberglass resin, produced in small or large-scale production, but also in individual production. The insulating board carries a conductive layer a few microns thick on its surface.

The conductive layer is usually copper, often tin-plated. Many different coated layer systems are used in the production of printed circuit boards. DIN 40 804 standard defines the most important quality requirements for solder resist coatings.

In addition, solder resist coatings also have insulating properties due to their good electrical and dielectric properties. Anti-solder mask plays a very important role in preventing electron corrosion of copper wiring running on the surface (Ginsztler, 2000; Suppa, 2004).

Circuit board manufacturers work with different materials. Two aspects must be considered when laser marking solder mask layers. One is if the material composition of the solder mask layer changes. The other is if the thickness of the solder mask layer is much thicker or thinner than specified. The laser processing parameters set during preliminary testing cannot process all layer thicknesses with adequate quality.

If the layer is too thin or thinner than specified, the laser beam used (1064 nm) will melt the copper layer very much during layer removal, which will distort the code shape. The laser beam used in the colouring method (10600 nm) can reach the copper layer. If the layer is too thick or thicker than specified, the laser processing parameters set cannot remove the layer to its full depth during layer removal.

Currently, two solution methods are possible to avoid this problem:

1. For a given circuit board, 2 or 3 different laser processing parameters are set. Codes are created for the designated test area with a “weak”, a “medium” and a “strong” marking setting. The problem with this is that if the layer thickness changes frequently, or if circuit boards with different material compositions but the same design is manufactured, then the test area of the given circuit board often must be marked with each setting. This increases the cycle time.

2. The other method is the application of the new measurement method developed by me, during which the material composition of the circuit boards used in production is examined and the colour coordinates of at least 5 samples of different thicknesses are measured with a new measuring device suitable for this purpose, in order to identify the thickness of the varnish layer. A sample must have the expected layer thickness specified by the manufacturer. Two samples must be within or outside the tolerance range, and 2 samples must be at least ±5 μm from the optimal thickness. A 5 μm difference in layer thickness can be measured using the colorimeter.

The measurement of the material composition is necessary because in the case of the colouring method, the ratio of chemical elements in the solder resist layer and the particle size of the compounds formed by them are decisive. The material composition and the particle size and distribution of the solder resist layer are also decisive parameters in layer removal.

With the application of the colour measuring device, solder mask layers can be separated by manufacturer by measuring the colour coordinates and colour depth of the layer, and the change in layer thickness can also be measured by changing the colour depth. By quickly and non-destructively checking the thickness of the coating mask, the number of rejects can be reduced or even eliminated. Since the goal during laser marking is not only the proper removal of the coating layer, but also the subsequent work process, the printing of the solder, is largely determined. Because if this layer is outside the normal range, either very below or above the expected mask layer thickness, soldering errors can occur, such as short circuits or smearing of the solder.

The colour measuring device is a simpler, safer and cheaper solution than the X-ray coating thickness gauges currently used on the market.

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DETERMINATION OF THE LENGTH OF DARK DOLDRUMS PERIODS BASED ON METEOROLOGICAL DATA

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Within the scope of this study, the meteorological extreme weather events that lead to dark doldrums in PV systems are identified. These extreme weather events can lead to damage to the system (extreme wind speeds, hail, breakage due to excessive snow masses) or to a dark doldrum (too low radiation due to cloud cover or snow cover, etc.).

Threshold values for individual extreme weather events were defined. Hailstones with a diameter larger than 2 cm are likely to cause damage to glass and PV modules. Wind gusts of 130 km/h and more can blow PV modules out of their anchors whereas the yield of PV modules will approach zero at global radiation values below 150 W/m²

Using meteorological data from the greater Vienna area, periods with extreme weather events were identified and compared with actual PV yield data. A two-year period of a PV system installed within the vicinity of Vienna was used for the analysis

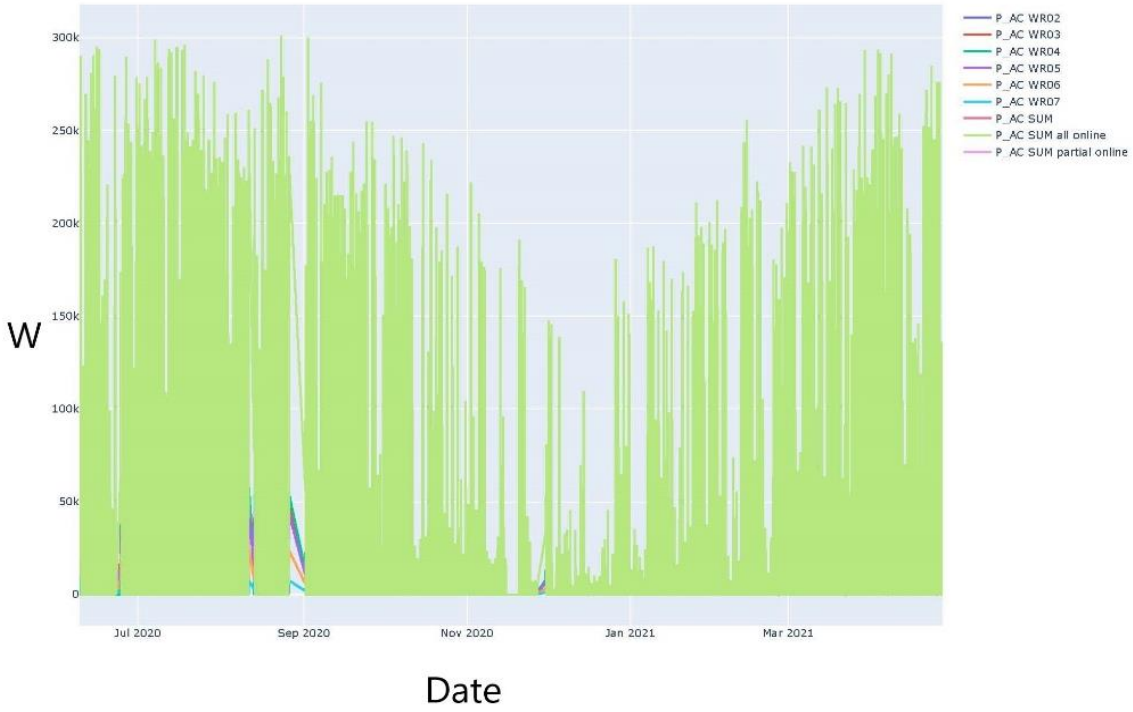
We first performed a data analysis, to investigate whether the determination of doldrum periods by using meteorological data fits with the "no yield" periods of real PV systems. Then we investigated the length of doldrum periods.

150 stations with classic meteorological measurements, including among other elements, air temperature and humidity, wind speed and direction, global radiation, precipitation and the form of precipitation are freely available.

Stations in the vicinity of Vienna were compared with PV yield data of a station situated in Greater Vienna.

In the figure below one and half year f hourly PV yield data (inverter data) are shown. Among other things, it includes a period of weather with strong thunderstorms (damage caused by lightning strikes in the region).

Results that are expected should bring conclusions to the question of whether the use of meteorological data is sufficient to draw conclusions about serious PV yield fluctuations, or whether data from PV systems are indispensable to precisely predict the possible effects of weather events.



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ROTARY TWIN SCREW AIR COMPRESSOR: VIBRATION PHENOMENA

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The air compressor is an essential component in modern industries, functioning to provide compressed air as an energy source for pneumatic systems.

In efforts to enhance machine efficiency and reliability, the rotary twin screw air compressor is widely used due to its ability to generate high-pressure air with low noise levels and stable performance. Its working principle is based on two helical rotors that interlock to form compression chambers, producing compressed air (Wu et al., 2021).

However, the performance of a rotary twin screw air compressor is highly influenced by its mechanical condition. One of the main indicators used to assess this condition is vibration, which can occur due to factors such as unbalance, misalignment, mechanical looseness, or bearing defects (Girdhar, 2004).

Excessive vibration can lead to decreased efficiency and even system failure. Therefore, vibration analysis is used as a diagnostic method in predictive maintenance to detect potential failures at an early stage, allowing maintenance actions to be taken promptly and ensuring operational efficiency remains optimal (Setyawan, 2013). The standard layout of a twin-screw air compressor is shown in Fig. 1 and consists of two counter-rotating helical rotors housed inside the compressor casing. Gas intake and exhaust occur through nozzles typically located at opposite ends of the compressor. The rotors can be designed with three, four, or five lobes.

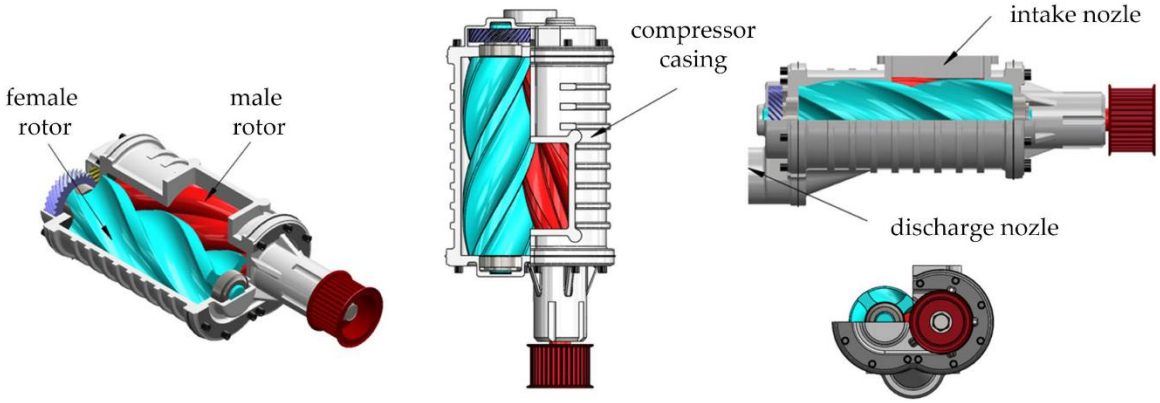

Fig. 1. Standard layout of a twin screw air compressor with corresponding parts

This study focuses on the vibration analysis of a rotary twin screw air compressor as an effort to evaluate its mechanical condition and detect potential component failures. The main objectives of this research are to determine the vibration characteristics during operation, identify the dominant sources or causes of vibration, and assess the vibration severity level based on ISO 10816-3 standards. Vibration data were collected using an Emerson CSI 2130 Machinery Health Analyzer equipped with a triaxial accelerometer, and the measurements were processed using AMS Machinery Manager software in both time and frequency domains to identify dominant fault signatures.

Through this analysis, it is expected that accurate information regarding the actual condition of the compressor can be obtained, which can serve as a basis for determining appropriate maintenance strategies and preventing further damage. The findings are expected to contribute to the development of condition-based maintenance models and improve reliability assessment frameworks for rotary compressors.

Furtherly, the results of this study are intended to improve operational efficiency, extend the machine's service life, and support the implementation of a more effective predictive maintenance system within industrial environments.

Acknowledgments

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EXPERIMENTAL ANALYSIS OF SOLAR DRYING FOR APPLE SLICE UNDER DIFFERENT LOADING CAPACITIES

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Solar energy is an important clean energy source with renewable and pollution-free characteristics. Solar drying, a key technology for the conversion and utilization of solar energy, is mainly applied to the drying of agricultural products. It is a highly effective and widely used method of food preservation with extensive practical applications. Many researchers have devoted their efforts to improving drying performance and product quality. This study experimentally analyses the differences in drying performance under various loading conditions (Madhankumar et al., 2025).

The experiment was conducted at the Solar Energy Laboratory of the Hungarian University of Agriculture and Life Sciences. The solar air heater used in the study was 1.25 meters long and 0.5 meters wide. The absorber plate of the air heater was made of copper, with dimensions of 121 cm in length, 46 cm in width, and 1.2 mm in thickness. The copper plate was coated with black paint to enhance its heat absorption capacity. A 5.5 cm air gap was maintained between the absorber surface and the transparent cover, forming an upper air channel. The outlet of the collector was connected to the drying chamber (Machi et al.,2025). The experimental setup is shown in Fig. 1.

Fig. 1. The experiment setup for solar drying

The drying chamber was constructed using high-performance extruded polystyrene (XPS) insulation boards with a thickness of 5 cm. The boards had a density of approximately 35 kg/m³, a specific heat capacity of 1450 J/(kg·K), and a thermal conductivity of 0.033 W/(m·K), which effectively reduced heat losses. The drying chamber was equipped with three trays made of fiberglass mesh, which facilitated air circulation. Apple slices were placed on the trays for drying (Halefom et al., 2025).

Temperature data were recorded using Type-T thermocouples, while relative humidity was measured with HIH-40000 series humidity sensors. The airflow rate was determined using a differential pressure sensor in combination with an orifice plate. Solar radiation intensity was measured using a pyranometer. All experimental data were recorded through an Advantech ADAM-4017 data acquisition module and stored on a laboratory computer.

In the experiments, two sets of drying tests were conducted: one with 0.9 kg and 0.45 kg of apple slices, and another with 0.9 kg of apple slices and an empty chamber. The temperature and humidity variations under different loading conditions were recorded. By analysing the corresponding experimental data, the performance differences under various load conditions were determined.

Acknowledgements

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