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Review Article

Photovoltaic Solar Chimney System: A Review

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ABSTRACT

Photovoltaic (PV) technology is one of the harvesting techniques for renewable energy resources, which can meet future energy demand. One of the most significant research issues right now is the marriage of solar cell technology with solar chimney technology. Because of its uses for simultaneous power production, ventilation, and heating, PV-solar chimneys are gaining a lot of interest. A study of the literature is presented in this article, which includes several designs of a PV-solar chimney system as well as their thermal and electrical applications. The review examines the impact of design and operational parameters on the performance of the PV-solar chimney, including the glass cover, use of a direct current fan, façade width, air vent, air gap thickness, thermal insulation, packing factor, coverage, heat storage, air mass flow rate, PV cell cooling, southern windows, and solar cell tilt angle. A comparison of the PV-solar chimney system and the traditional solar chimney is also shown, as well as the application of this unique technology. Engineers and researchers will benefit from this review paper, which will give information for future study.

1. Introduction

The rising cost of existing fuels, as well as the associated pollution, has prompted scientists to look for renewable and non-polluting energy sources for the environment [1]. Because it is easily available, does not need complex technology, and does not contaminate the environment, solar energy is one of the most significant energies that scientists have sought to use [2]. However, the problem with solar energy systems is that they are inefficient, and researchers have been working to enhance their efficiency. Solar chimneys, also known as sun updraft towers, are one of the methods that are now being utilized to generate electricity utilizing solar radiation [3]. The solar chimney includes a circular area of glass placed at a certain distance from the Earth's surface, and at the center of this circle is a high chimney similar to the chimneys utilized in electrical power stations. The world is currently experiencing an energy crisis, which has emerged as one of the most pressing issues as a result of the massive and ongoing growth in energy use, which has exhausted traditional energy supplies. There is also a finite supply of traditional energy supplies, as well as a major

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increase in fuel prices and environmental concerns. As a result, research and studies have begun to focus on renewable energy, particularly solar energy, to address traditional energy problems and fuel scarcity, and to replace them with a clean and ecologically beneficial alternative. One of the most essential sources of energy that humans can use is that which comes from the sun. It is a permanent energy source that does not require the use of gases or byproducts that are harmful to the environment in comparison to other resources.

Schlaich Bergermann [1] did research on At 1981, a German structural engineering business built the first prototype solar chimney power plant in Manzanares, Spain, some 150 kilometers south of Madrid, with a peak power output of 50 kW. (Fig. 1). A solar chimney with a height of 194.6 meters, a diameter of 5.08 meters, a metallic wall thickness of 0.00125 meters, and a collector with a radius of 122 meters and a PVC roof, as well as a single-rotor turbine system with four blades at the chimney base, were among the components of the plant. This prototype was operational from 1982 to 1989, and the electricity generated was supplied into the local power supply.

Figure1.Solar Chimney Test Facility, established in 1982–1983 in Spain.

In addition to the saline water desalination approach, K. Rahbar and A. Riasi [2] suggested two unique ideas for solar chimney power plants utilizing translucent photovoltaic cells (PVSCP) (PVDSCP). The models were created using mathematical designs.The study showed that the collector efficiency of PVDSCP reached 26.13% and 21.92% which is higher compared to the conventional and PVSCP respectively(Fig.2).Plant's efficiency optimization exhibited PVDSCP efficiency of 37.15% and 36.1% which is higher than the optimized CSCP and PVSCP respectively. Hence, using PVSCP and PVDSCP can improve plant efficiency of the main Manzanares pilot plant almost by 55.97% and 71.8% respectively.

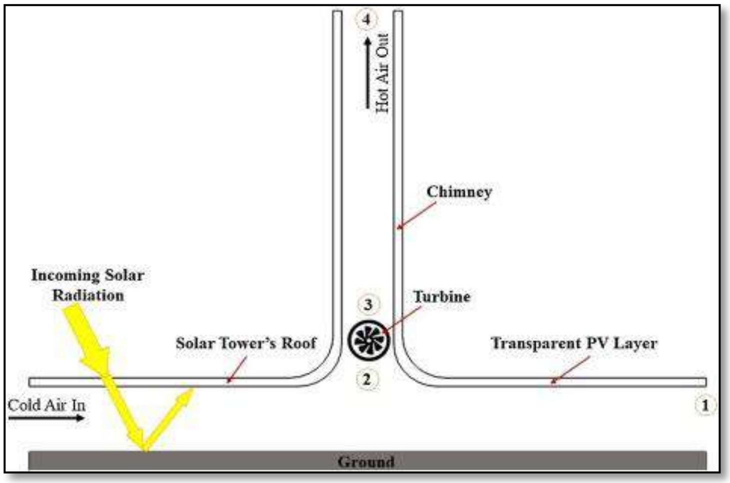


Figure2.Solar Chimney.

A prototype solar chimney system was created by Ketlogetswe et al. [3] with a glass-reinforced polyester chimney with an inner diameter of 2 m and a height of 22 m, as well as a 160 m2 collection base area. The highest peak temperature was recorded after the largest peak of irradiation because the earth absorbed part of the incoming solar energy, which was later released. Two layers of compacted earth around 10 mm thick and a layer of crushed stones make comprised the absorber materials under the roof. The crushed stone layer was put over the compacted soil layer's top surface.

Siamak et al. [4] investigated the use of an innovative solar chimney design to cool a semi-transparent photovoltaic (STPV) system. For the system, a mathematical model was created. The suggested approach can lower the STPV average temperature by up to 15 degrees Celsius (Fig.3). The results revealed that sun radiation of 500 W/m2 would boost electricity output by 29%. The temperature of the collector output indicated by the suggested model was 38.54 °C, which was in good agreement with data from the Manzanares power plant (38 °C)..

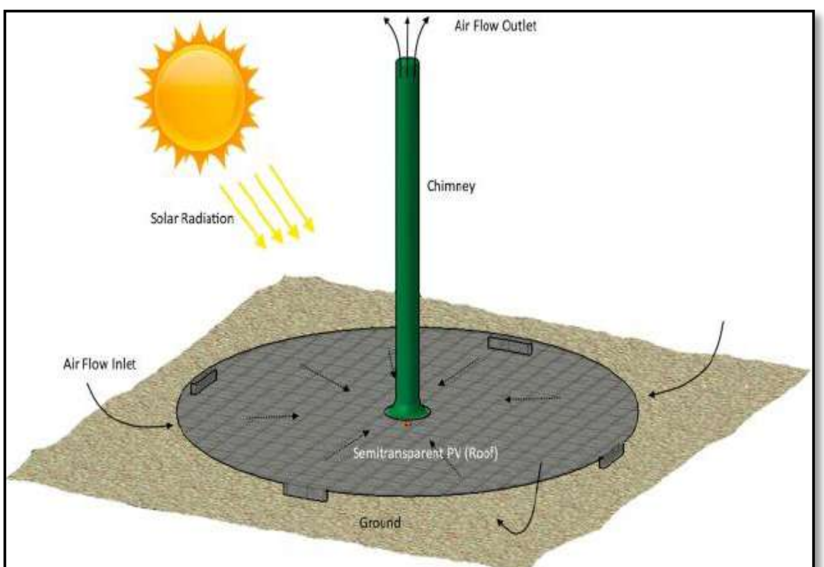


Fig 3. Schematic diagram of the proposed system.

Shahreza and Imani [5] planned and built a solar chimney with two intensifiers to increase the irradiance of the sun all around it. The employment of these intensifiers surrounding the solar chimney led air velocity to rise, which resulted in a significant boost in power output. Figure 4, shows a shot of the solar chimney and intensifier also Results show that utilization of intensifiers caused an increase in velocity magnitude in the chimney and consequently more power was generated. The maximum velocity of 5.12 m/s was reached which is remarkable, considering the small size of the SC structure.

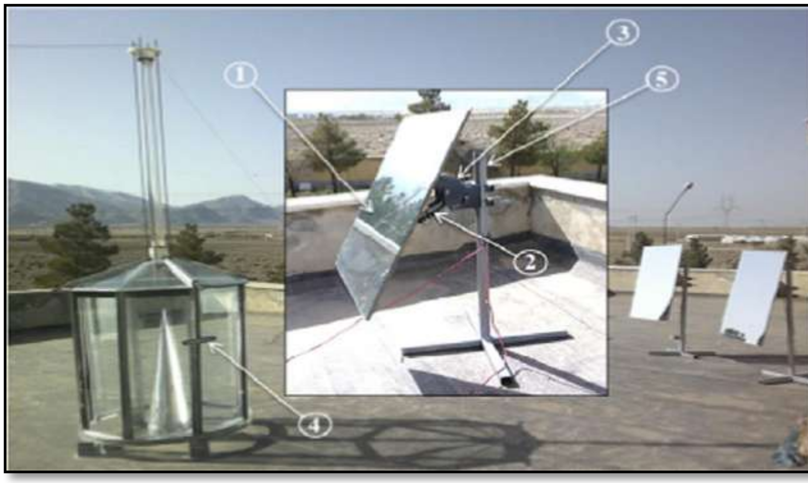


Fig.4. solar chimney and intensifier.

A. Habibollahzade[6] studied solar updraft tower (SUT|) by employing photovoltaic-thermal (PVT) panels. A parametrized study was conducted to check out the effect of convenient metrics on the system performance utilizing EES software. Another multi-objective optimization (MOO) was performed to evaluate the maximum solution points from 3E perspective and also the well-balanced solution perspective. Parametrizes study showed that at lower temperature of PV surface, the SUT/PV system does more efficiently. MOO results found out that well-balanced operating point, exergy-efficiency and cost value of the SUT/PV were acquired as 3.304% and 241.6 $/h. see Figure 5.

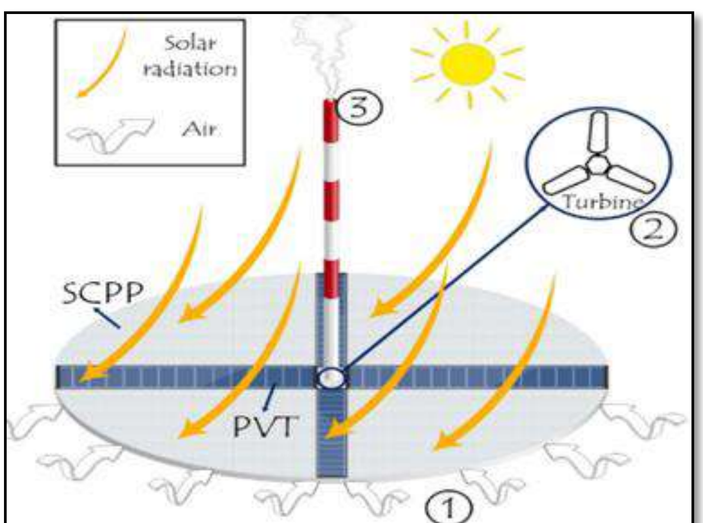


Fig 5. Schematic diagram of the proposed renewable energy system.

In Malaysia, Al-Azawie et al. [7] conducted an experimental and numerical evaluation of the potential of six different ground materials. Ceramic, sawdust, sand, dark green painted wood, black stone, and pebbles were among the materials used to convert sun radiation to kinetic energy. The results showed that black stone and ceramic fared better than other materials. Black stone has been recommended as an absorbing material in solar chimneys due to its availability, despite the fact that ceramic has a higher heat storage capacity.

Koonsrisuk [8] conducted two studies, one upon modeling a solar chimney, taking into account the solar collector, chimney, and turbine. Another straight forward strategy to find the output power of the turbine. The proposed and resultant mathematical models were solved theoretically by an iterative method. This study declared that the optimal relationship between the turbine extraction pressure and the usable running pressure for the designed system is seen to be roughly 0.84.see figure 6.

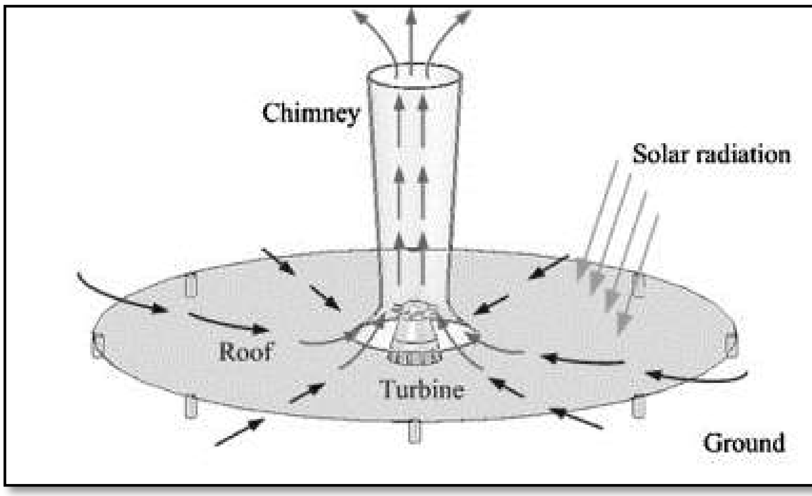


Fig 6. solar chimney power plant.

Aja et al. [9] investigated the impact of wind speed and direction on the performance of a south-facing inclined solar chimney. The wind speed was shown to have a significant impact on convective heat loss to the ambient through the walls and cover. The results also showed some performance degradation when the wind is from the north. The findings also revealed that the walls of the air flow channel of the system resist the wind from sweeping the hot air generated in the system out to the ambient.

D. Eryener and H. Kuscu [10] studied an innovative composite solar chimney model considering photovoltaic panels and percolated solar collector. The outputs of the study were monitored for 18 months. Outcomes showed that the performance of the hybrid solar chimney improved by about 2 percent on average compared to the stand-alone PV system. On an average sunny day, the temperature increases in the hybrid solar tower is seen to be 12 to 14 ° C. During 24 hours, energy was delivered on a continuous basis. The results showed that the use of solar energy varies from 60% to 80% during the day.

Fig 7. solar chimney power plant.

Okada with his coworkers[11] In 2015, instead of using a cylindrical tower, they used a diffuser tower to boost the air velocity in the turbine. The results showed that compared to the convectional cylindrical model, this model increased air velocity by 1.38–1.44 times, resulting in 2.6–3.0 times more power generation.

F. Cao et al. [12] built a program to simulate the solar updraft tower (SUT) performance by using TRANSYS software. Results showed that the power output of SUT is more appropriate to the local solar irradiation than it is to the environment temperature. Also it's found that the higher-capacity SCPP has better cost-benefit characteristics

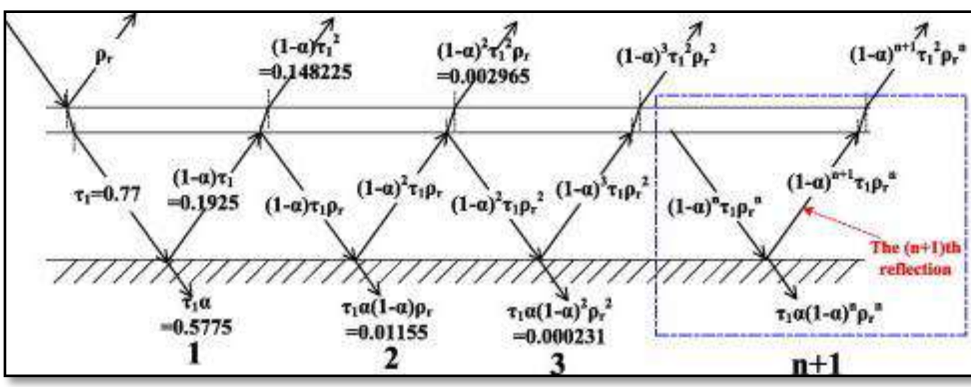


Fig 8.multible reflection between the solar collector cover.

Von Backstrom and Fluri [13] focused examined how volumetric airflow affected chimney power production under different turbine operating conditions and aerodynamic losses. The pressure drop value range anticipated by the study agreed with other researchers' predictions.

Sherif and Padki [14] are two of the most well-known figures in the Islamic world. They developed a single model in 1999 to examine the performance of solar chimneys. The analytical model was used to get the equations for available power and solar chimney efficiency. The equation showed how several geometrical and operational characteristics influenced the chimney's performance. The analytical model's predictions have an error rate of 4–6%.

Hussain et al. [15] studied and proposed a hybrid solar updraft tower approach using a traditional solar chimney combined with an external heat supply from flue gases. Moreover, three operational cases of the proposed system were examined. It was found that the heat supplied by flue gases led to the overall improvement of the solar chimney and increased the power output throughout the night. By placing thermal enhancing channels without flue-gas, flow at chimney base had an overall increase of 6.87 in the velocity and 6.3% in air flow temperature.

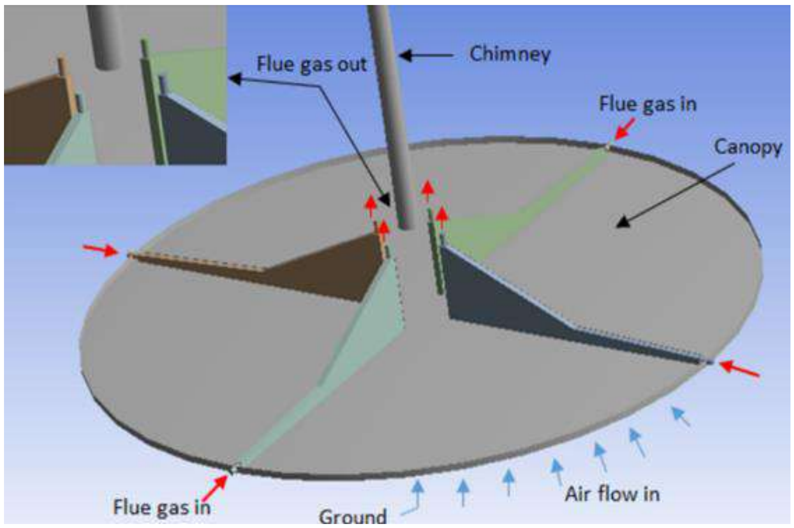


Fig 9. Experimental thermal solar chimney.

In 2004, von Backstrom and Gannon [16] provided mathematical formulae to demonstrate the impact of each coefficient on turbine efficiency, constructed solar chimney turbines, and established the basic turbine architecture based on turbine efficiency. Figure 10 depicts a basic schematic turbine configuration.

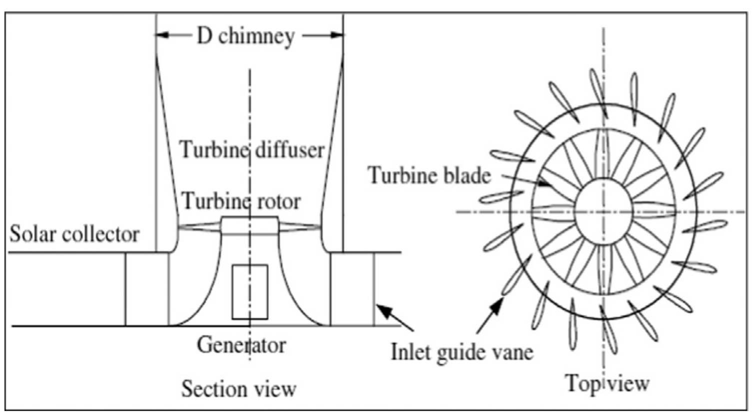


Fig. 10. solar chimney and turbine .

Mehran et al. [17]Developed and manufactured a small solar tower power plant. Results showed a temperature gap between collector outlet and environment reached to 26.3^{o}C. It was found that for various collector inlet gaps, shrinking the size of the inlet has a beneficial impact on the performance of solar chimney output. inside the chimney, the peak air velocity of 1.3 m/s was registered, while the entry velocity of the collector was about zero.

Fig11. View Experimental solar chimney power setup.

Huang et al. [18] in 2007. Studied A numerical simulation was done using the Spanish prototype plant by .The Boussinesq model and the Discrete Ordinate radiation model (DO) were adopted for natural convection and radiation, respectively.They concluded that the increase of solar radiation intensity increased the temperature difference be- tween the inlet and outlet of the collector and the differential pressure of the collector-chimney transition section.

Koonsrisuk and Chitsomboon [19] In 2009, by integrating eight key factors into one dimensionless variable, researchers were able to build a dynamic resemblance between a prototype and its scaled models. They quantitatively compared three physical configurations of the plant (totally geometrically identical, somewhat geometrically similar, and different kinds).

Ming-Hua et al. [20] studied the conventional solar chimney by implementing an axisymmetric, two dimensional (2D) CFD analysis. A numerical simulation relying on Manzanares power plant included an enhanced solar radiation model in the collector has been proposed which was completely coded to emulate the DO radiation and solar ray tracing. It's found that the proposed 2D simulation showed a good compatibility with the three-dimensional methods in the literature and experiment results.

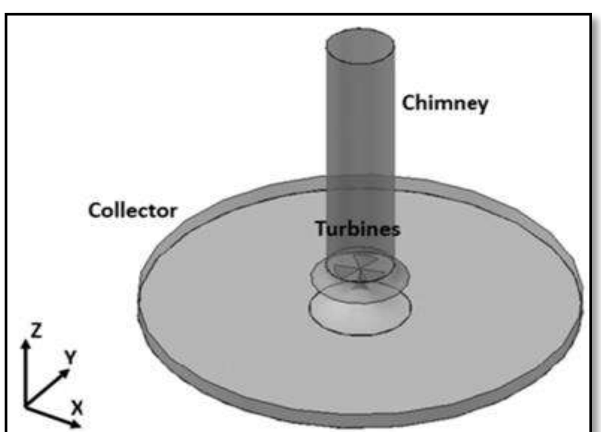


Fig 12. Schematic diagram of the proposed system.

Chergui et al. [21] (2010). They investigated the fluid dynamics and heat transfer of air flow with an axisymmetric system in a dimensionless form. The study's scope and boundary conditions are depicted in Figure 20. The results indicated that the flow remained laminar for most Rayleigh numbers, with the exception of the Raleigh number of 108, which had minor disruptions.

Using numerical airflow models, Xu et al. [22] calculated the power output of a solar chimney coupled to the storage layer and turbine, which was identical to the Spanish prototype. When the solar radiation was 600 W/m2 and the turbine efficiency was 80%, they stated that the system's output power reached 120 kW.

Mohammed et al. [23]proposed the perfect Solar Chimney (SC) structure to enhance efficiency of photovoltaic (PV) system with assistance of Particle swarm optimization (PSO). optimization of chimney height Hc, Width Wc, and thickness tc was done. Mathematical model was proposed and solved by using Matlab software. Results showed that efficiency of PV system exhibited good enhancing by increasing Hc, while it was reacted negatively to the increase of Wc and tc.

Li et al. [24] used a theoretical model to assess the impact of collector radius and chimney height on SCPP power production, which was confirmed by experimental data from the Spanish prototype. In Figs. 22 and 23, the theoretical power output of a SCPP was claimed to be proportional to the collector radius and chimney height, respectively..

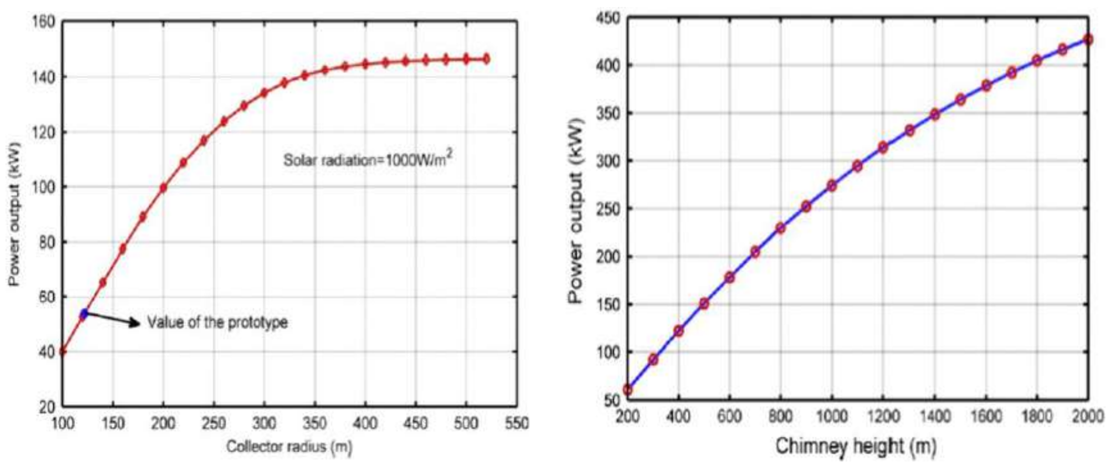


Fig.13(a)Variation of power versus collector radius (b)Variation of power versus height

The airflow in SCPP was handled as a compressible fluid in Zhou et al [25] .'s model for coupling atmospheric cross flow and fluid flow within a solar chimney system. The atmospheric cross flow had a significant influence on the SCPP input, with the SCPP intake air velocity being about similar to 26% of the cross flow velocity, according to their data.

By adjusting the design of crucial parts of the solar chimney, Patel et al. [26] increased its efficiency. The collector intake opening, collector outlet diameter, divergence angles, and chimney inlet opening were all changed, but the collector diameter and chimney height were not.

O. Khalil and A. Sabah[27] offered a novel design of solar chimney using both PV panels as well as solar chimney for producing electricity. They built two experimental layouts (A&B) for the hybrid solar chimney, (A) has a collector of glass with PV as an absorber, (B) was similar but with PV as a collector and an absorber of plywood. This study found out that (A) gained higher thermal energy than (B) meanwhile, overall electrical power in a daily basis in (B) was (75.6 W) more than (A) (79 W). it's also found that daily average conversion of thermal energy into kinetic one in (A) was (0.008 W) and (0.006 W) in (B). Overall power generated by (B) was higher than (A).

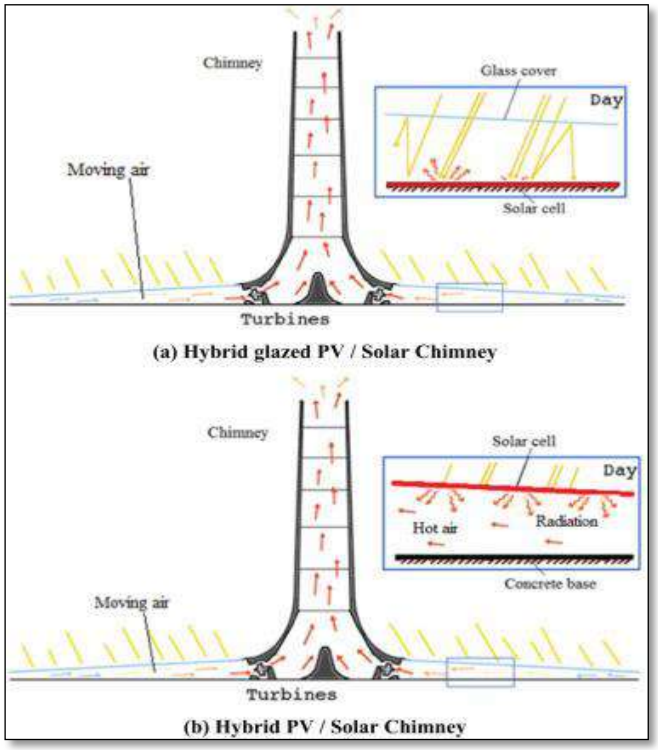


Fig. 14. Schematic diagram

Hamdan [28] contrasted the use of a more realistic chimney mathematical discrete model that enables density variation across the chimney to the use of a constant density assumption across the solar chimney. At a chimney height of 1000 m, Fig. 15, indicates that applying constant density across the chimney overpredicts power generation by less than 20%. It has also been established that, for a constant power generation, the collector diameter should rise as the chimney height increases (Fig. 16).

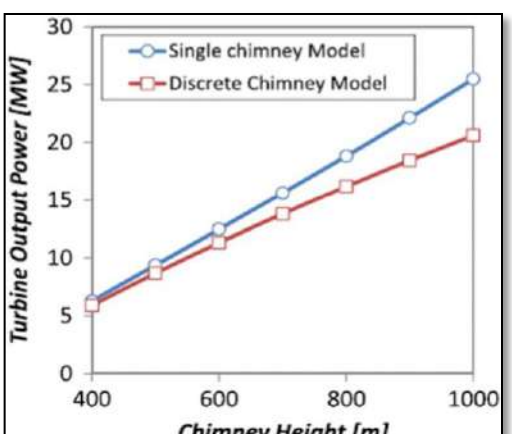


Fig. 15. Evaluation of the solar chimney

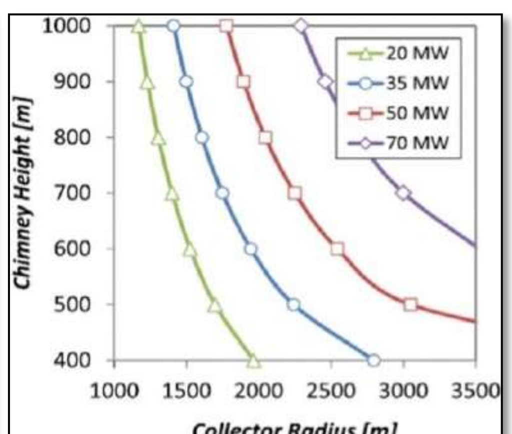


Fig. 16. The turbine output power as a function of chimney height

Khanal and Lei [29] investigated and examined the air flow behavior generated by natural convection in a solar chimney in order to assess ventilation efficacy in 2014. The results revealed that the Rayleigh number has a direct relationship with the mass flow ventilation performance for all flow regimes. In 2015, they investigated the effects of buoyancy on convective flow in a room-mounted inclined passive wall solar chimney (IPWSC). They looked examined how well the method worked with various passive wall inclination degrees and Rayleigh numbers.

P.J. et al. [30]explained with accuracy, the solar collector thermodynamics by developing a steady state mathematical model and studied the effect of various collector canopy layouts on the performance. The study showed that the plant efficiency is impacted by the height of the canopy and maximum kinetic energy occurred at junction with the chimney. By presenting a segmented canopy profile as flat from the collector inlet to a point r_{grad} on the radial path, the resultant power output for such a design was seen to be greatly firm for a large range of ambient conditions.

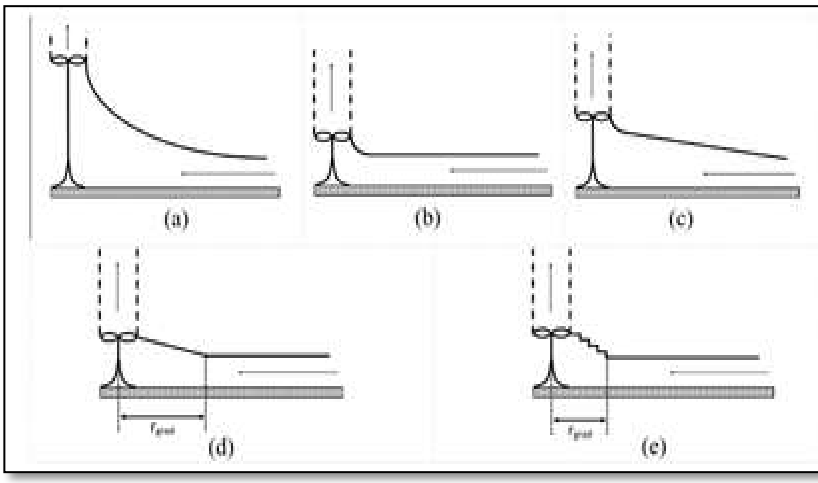


Fig. 17. (a)exponential (b) flat (c)constant gradient sloped(d) segmented (e) segmented stepped.

On a mountain in a location with consistent geology, Zhou et al. [31] examined a new design for a big solar collector based on hollow space. The mountain's huge area was carved down to create a safe and cost-effective updraft solar chimney. The prototype is seen vertically in Fig. 18.

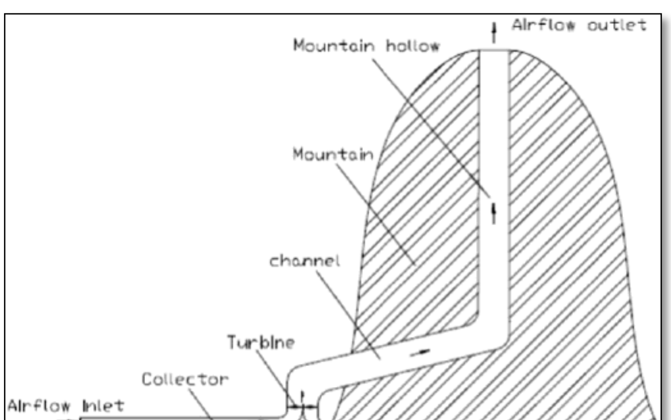


Fig. 18. Schematic view of SCPP with mountain hollow SC .

Penghua et al. [32]studied the solar chimney power plant by building a synthetic environment simulation lab (SESL). Radius of collector and height of chimney had maximum limitations which were discussed depending on experimental data. Result exhibited a maximum limit for the flow temperature inside the collector resulted from the balancing between incident radiation and heat losses, collector performance is affected considerably by incident radiation with a non-linear relationship, and ventilation effect drops along the chimney height because of the loss in heat and flow.

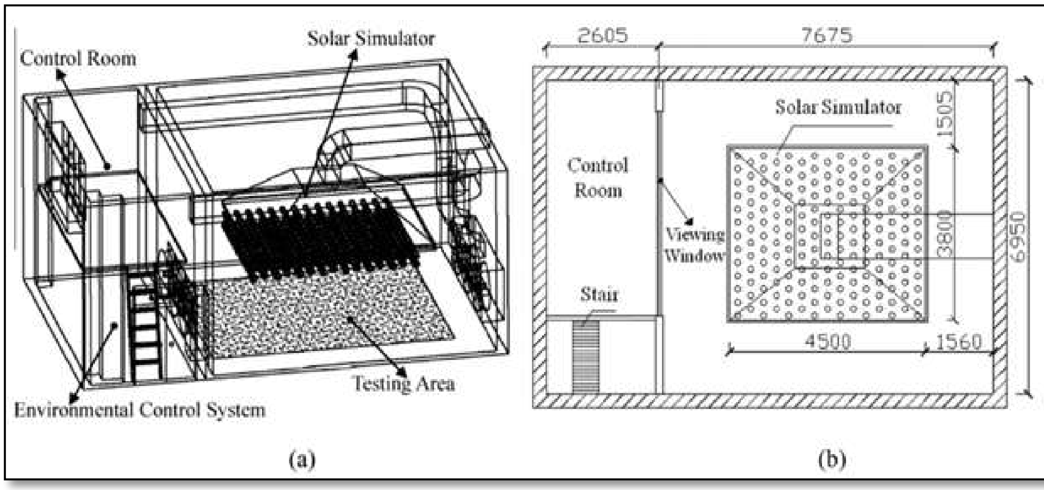


Fig. 19. Schematic of the AESL(a)3D view (b) top view

Penghua et al. [33]carried out 3D numerical simulations and theoretical analysis to predict the peak ratio of the turbine pressure difference to the available total pressure drop in a solar updraft tower system. Results showed that maximum ratio was seen to differ according to the incident radiation intensity, and to be about 0.9 for the Manzanares plant in Spain. Results validation of numerical and theoretical study declared that the maximum ratios calculated of the analytical model are in a good agreement with the numerical simulation at a relative discrepancy of less than 6%, this difference due to the neglected losses of flow in the mathematical analysis.

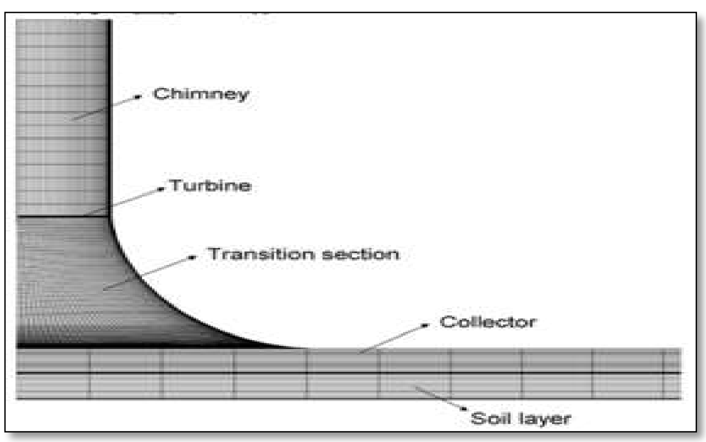


Fig 20. Computational grid

To reproduce the whole system, Zuo et al. [34] built an integrated small-scale solar chimney power generating with sea water desalinization system. According to the researchers, the biggest temperature difference between the heated air flow and the ambient temperature was 15 degrees Celsius, and the solar energy utilization efficiency was above 21.13 percent

W. B. Kra¨tzig[35] carried out the power / energy yield assessment of solar chimney power plants (SCPP) by using computer simulations which cover all physical processes in the plant components. By describing and formulating thermo-fluid dynamics processes, output results of the plant showed the power of the software and the efficiency of SCPP.

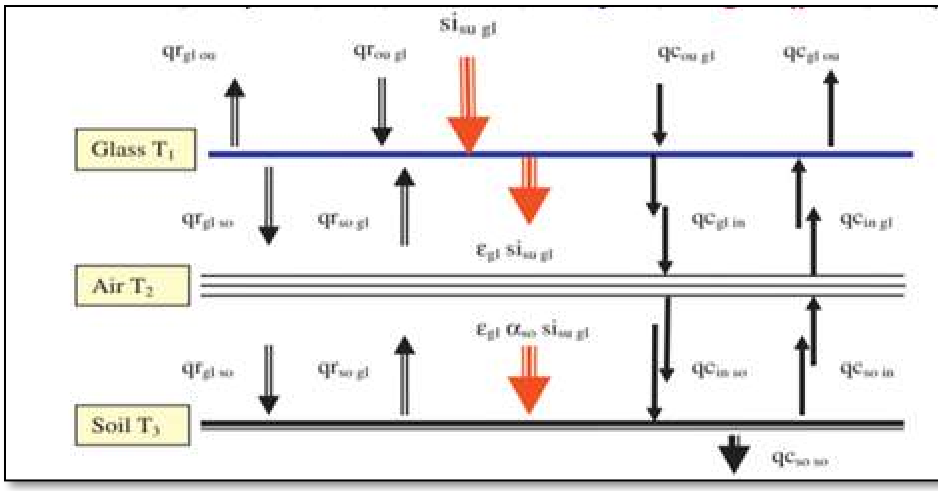


Fig.21. scheme of the heat transfer of a glass/air/soil collector

Y. Li and S. Liu[36] evaluated the thermal performance of a solar tower integrated with phase change material (PCM) in a laboratory setting, taking advantage of the PCM's enormous ability to store thermal energy and exposing three examples of heat fluxes of 500, 600, and 700 W/m2. The ideal thermal efficiencies of the solar tower are determined to be approximately 80% in all cases during the early ventilation stage, according to the findings. The findings of the PCM-based solar tower were good in this study.

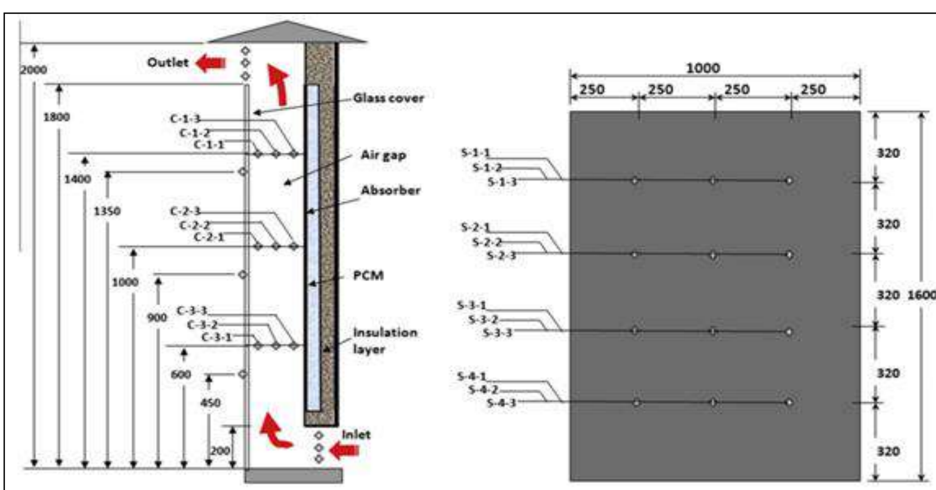


Fig.22. experimental system and locations of thermocouple on absorber.

Zhou et al. [37] (2010) compared a traditional SCPP with a hybrid system that included water desalination. They found that the hybrid system's power production and air flow rate were lower than those of a traditional solar chimney power plant.

Maia et al. [38] conducted a realistic evaluation of airflow through a solar chimney. On the campus of the Universidade Federal de Minas Gerais in Brazil, they developed a prototype for drying agricultural products. The solar chimney had a diameter of 1 m and a height of 11 m, and it was supported by six mechanical tubes 1.3 m above ground. The diameter, height, and height at the edge of the collector were all measured.

M. Sh-eldin et al. [39]studied the enhancement of the performance of the photovoltaic (PV) cooling system using the solar cooling tower design. effect of atmospheric wind speed on the photovoltaic panel has been discussed as well as measuring air velocity at various locations in the solar cooling chimney. Results showed that the air velocity rises from 0.6 to 1.78 m / s and the pressure differential between inlet and outlet increases from 0.5 to 5.3 KPa for the chimney height range from 0.3 m to 3 m and at 60 ^{o}C, which boosts the voltage of the PV panel by 8%.

A hybrid solar chimney with seawater desalination was proposed by Yiping et al. [40,41]. The system's outputs were electric power from water generators, power from air turbine generators, and fresh water.

Mohammad O.Hamdan [42] conducted a simplified theoretical model of thermodynamics for steady airflow within a solar chimney, where Bernoulli equation and fluid statics with ideal gas equation has been solved by using EES software to estimate solar chimney power plant output. The research found that there is a non-monotonic relationship between second-law efficiency and turbine pressure head. The model suggests that, with increased chimney height and/or diameter, second-law efficiency and power extracted will increase.

Ferriera et al. [43] investigated if a solar chimney might be used to dry agricultural products. An open-edge transparent circular collector is attached to a tubular tower at the center of a solar chimney drier (Fig. 24). A prototype solar chimney was created in Belo Horizonte, Brazil, to assess the practical viability of this drying apparatus. The air velocity and climatic parameters were measured as functions of solar insolation after the apparatus was built. This solar chimney was formed of wooden sheets and wrapped in fiberglass, with a tower height of 12.3 meters and a collector diameter of 1 meter.

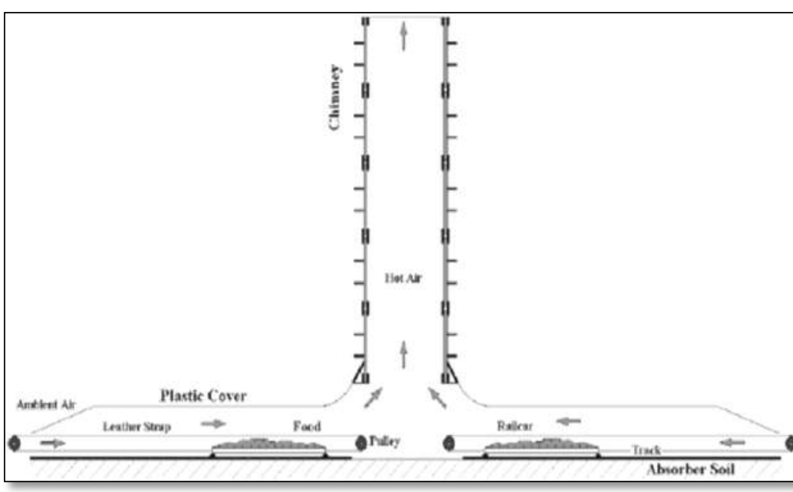


Fig.24. the solar chimney prototype as a solar dryer.

Sivaram P.M. et al. [44]Performed an experimental and numerical work across the solar chimney relying on one-dimensional energy and mass balance. Collector tilt slope, hourly incident radiation, environment temperature, and wind speed are tested for airflow attributes such as velocity outlet and temperature. They presented optimal driving conditions of an inclination angle of 75 °, area of absorber 0.63 m^2, and height of chimney 0.48 m. Results showed the following, it is recorded that the velocity of exit air raises by enlarging the absorber zone area from 0.5 to 3 m2 for a 0.5 m high solar chimney, an increase of 52 percent in exit air velocity was achieved by raising the chimney height from 0.5 to 3 m for a 0.64 m2 absorber area solar chimney, and increasing wind speed around the glass cover will lead to reducing outlet air velocity

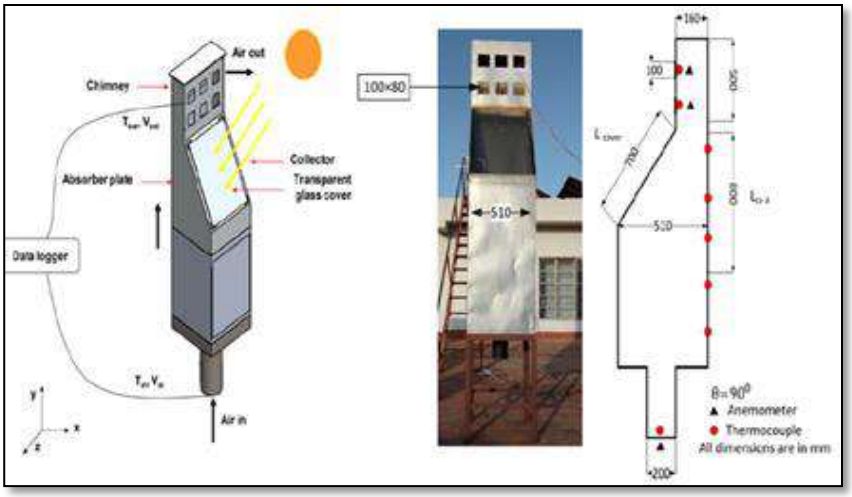


Fig. 25. The solar chimney and dimension.

Afriyie et al. [45] that looked at the performance of a solar crop dryer with a solar chimney and no preheating air. The chimney had a rectangular cross-section with a width of 440 mm, an average spacing of 80 mm, and a height of 625 mm. The findings imply that a solar chimney can increase the airflow rate of a direct-mode drier, especially if it is built properly with the optimum angle of the drying-chamber roof.

L. Boutina et al. [46]studied a two-dimensional computational modelling of the turbulent free convection for solar panel cooling in a new invention of integrated photovoltaic / thermal solar collector by adding a chimney stack. They studied the effect of non-dimensional geometric variables on the airflow and heat transfer characteristics. The data collected revealed that the new hybrid system's proposed optimal non-dimensional geometric variables result in an increase in the heat transfer rate of 78.13 percent relative to the conventional case.

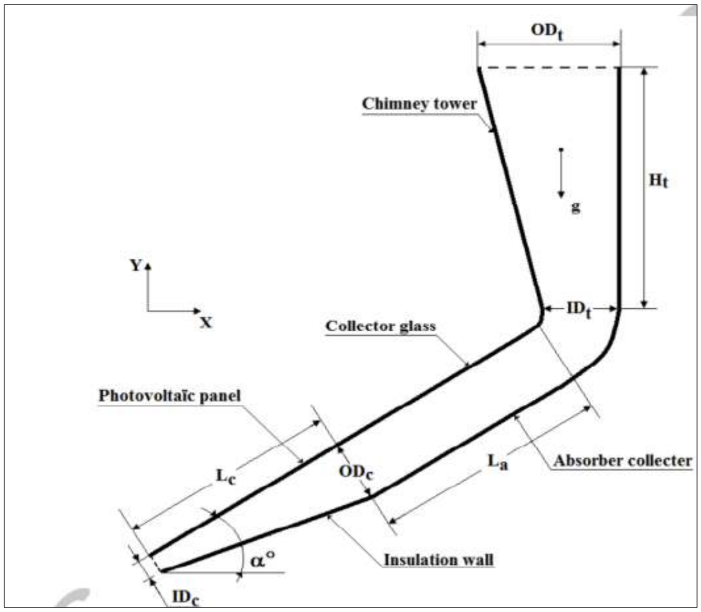


Fig. 26. the solar chimney and dimension.

A. Ravanfar et al.[47]Presented and implemented a thermal design model by using SIMULINK to study the solar chimney-assisted solarium power output integrated with the Photovoltaic (SCASPV) system and analysing the effects of solarium incorporation with PV cells under summer conditions. They utilised SIMULINK software to simulate the system performance by adding semi-transparent photovoltaic cell(STPV). They calculated the temperature of greenhouse effect, ventilation rate and power output of the STPV. Numerical computation results indicate that SCAS system integration with STPV system increases system performance and generates electricity that can be used to cool the adjacent building.

Mekhail et al. [48]They studied an experimental model of a very small 6 m chimney height model, 6 m collector diameter and 0.15 m chimney diameter. The conceptual model based on the thermodynamic study of the flow within the SCPP is used to estimate its system efficiency. The findings indicate that the larger model can generate about 600 times more than smaller one in terms of hypothetical power. This analysis allows to pick the power generated for the larger model.

Chen and Qu [49] devised and tested a solar chimney-based drying system with a porous absorber in 2014. They also looked at how the angle of the absorber and the height of the drying system affected the solar dryer's heat transmission.

AlNimr et al. [50] introduced a unique hybrid solar photovoltaic/wind model, which they mathematically analyzed. The integrated system depends on a converging angled duct being inserted beneath the photovoltaic (PV) plates and directed upward after the panel is completed. A wind turbine is installed at the end of the converging duct. Both systems' implementations, according to the simulation research, not only increase PV cell performance owing to active cooling, but also generate more electrical power via the integrated turbine. At low wind speeds, the ducting system appears to operate more as a cooling mechanism for the panels than as a source of energy for the wind turbine.

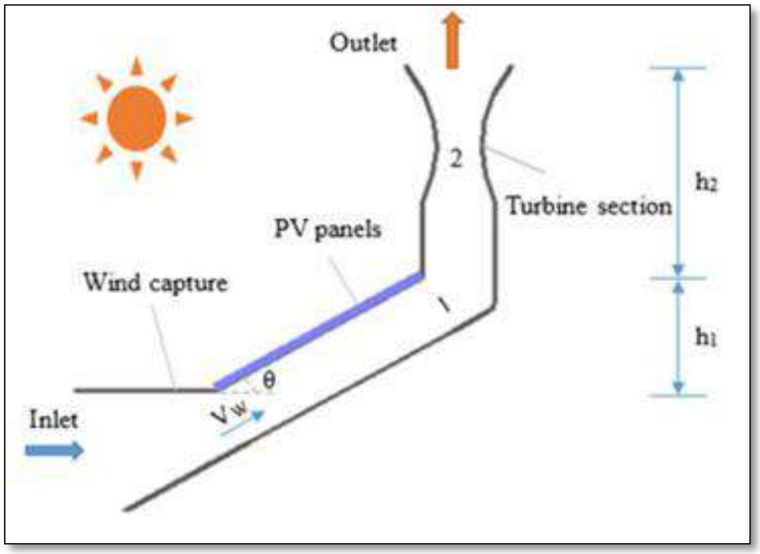


Fig 27. Schematic side section of SCPP

A. El-Ghonemy[51] Has evaluated in his paper, the efficiency of a conventional solar tower. A conceptual model was established to predict those parameters: power produced, turbine pressure drop, optimum tower height, temperature & velocity of airflow and overall performance. Results revealed that a solar chimney power plant with a chimney height and diameter of 200 m and 10 m (respectively) and a solar collector diameter of 500 m would produce a monthly average of 118~224 kW of electricity throughout the year.

S. AL-AZAWIEY & S. B. HASSAN[52] Studied the enhancement of the collector's energy conversion capacity and the extension of the operating time using a heat storage material. They have analyzed experimentally and numerically, the solar-to-thermal conversion and thermal storage capacities of six materials (ceramic, black stones, sawdust, dark-green painted wood, sand, and pebbles) that are clearly available in Malaysia. The study showed that there are various thermal storage capacities for various materials and that ceramics prolong the process until night with efficiency improvements. The study also showed better quality for ceramic and black stones than the other materials. Nevertheless, black stones are preferred because they are easily available as the absorbing medium for solar chimney power plants in Malaysia and regional countries.

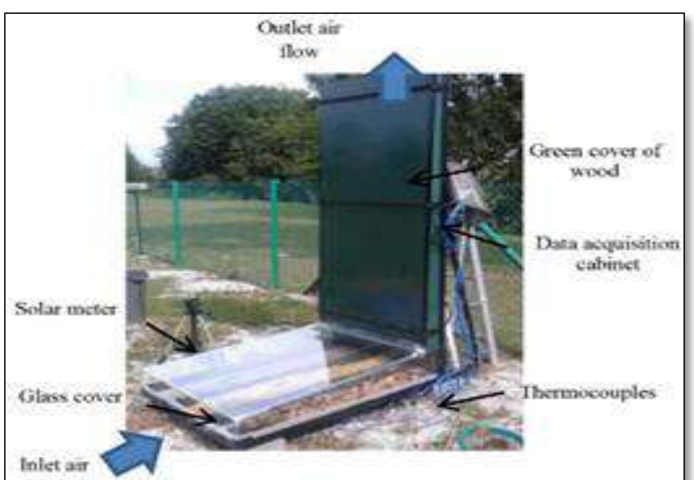


Fig.28.Experimental device

L. Beneke et al. [53]have focused in their study on the principle of solar chimneys, which utilise solar and wind energy to generate power, especially in the sunshine regions of South Africa's Northern Cape and Karoo. The research included a simulation work and studied different chimney styles to determine the best performance (cylindrical and octagonal shapes). The researchers found that the octagonal chimney surpassed the standard cylindrical one, primarily due to an intensified airflow and the turbine being located at the chimney outlet (while it is at the base of a cylindrical tower). Having mirrors installed has improved the efficiency because of incident radiation from all sides all over the chimney. The findings were verified by a 24-month continuous operation of a pilot plant.

Fig.29.the complete construction pilot plant

A. Ndiho et al. [54]Have numerically analysed the transient combined convective airflow in an innovative Construction Solar Chimney, designed to connect a Photovoltaic / Thermal (PV / T) collector with transparent PV cells as an effective layer and a solar thermal flat-plate collector together as a single platform. The numerical study showed that the Photovoltaic / Thermal Building Solar Chimney system provides a decent electrical efficiency whereas the Photovoltaic/Thermal Reverse Building Solar Chimney collector provides a good thermal efficiency.

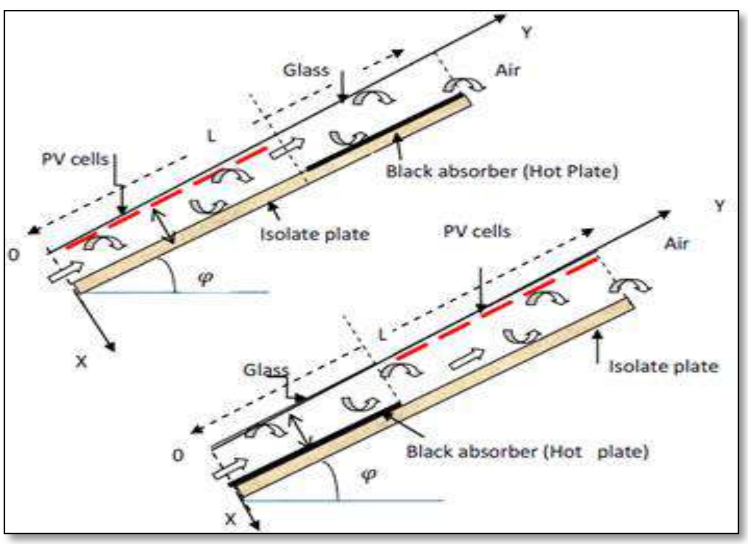


Fig 30.hyprid photovoltaic /thermal building solar chimney.

Papageorgiou [55] demonstrated a solar collector that is modular. Traditional solar collectors are more costly than these modular solar collectors. The modular solar collector, which consists of a series of triangular warming air tunnels with double-glazed transparent roofs, is expected to have an efficiency of more than 50%.

Z. Zou al. [56]have introduced a new passive air cooling system called the Solar Improved Passive Air Cooling model. A three-dimensional model was established in the CFD application to confirm its increase in performance over traditional aluminium plate heat sink. The results of their study showed that the proposed new system would be capable of keeping cell temperatures below 75°C when the concentration ratio exceeds 700, whereas traditional aluminium plate heat sink cooled solar cells would be overheated at the same rate.

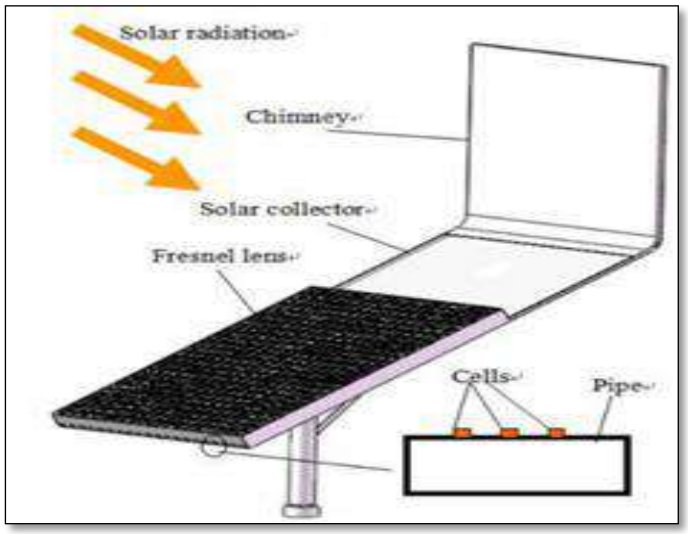


Fig 31. the main component of a SEPACE.

F. Stojkovski et al.[57]They presented a study based on computational fluid dynamics (CFD) technique involving mathematical analysis of the model. The technological characteristics of solar chimney power plants were studied using CFD technique as a way to optimize the structure and thermo-fluid aspects of the system effectively. They performed their work using the assumption of steady 3-D flow and the turbulence is taken into consideration with the k-e realizable model. Using the assumption of a steady 3-D flow, they performed their work and the turbulence is taken into account with the k-e realisable approach. The method of discrete ordinates (DO) is chosen as the model of solar radiation. The initial results obtained prove the CFD's capacity as a powerful tool for research and engineering to analyse complex aerodynamic and thermal systems.

Y. Ohya et al.[58]They have developed a novel type of solar chimney by laboratory experiments and numerical simulation. There are three components in the framework. The transparent collector region is a glass roof above the surface, with height to the middle rising. A vertical tower is connected to the middle of the inside of the collector, where a wind turbine is mounted at the lower entrance to the chimney. In order to improve the performance, the research study designed a diffuser tower rather than a cylindrical tower and explored an acceptable diffuser design for operational use. The study declared that a diffuser tower with a semi-open angle of 4 degrees was found to be an ideal design, providing the quickest improvement in both laboratory experiments and numerical analysis at each temperature difference. They also came out with a formula the updraft air velocity was found to be proportional to the square root of the difference in temperature and/or tower height.

To provide natural ventilation, Hao et al. [59] employed a solar chimney. They used vertical panels that were 2000 mm in height and 1000 mm in length to investigate the internal velocity of the solar chimney. They discovered that when the chimney gap widens, the air flow increases and the air velocity falls, and that as the radiant solar intensity rises, the airflow and air velocity increase. Natural ventilation is provided. To examine the inner velocity of the solar chimney, they employed vertical panels with a height of 2000 mm and a length of 1000 mm. They observed that when the chimney gap widens, air flow increases and air velocity decreases, and as radiant solar intensity rises, airflow and air velocity rise..

R. Rabehi et al.[60]Presented a computational fluid dynamics (CFD) study for the solar chimney updraft of Spanish prototype by taking into consideration the turbine zone as fan model using ANSYS Fluent software. The three-dimensional system with turbulence model of standard k-epsilon have been used to simulate the system. Findings showed that the variability in solar radiation has a strong impact on the characteristics of flow and heat transfer. In the meantime, the impact of the turbine pressure drop on the collector performance has been small, while it had a significant on the power produced.

Liu et al. [61]. They investigated the impacts of installing a chimney on a solar hybrid double wall used for natural ventilation and building air heating in 2015. Different chimney wall gaps and radiation fluxes were tested. The airflow velocity grew steadily when the wall gap was raised, but the researchers were unable to determine the optimal wall gap. Their findings also show that with a gap width-to-height ratio larger than 0.3, flow inversion occurs in the solar chimney.

A. B. Kasaeian et al. [62] Have Investigated the influences of environment temperature and dimensional variables on the efficiency of solar updraft tower power plant. The conceptual model was produced and tested by an experimental pilot data. Results found that the atmospheric temperature has a negative influence on the system output. To this end, they built a solar chimney with chimney height 7.4m, chimney diameter 0.6m, collector diameter 8m, and 0.2m average collector height. They obtained a dimensionless variable. The examination of system performance using this non-dimensional variable indicates that the power output increases with a polynomial third-order relationship by increasing the system size, and a linear relation by increasing the solar incident radiation.

Fig 32. A photo of a solar tower

A. Tan and N. Wong[63] Have made a parameterization study using simulations on the solar chimneys in the tropics by examining the following parameters of the tower, the height, depth, width, and position of chimney inlet and their effects on the system performance of air velocity and temperature as well as providing an ideal model of the tropical solar chimney. Computation results revealed that the temperature of output air remains constant while the size of the solar chimney is the most important factor affecting output air velocity. The inlet location of the solar chimney has minimal effect on the output air velocity, while regions near the inlet of the chimney have increased air velocity. In addition, a regression model is done based on the tower height, depth and width of the solar tower to estimate the internal air velocity.

Jing et al. [64] constructed a solar chimney on a single wall with a large gap-to-height ratio of 0.2 to 0.6 and tested it in a variety of chimney gaps and heat fluxes. When all other parameters remain constant, increasing the chimney gap results in a maximum air-flow rate of around 1000 mm, which is the ideal chimney gap among the chimney gaps studied in this study.

M. Motoyama et al. [65] Improved the performance of a solar chimney using a diffuser-shaped chimney in comparison with cylindrical solar chimney. The results showed that the air velocity for the diffuse chimney was 1.5 – 1.8 times greater than the velocity of air in the cylindrical solar chimney. The results are important and confirm the adoption of the new design in solar chimney plants.

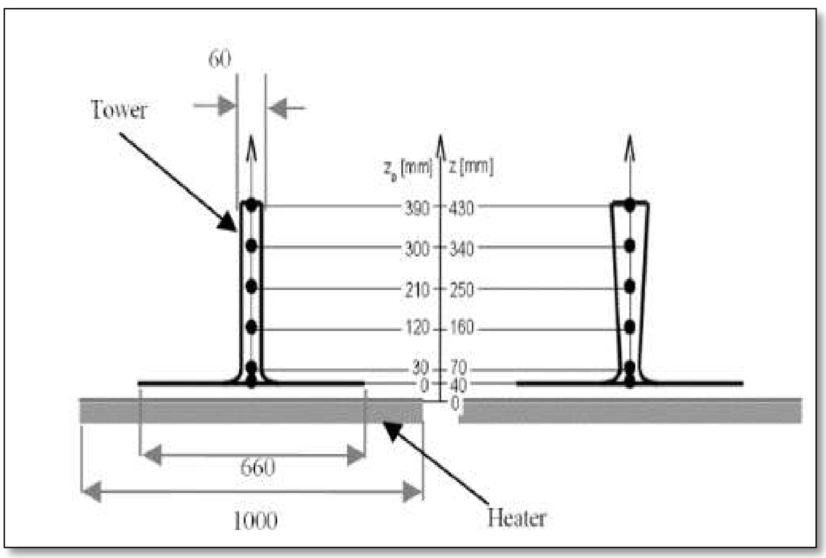


Fig .33. solar chimney.

In Japan, Song [66] investigated the ventilation effectiveness of solar chimneys. He looked at the inlet and outflow relationships, the chimney shaft and chimney connection circumstances, and the solar radiation heat-receiving chimney area.

H. Nasraoui et al. [67] Presented a numerical and experimental assessment to enhance the performance of solar chimney power plant. A new design was studied by changing the ratio of hyperbolic chimney radius with respect to the chimney height. The results demonstrated that the increase of the chimney radius led to generate more power.

Fig.34.Experimental device

Imran et al. [68] In Iraq, in 2015, an experimental and computational model of a solar chimney for ventilation and cooling of a single room was developed. The induced air velocity, as well as the temperature of the glass cover of the chimney, the absorbing wall, and the induced air, were all measured and investigated. Marigorta et al. [69] conducted an energy study of the solar chimney used in buildings to improve natural ventilation in 2015. A three-dimensional CFD model was used to assess the thermal and dynamic behavior of the fluid inside a solar chimney. The thermal efficiency was 0.55 percent, while the energy efficiency was 0.0006 percent, according to the findings. They claimed that solar chimneys as natural ventilation systems had poor efficiencies as a result of their low efficiencies..

P. Das and V. Chandramohan [70]Developed a three-dimensional computational design for estimating and evaluating solar chimney power plant flow and quality parameters. The influence of structural variables such as height of the tower and angle of the roof of the collector are observed. In order to solve the governing equations, a turbulent flow with RNG system and discrete ordinates (DO) is used. Results showed tha t the air velocity increases but the air temperature decreases with an increase in the collector ceiling angle. When the tower height increases from 3 to 8 m, velocity improvement increases by 31%.

A. Bouabidi et al. [71] studied the solar chimney based on Tunisia's climatic conditions. Under the weather conditions in Tunisia, an experimental setup is evolved to investigate the solar updraft tower. To show the effects of the chimney diameter, multiple simulations were performed. it is found that The contraction zone in the inlet of the chimney increases as the chimney diameter increases. As a consequence, the rate of the air velocity increases. A good agreement is shown by the comparison between the numerical and experimental results.

Fig.35.Experimental device.

S. J. Yelpale et al. [72] In their research, they performed an experimental assessment of solar updraft tower in addition to solar panels to improve the performance of polycrystalline solar photovoltaic systems. Integrating the solar chimney into the solar photovoltaic system can allow the airflow beneath panels to cool the panels and can increase their efficiency and thus the output. Results showed that as the chimney height increases, it is found that the air speed in the duct below the panels increases. This yields in a 0.69 to 1.61 percent increase in the efficiency.

Fig 36.experimntal device

Y. Nougbléga et al. [73] Studied and predicted with simulations, the dynamic sectors and, in particular, the air thermosiphon drawing mass flow in the hybrid photovoltaic-thermal chimney incorporated into a construction for passive cooling in the room. They determined Grashof number based on the region's solar radiation frequency, the inlet clean air mass flow, the combined chimney size on the airflow and on the heat transfer features. The results showed that the current problem solution and Wam et al.[40] work very well. Where a rectangular enclosure with two differentially heated vertical walls and horizontal adiabatic walls without slip boundary conditions applied to all the walls.

Buonomo et al. [74] investigated natural air convection in a convergent chimney. Fluid dynamics and thermal behaviors were investigated in order to improve the system's energy efficiency. They discovered that the chimney shape has a direct impact on these characteristics. The findings also revealed that a solar chimney may be used to heat a building in the winter.

A. Habibollahzadea et al. [75] proposed a unique method for merging a waste-to-energy plant in Tehran with a solar updraft tower power plant. The novel system was assessed from the viewpoints of energy, exergy, exergoeconomics, and the environment using parametric analysis. Throughout the evening and day, the availability efficiency, total power production, power output of the solar chimney, total system cost, and cost levels were monitored and correlated. The system's availability efficiency was better at night, while the overall cost of the product was lower during the day. However, the results revealed that the turbine's input pressure has the greatest impact on CO2 emissions and the most significant energy deterioration in the solar chimney.. Multi-target enhancement results figured out that the system's availability efficiency and total cost level are 7.56% and 406.8$/h at the easiest solution level.

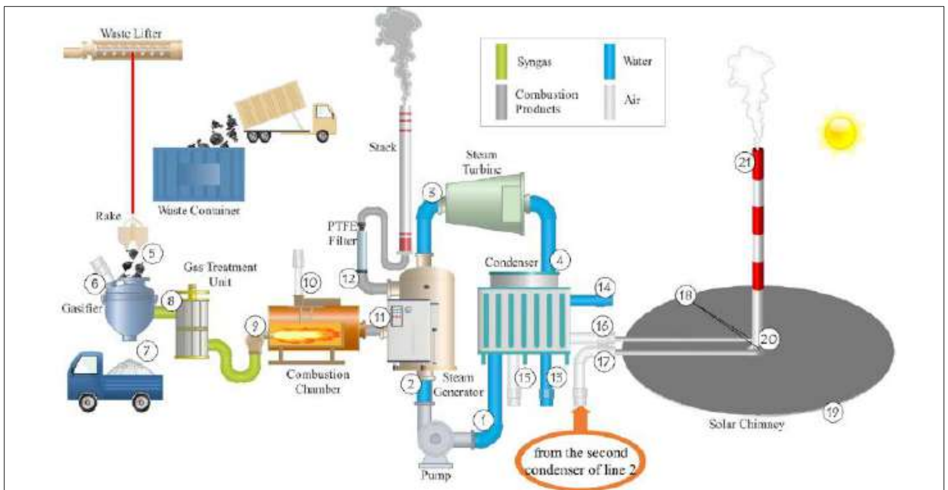


Fig. 1. Schematic of the proposed integrated renewable system (Habibollahzade et al., 2018c).

Fig. 36 Flowchart and schematic of the proposed integrated renewable cycle.

A. Raj et al. [76] Analyzed The extent of panel cooling in the by performing an experiment and a computational fluid dynamics study through the optimization of different geometrical dimensions of the solar combination system. The adaptive geometry provided 0.034 kg / s air flow rate that can cool the PV cell by 5 ° C when subjected to 800 W/m^2 solar incident radiation. it is found that as the solar combined system simultaneously performs air heating and panel cooling operations, the overall efficiency of the system is higher and more cost-effective comparable to two separate units. The mass flow risen with the rise in chimney height until the chimney height exceeded 10,000 mm and afterward becomes more stable. The departure from the solar system is hot air that can be utilized for any appropriate process.

Fig. 37 Thermal solar system

A. Habibollahzadea et al. [77] Presented a groundbreaking approach for boosting power output and addressing intermittent solar updraft tower (SUT) power generation during the night. They suggested an optimized renewable process by incorporating two innovations: solar tower and waste-to-energy (WTE). The combined system is conducted by using the condensers outlet's warm air throughout the SUT. Results demonstrate that the net power production of the WTE plant rises from 1350 kW to 1650 kW by rising the feed rate or by reducing the humidity of municipal solid waste in particular range. It is also seen that, in the interconnected system, the output power of the WTE plant and SUT increases by 22 percent and 7 percent respectively, when feed rate of MSW increased by 22% or the humidity reduced by 10%.

M.S. Abd-Elhady et al. [78] studied experimentally and numerically and presented a ground breaking approach to eliminate the excessive heat of PV panels, based on free convection. They made drilled Holes in the photovoltaic panel to help uplift the warm boundary layer below the panel which allows the panel temperature to cool down. Results observed that the temperature of the transpired cells is less than that of the non-perforated cells and that with increasing the number of holes, the temperature difference get increased. However, the hole size has a critical diameter, so that the temperature of the PV panel increases before and after that diameter.

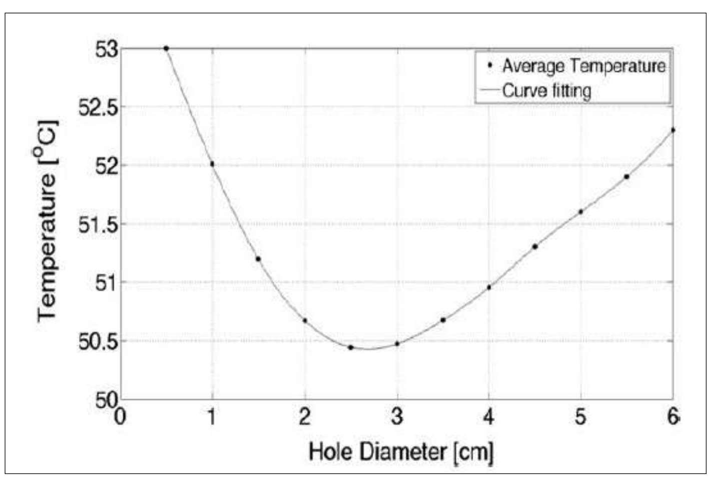


Fig.38.temperatuer with hole diameter

Chung et al. [79] studied the usage of a solar chimney in a terrace house to improve the ventilation performance of the internal environment. They were able to find the appropriate length and width gap for the solar chimney, which resulted in the best chimney air velocity and thermal performance in the interior environment.

Y. Amudam and V. Chandramohan [80] performed a 3D simulation study to detect the influence of the thermal energy storage solution for the solar chimney power plant. Flow variables including velocity, temperature, density, and pressure are predicted, investigated and pales in comparison for two different designs, design-1 (absence of thermal energy storage) and design -2 (with thermal storage). Output variables such as output power, efficiency of collector and total system performance were calculated and model 2 values were found to be lower due to thermal storage unit heat collected. The peak output was recorded at 1.00 pm for both designs (79.92 W for design – 1 and 63.8 W for design – 2). Adding the thermal storage unit extended the running time of the plant until 8.00 pm.

R. Balijepalli et al. [81]Presented complete model parameters of a low-scale and less expensive model solar updraft tower for individual components. The key material for this study were: solar incident radiation measurements, chimney configuration, calculations of the design of wind turbines, heat and pressure loss assessments of the collector. The results of the study showed that the theoretical maximum air flow velocity was noticed at the base location of the chimney and it value was 1.9 m/s. They estimated total efficiency about 0.0019%.

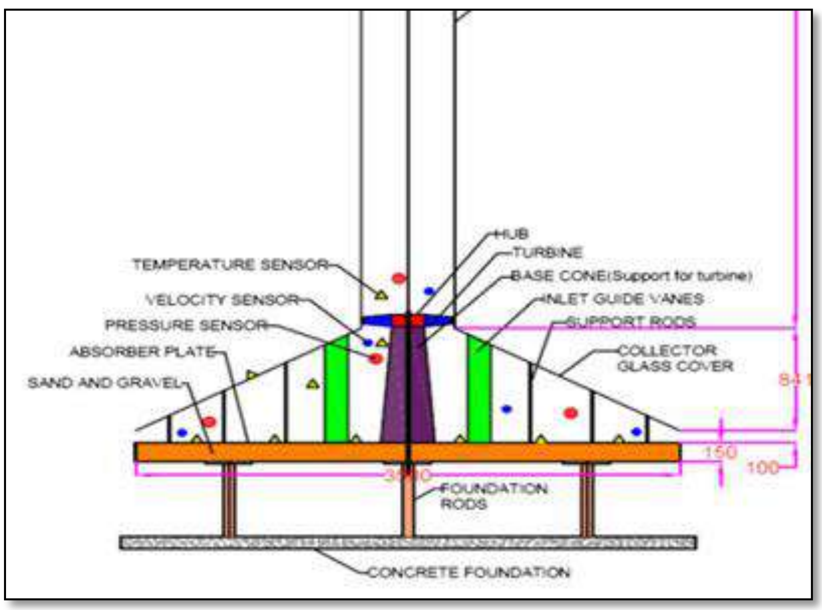


Fig 39.solar updraft tower power plant

In Bundoora, Australia, Golder [82] erected a SC 8 m high and 0.35 m in diameter, which he connected to a solar pond 4.2 m in diameter and 1.85 m deep. The tower was made up of flexible circular ducting and supported by a tiny experimental air generator tower's framework. In the prototype chimney, a water-to-air heat exchanger was employed. The mass flow rate of the brine and its temperature decrease over the heat exchanger were used to determine a heat transfer rate of 1 kW.

S. Haghighat et al. [83] Designed an innovative system of hybrid photovoltaic panels and solar tower using the airflow generated under the solar chimney collector to cool the photovoltaic panels. The PV panels ' dissipated thermal energy is utilized under to heat the airflow below the collector. they have explored two key factors in their simulation as the position and size of the PV panels in the solar tower. The best possible outcome was recorded when placing a PV cell of 50cm wide, rather than placing a transparent collector for the hybrid of PV panels and solar chimney. This scenario demonstrated that the average temperature of PV panels was 5 ° C lower than the average temperature of PV panels of the solar chimney in non-hybrid mode. The drop in temperature will increase the PV panel performance by 1%. In contrast, the total airflow velocity in this mode indicates a decrease of 0.2 m/s compared to the transparent collector.

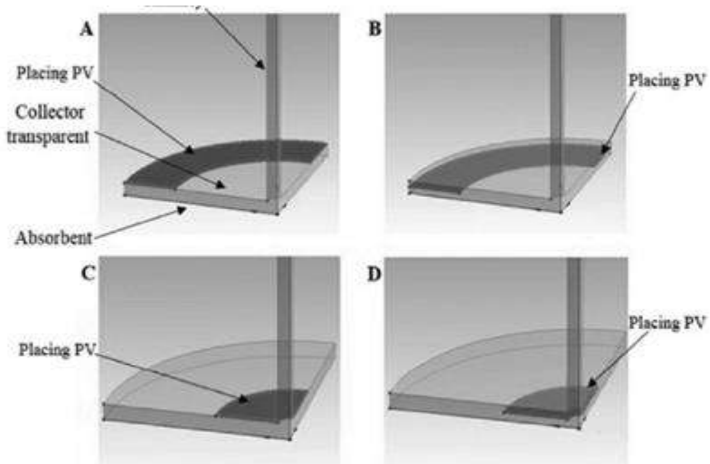


Fig 40.placing of PV in different positions in(A.B.C.D)

S. Hong et al. [84] the solar chimney (SC) energy efficiency in an elevated-performance 2-story detached house with a floor area of 220 m2 by using EnergyPlus and the hot summer and cold winter climate data in China. In order to provide heating and cooling and a discrete ventilation system for ambient air, the house used a variable coolant flow (VCF) process. The study showed that the SC generates higher ventilation loads than the required minimum level most of the year and hence it needs to be regulated to avoid heavy outside air resulting in higher heating / cooling loading during the heating / cooling periods. it is also shown that the SC can decrease the yearly energy of ventilation by 77.8% and the VCF by 2.3%.

Fig 41.experimntal device

In 1986, Sampayo [85] called for the installation of a multi-cone diffuser at the top of the chimney to allow it to act as both a high-speed chimney and a draft tube for any natural breeze. Ming et al. [86] investigated the decrease in the fluctuation factor of output power in SCPP using a novel hybrid energy storage system comprised of water and sandstone. The findings imply that using a water-and-sandstone hybrid energy storage technology decreases the SCPP output power fluctuation factor.

M. T Chaichan et al. [87] Studied the impact of deposition of dust and contaminants on the model of the solar chimney, given that Iraq, such as many countries, is subjected to sandstorms many times a year and its environment is filled with pollutants from power plants, industries and traffic. findings of their study demonstrated that solar collector cleanliness and transparency play a significant role in the solar chimney application performance. the chimney is significantly affected by the accumulation of dirt. The solar collector cleaning process brings back some dust-related efficiency losses. Hence, it's found that the closer the intervals of cleaning, the higher the efficiency of the solar chimney.

Fig 42.experimntal device

N. Jafarifar et al. [88] Conducted a numerical simulation to investigate the reliability of a solar chimney in areas that profit from heavy winds, despite the low solar incident radiation. They validated their work in terms of the efficiency of conventional model of Manzanares (Spain) and one of identical size found in the windy and tropical climate of Scotland (in Orkney Islands). The results indicate that atmospheric high winds can boost the solar chimney's internal air velocity and performance by more than 15% and 50% respectively. Such a solar chimney in Orkney can therefore deliver more than 70% of the Manzanares model's efficiency.

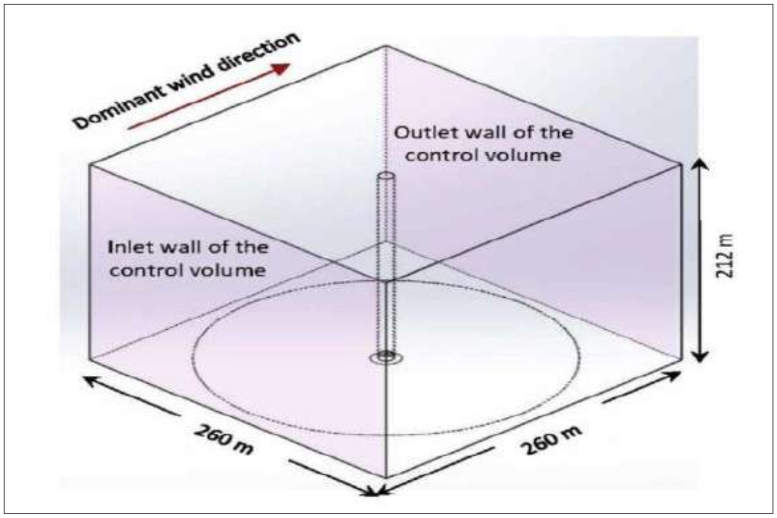


Fig 43. 3D Schematic diagram of SC.

J. C. Lizcano et al. [89] Introduced the idea of a solar chimney that is powered by photovoltaic (PV) cell. They modelled and experimentally examined the integration of a PV device into a freely ventilated frontispiece (NVF), aiming to use the patrimonial cavity as a heat transfer ventilation stream. Study showed low root mean square error (RMSE) values to estimate the temperature and mass flow of various materials in the chimney. Optimization gave that the annual power produced is maximised with a cavity depth of 0.2 m with PV modules situated on the front layer. Placing the modules in the middle boosts the production of heat flow considerably for the same cavity depth, though with a decrease in electrical performance.

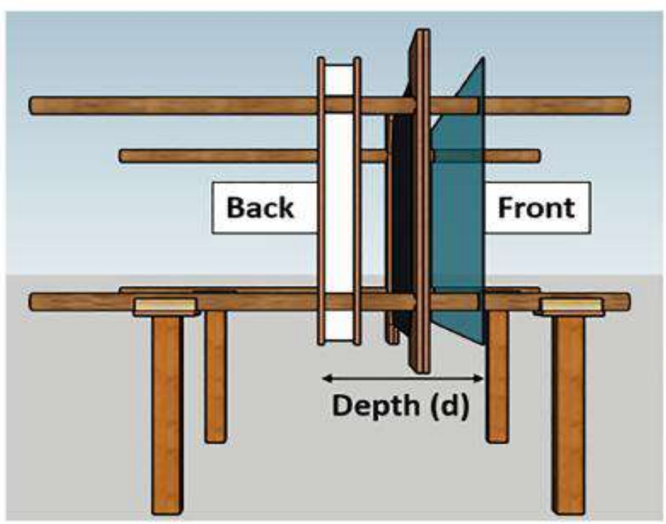


Fig 44.Experimntal device

M. Lucas et al. [90] Studied the possibility through evaporative cooling to increase the efficiency of solar photovoltaic panels. Combined with the usage of a water-condensed chiller, this will make for an effective overall design of the cooling system. They studied the thermal and electrical efficiency of a PV evaporative solar chimney experimentally. Depending on the wind conditions and the psychrometric properties of atmosphere, the temperature differences of the unit exceed 8 K. With regard to electrical efficiency, on a typical summer day for a Mediterranean climate, the results showed an average increase of 4.9 percent to a peak of 7.6 percent around increase of 4.9 percent to a peak of 7.6 percent around midday.

Fig 45. photovoltaic evaporative chimney

Davey [91] They developed an idea in 2008 for using solar ponds with solar chimney thermal storage to generate electricity during overcast days and nights. Akbarzadeh et al. [92] examined the generation of energy in salt-affected areas using a power station with a solar pond in 2009. The solar pond, which was located in northern Victoria, Australia, had a surface area of 60,000 m2, a depth of 3 m, and a 200-meter-high chimney with a diameter of 10 m. C. G. Popovicia et al. [93] Proposed a numerical strategy using ANSYS Fluent software to achieve reduction of photovoltaic panel temperature through the use of air-cooled heat sinks. They researched many different heat sink setups, acquired by changing the angle between both the ribs and the base sheet. Results showed that if no ribs are used, the operating temperature of the PV module approached nearly 56 ° C for the case studied, the maximum power provided is 86% of the marginal. Also, after using a heat sink, the mean temperature of the PV panel decreased even for tiny rib lengths. The temperature is decreased by at least 10 ° C beyond the value achieved in the basic case

K. Hidaka et al. [94] conducted A simple ventilation study using semi-transparent photovoltaic organic plates for solar chimney power plant by presenting a power-efficient ventilation method for buildings combining semi-transparent photovoltaic organic (SPVO) innovation and solar chimney systems. The study results produced a windspeed of 0.25 m / s and about 1.03Wat power output with an artificial light strength of 320 W / m2, which refers to cloudy weather. The study revealed that solar chimney ventilation integration with SPVO power generation might be a successful power-saving solution in the future.

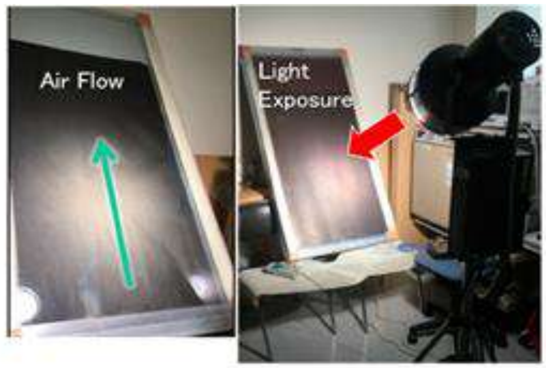


Fig 46. Experimental view of large scale.

Lu Zuo et al. [95] presented a wind surcharge solar chimney with seawater desalination and waste heat (WSCDW) as well as a solar chimney with seawater desalination and waste heat (SCDW) (SCDW). Both had a spiral-shaped exhaust gas heating path (SGC). The increase in chimney elevation and flue gas temperature were both beneficial to WSCDW and SCDW overall performance, according to the findings. WSCDW has always outperformed SCDW, and amid elevated-altitude wind demands, WSCDW's extensive energy efficiency has been raised by 15.4 percent. WSCDW's hourly fresh water output, energy generation, and total efficiency, respectively, were 193.7 kW, 17.2 tonne/h, and 13.5 percent.

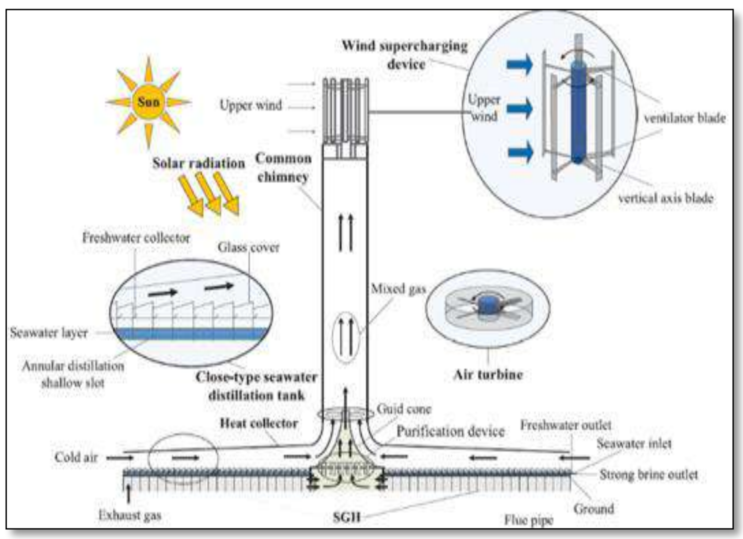


Fig 47. Structure and Schematic diagram of WSCPPDW.

Kashiwa et al. (Fig. 76) [96,97] presented the solar cyclone as a method of obtaining fresh water from the Earth's atmosphere. This solar cyclone has the potential to produce both power and fresh water. They tested the viability of the solar cyclone using a theoretical model of a 500-meter-high, 42-meter-diameter cyclone. In a dry environment, the solar cyclone may create an annual power output of 3 MW and an annual freshwater production of 2106 tons if the separation efficiency is assumed to be 80%.

N. Fathi et al. [98]Performed a Computational fluid dynamics (CFD) study and thermal analysis to analyse the excess heat from a nuclear process to be used to raise the air temperature in the collector and thus generate extra power in the solar chimney system. Results showed that the thermal efficiency can be boosted by up to

8.7 percent, which is important for the electrical power sector and is expected to have a major impact on the capital cost and introduction of new power plant generations. Also it's found that, utilization of the extractable power enhances the Manzanares-type SCPP output power by up to 150 percent annually.

A. H. Laatar et al. [99]Conducted a Computational Fluid Dynamics analysis to assess the impact of a PV panel inclination on air-natural convection in a laminar regime asymmetrically heated channel (constant heat flux). The system models the passive and natural air cooling of PV cells by angled chimneys. The results indicated that the average Nusselt number and mass flow rate improve with both the inclination angle and the adjusted Rayleigh number. It is shown that when extensions are added at the inlet and outlet of the channel, cooling of the PV panel will be improved. Hence it's noted that only the channel's downstream extensions are beneficial in enhancing the driven mass flow rate and thus the convective heat transfer.

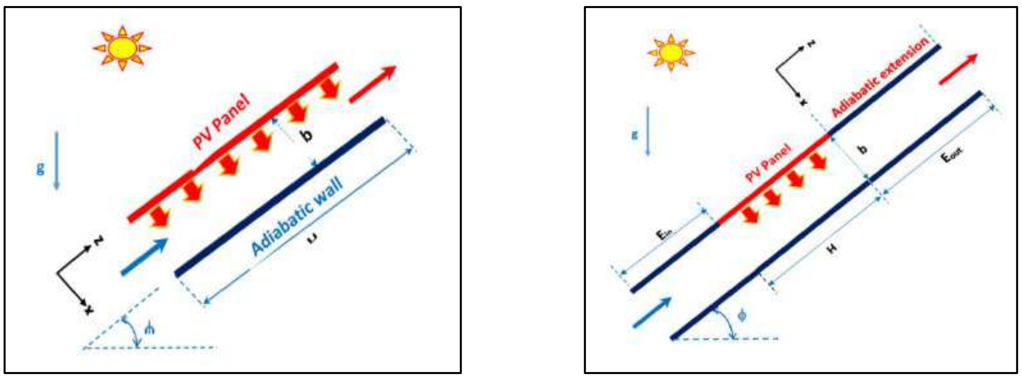
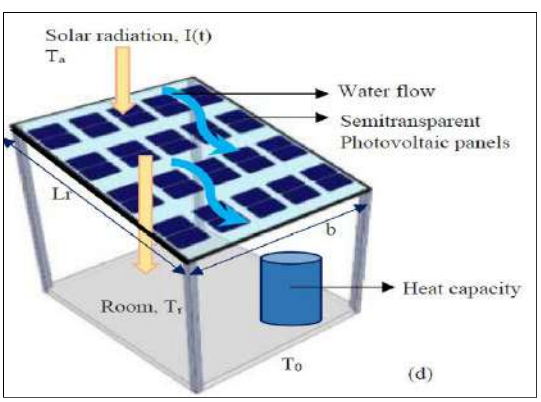


Fig. 48.(a) PV in upper solar chimney (b) PV in middle solar chimney

N. Gupta and G.N. Tiwari [100] Parametric analysis for a Buildings Hybrid Semi-transparent Photovoltaic Thermal (BiSPVT) model with different air cooling variables such as water mass (heat capacity), water flow (evaporative cooling) and daylight, for 4 situations, a comparative study was conducted: (a) BiSPVT model (b) BiSPVT model with water flow (c) BiSPVT model with heat capacity and (d) BiSPVT scheme with water flow and heat capacity to figure out the effect of each variable on the BiSPVT system. Results reported that the case (d) provides optimal cooling relative to other cases (with cases b, c and a follow-up case respectively). In case (d) there is a fall of 38.84 ° C in the mean room temperature relative to case (a). Also, the cooling provided by letting the water to drain over the SPV modules provides



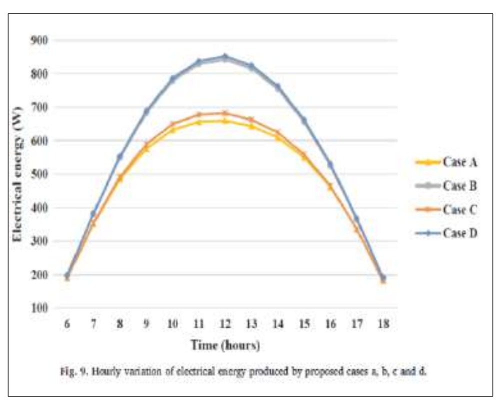


Fig.49. The schematic device Fig.50. variation of electricity energy

Kasayapan [101] used numerical simulations to study the process of natural convection inside inclined solar chimneys, including an electro-hydro-dynamic effect caused by wire electrodes. Natural convection inside the EHD solar chimney is seen schematically in Fig. 38. In addition, according to Fig. 39, the optimal inclination angle for obtaining the highest volume flow rate and heat transfer is 60°.

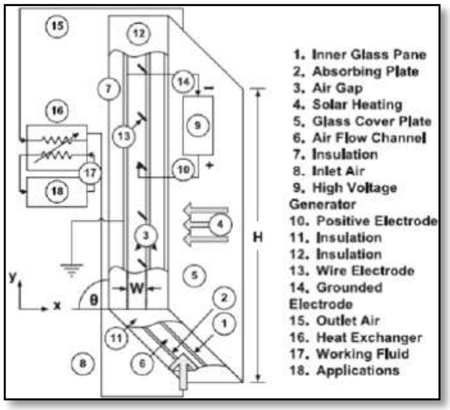


Fig. 51. The schematic of EHD solar

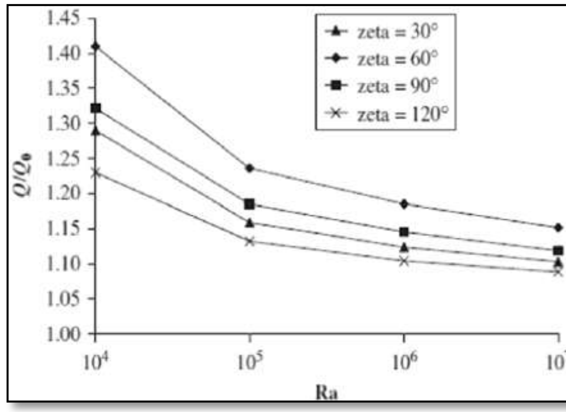


Fig. 52. inclined angle with heat ratio.

Because the effectiveness of the solar chimney is dependent on solar radiation, it is prone to malfunction. Cao et al. [102] solved the above-mentioned difficulty by using low-temperature geothermal water for the solar chimney in 2014. (Fig. 53).

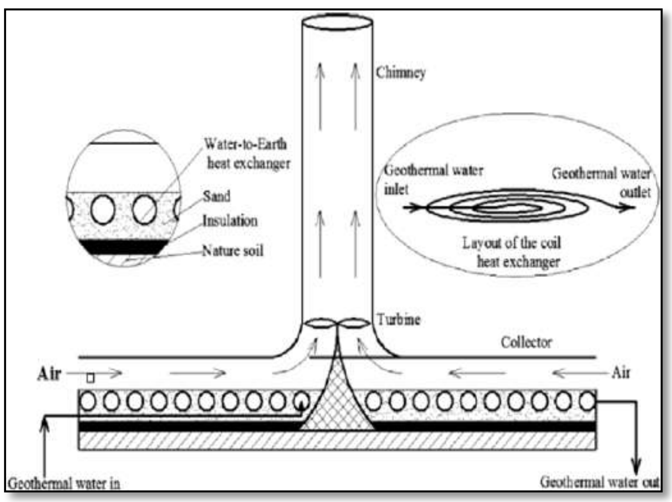


Fig. 53. Geothermal–solar chimney power plant .

In 2015, Zou and He [103] invented the HCTSC, which combines a solar chimney with a natural-draft dry cooling tower to generate electricity and remove waste heat. In compared to a standard solar chimney of the same proportions, the HCTSC system may create significantly more electricity per turbine.

Chr. Lamnatou et al. [104]Experimentally investigated the integrated photovoltaic (PV) cell system with reflectors and cooling coupled solar still formed with air injection, the cooling has been used to lower the temperature of the PV layer. At the other side, reflectors were used to reduce the reduction of reflection and increase the solar radiation rate that PV panels absorb. they studied Five operational scenarios: scenario-A (standard SPV panel), Scenario-B (reflector RPV), Scenario-C (reflector RPV with air cooling), Scenario-D (reflector RPV with water cooling) and Scenario-E (reflector RPV, water and air cooling). Results showed that 16.81, 21.62, 35.13, and 39.69 percent increase in the PV panel's electrical power was reported in Scenarios B, C, D, and E, respectively, relative to Scenario -A. Furthermore, the use of the air injection system increased the production of freshwater by 40.98 percent and 21.96 percent in cases C and E relative to the case where no air injection system presents.

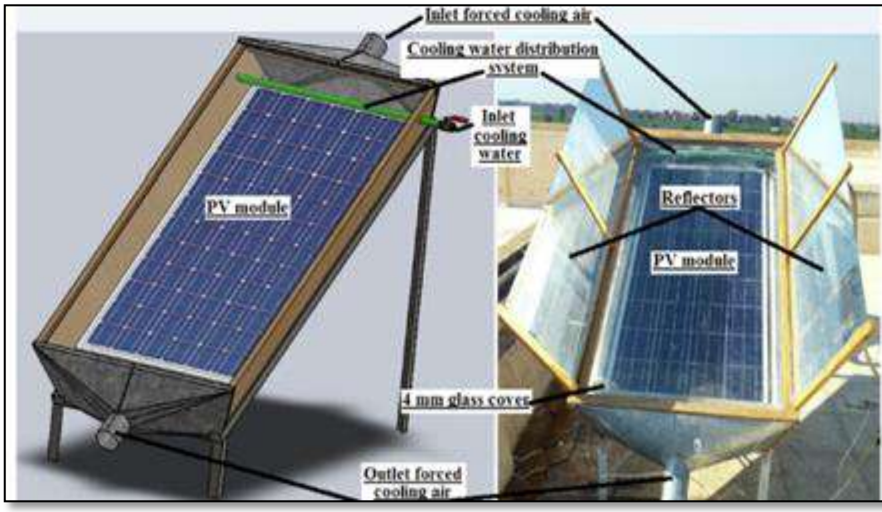


Fig. 54.A photographic view of a PV reflector with cooling system.

A.B. Kasaeian et al. [105]Performed an experimental analysis of climate influences on the performance of a solar chimney, by designing and manufacturing a solar chimney plant with a collector diameter of 10 m and a chimney height of 12 m. They measured temperatures and air velocities for certain collector and chimney positions with differing parameters on different days. Results found that the difference in temperature between the exit of the collector and the ambient approached 25 ° C and this phenomenon induced air flow from the collector towards the chimney. Upon sunrise, at both cold and hot days, the air inversion at the base of chimney was detected. The peak air velocity of 3 m / s was registered inside the chimney, while the entry velocity of the collector was zero.

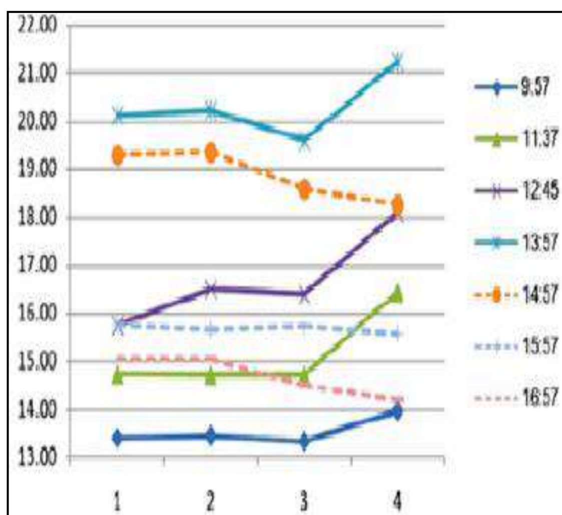


Fig. 55.solar chimney Fig. 56.temperatuer different along height sc.

Yu Y et al. [106] tested a hybrid geothermal cooling system in an experimental setting. (Fig. 57.) They upgraded the system with an earth-to-air heat exchanger and a solar collector-enhanced solar chimney. The researchers conducted active trials with forced airflow, a passive cooling test using natural airflow, and another passive cooling test. It was discovered that in the natural operating mode, the described system may provide cooling without requiring any power, and that the solar chimney can improve airflow to the system during the daytime when insolation is high.

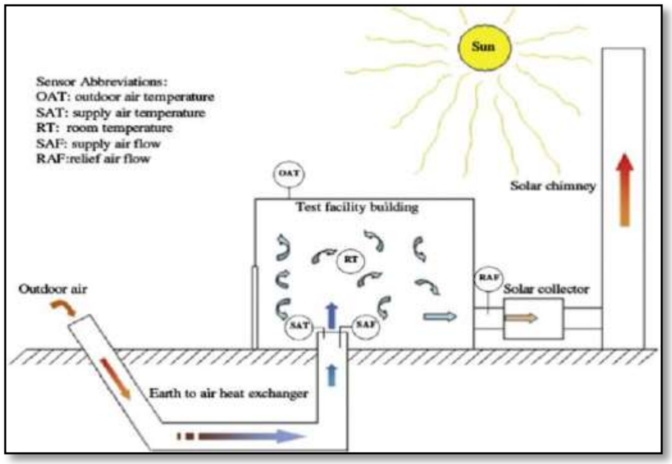


Fig. 57. diagram of the geothermal cooling system

This linked system, according to Li et al. [107], can generate a considerable energy reserve in buildings while also decreasing peak electricity consumption during the summer. A volumetric amount of 0.28 m3/s of outside air is sent into space by the solar chimney. In a single day, the earth-to-air heat exchanger may produce up to 3308 W of total cooling capacity..

In Turkey, Ozdemir et al. [108] pioneered a low-cost, high-efficiency way of generating renewable energy. As an example, they showed a wind chimney with a thermoelectric generator. A heat pipe for solar heating and a wind tower to improve the thermal efficiency of a normal steam power plant's Rankine cycle make up this system. This study focuses on the Shahid Rajaee 250 MW steam power plant in Iran. The thermal efficiency of the fossil fuel plant increased by 0.53 percent, according to the report. Rabani et al. [109] presented a built Trombewall in Yazd (Iran) with desert climatic conditions in conjunction with a solar chimney and water spraying system (Fig. 58). The use of a water spraying system enhanced thermal efficiency by 30%, according to the findings.

Fig. 58. Trombe wall and solar chimney .

Mareeswaran and Gopal [110] built and constructed a rectangle-shaped sun cooling chimney (SCC). The aforementioned technology can give a passive way of cooling solar photovoltaic in solar power plants due to its operational temperature rise and low efficiency.

2. Conclusions

The ongoing study focused on a complete review of the literature on SCPP ideas, designs, and performance. The majority of previous research has been on numerical simulation utilizing the CFD model. In light of all of these investigations, it was discovered that the literature on SCPP systems had several gaps.

1. The system's driving force, the chimney, should be developed in a safe manner for increased power pro duction, operation, and efficiency.
2. In addition, in order to maintain continuous growth, the SCPP technology's vulnerabilities and dangers must be thoroughly analyzed in the changing environment. For the commercial application, the best per forming SCPP setup must be identified.
3. Numerical turbulence model computation was used to investigate temperature, pressure, and flow profile.
4. Innovative techniques to collector and chimney design that are relevant to the local geographical circumstances can enhance power production.
5. The collector area, height, diameter, and slope; the chimney height; and the turbine pressure drop are all key design characteristics that determine the plant's efficiency.
6. According to a literature review, the installation cost of a solar chimney power plant is expensive, with the chimney accounting for the majority of the cost. According to literature, the power generating capability of a turbine located within a chimney is also dependent on the velocity of air achieved inside the chimney. As a result, in order to lower the system's installation costs and improve the velocity of air inside the chimney.

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