# Economic Analysis Of Solar Tower Plant Field Selection And Suitability Of The Location Study For Deployment Of Solar Tower Plant

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**Abstract-**
**Background:** The heliostats of a solar tower power plant concentrate the sun's beams onto a heat receiver mounted on top of a tall tower. Renewable energy initiatives are crucial to the ongoing paradigm change in conventional power generation. Taking use of the abundant solar radiation might help alleviate pressure on the power grid. In addition to assisting with land resource management, the installation of solar power plant units in unused regions is anticipated to result in the creation of local employment possibilities, the improvement of local infrastructure, the conservation of water resources, and the generating of energy money. One way to collect energy from the sun is via a solar updraft tower (SUT) plant.
**Aim and Objectives:** The aim and objectives of this study is to analyze solar tower plant field selection and suitability of area for deployment.
**Methods:** In this research, we identified the optimal spot to set up our solar tower facility. Warangal, Telangana, India, serves as the case study site. Energy from the sun is harnessed both directly and indirectly in a solar updraft tower (SUT) facility. ANSYS Design Modeler was used to build the models' computational domains, and the commercial software program ANSYS Fluent 16.0 was used to run the simulations.
**Research Findings:** The feasibility of installing a solar vortex engine (SVE) in place of the chimney at the SUT facility was analyzed numerically. By altering its geometrical configurations, such as the top-hole diameter (from 0.2 to 0.5 m) and the number of air entry slots (AES) (from 6 to 12), we are able to study the effect on flow and performance and provide a viable solution for power production. Guide vanes may be added to the SUT system to improve its performance by using the nozzle effect. The SVE plant might have been used to replace the SUT plant's chimney, increasing the efficiency of the latter.

**KEYWORDS:** Solar Tower Plant, Suitability, Economy, Field, Deployment

## I. INTRODUCTION

Almost every country in the world is now looking for a replacement for fossil fuels as a means of producing power because of global warming caused by greenhouse gas emissions. Alternatives to fossil fuels are being explored, and renewable energy sources including solar, wind, geothermal, and wave power are being seriously studied. While nuclear power is a viable option for wealthy countries, the prohibitive cost prevents developing countries like Bangladesh from ever considering it [1]. Therefore, solar energy is the most viable and cost-effective choice for Bangladesh right now. Since solar energy can be used indefinitely and also helps cut down on greenhouse gas emissions, it is quickly gaining popularity as an energy source. The quantity of sunlight striking a solar power plant is directly proportional to its production. Outside of Earth's atmosphere, the "solar constant" for power density perpendicular to the sun's radiation is 1365 $W/m^2$. Some of the photovoltaic radiation will be dispersed and absorbed by the environment due to the route length and the relative amounts of dust, water vapor, ozone, carbon monoxide, and other aerosols gases. Photovoltaic modules up to 1000 $W/m^2$ have been evaluated using standard values set by the industry. More essential than the photovoltaic radiation or the instantaneous solar radiation is the total quantity of solar energy received on a daily basis in a certain area. Because solar energy resources are not distributed uniformly, every project should assess the viability of the photovoltaic project in light of this fact [2, 3]. The heliostats of a solar tower power plant concentrate the sun's beams onto a heat receiver mounted on top of a tall tower. Each heliostat has a solar tracking mechanism that allows it to follow the Sun as it travels across the sky.

In order to tackle issues like energy security, climate change, and sustainable development on a global scale, the development of cutting-edge clean energy technology must be rapidly accelerated. As a promising future alternative power source, solar photovoltaic is a crucial technology for bringing about a decarbonized energy supply. From 7.6 GW in 2007, solar PV grid connected capacity jumped to 13.5 GW in 2008, and then to 21 GW by the end of 2009. The yearly output of solar photovoltaics (PV) increased from 3.7 GW in 2007 to 10.7 GW in 2009. The expansion pattern persists and will likely accelerate until grid parity is reached. Because of its position on Earth's equator, India benefits greatly from the sun's rays. The India Meteorological Department (IMD) keeps track of solar radiation and the length of daylight through a system of radiation stations spread across the country. About 250–300 days a year see bright, sunny skies over much of India. Radiation received in the tropics and subtropics is representative of the yearly world average, which ranges from 1600 to 2200 kWh/sq. m. About 6,000 million GWh of energy per year is the corresponding energy potential. Rajasthan and northern Gujarat experience the greatest yearly global radiation. Large swaths of Rajasthan are undeveloped and thinly inhabited, making them ideal sites for massive solar-powered central power plants [4]. Many nations have turned to renewable energy sources because they have been obliged to reduce their reliance on fossil fuels, which are in short supply and have severe environmental consequences like global warming. The solar power plant is capable of harnessing the Sun's energy output of over 2500 terawatts (TW). In light of the unpredictability of the price and environmental impact of fossil fuels, it is one of the renewable and eco-friendly options for maintaining energy consumption and energy independence. A solar PV plant provides a photovoltaic system that is connected into the grid and includes solar panels, inverters, power conditioners, and grid connection hardware. Semiconductor-based photovoltaic (PV) panels directly transform sunlight into usable power.

## II. LITERATURE/STATE-OF-THE-ART REVIEW

Kaushik & Siva, Vundela, s. C. & Tyagi, S., (2014) [5] This article provides an exergy analysis-based assessment of a solar thermal power plant with a central tower receiver and an air-cooled volumetric receiver. Under these precise circumstances, we have calculated the energy and exergetic losses, as well as the efficiencies, of a standard central tower receiver-based solar thermal power plant. It has been calculated how much more efficient the plant will be after it has attained a constant power input, which can be done with a thermal storage backup state. An improvement from 24.15% to 25.08% in annual average energy efficiency and from 26.10% to 27.10% in annual average exergetic efficiency is possible in the case of the chosen site Jodhpur. Using a 10% interest rate over the solar plant's expected 30-year lifetime, we calculate that the cost per kilowatt-hour of electricity generated is INR 10.09. This research lays the groundwork for building solar thermal power facilities in India in the future.

Miguel, Zhu, Yong & Zhai, Rongrong & Yang, Yongping & Reyes Belmonte (2017) [6] In this work, we evaluate the techno-economics of a 1000 MWe solar tower supporting a coal-fired power plant during its entire operational lifetime. In the first step, we examine coal and solar thermal energy power production in the presence of varying direct normal irradiance and grid demand. The second step is to calculate the potential gains and losses from the plant construction project. Finally, a sensitivity analysis is performed on a number of external variables that may have an impact on the plant project's cost or profits and losses. The project's internal rate of return (IRR) is 8.7 percent, which indicates strong earnings. Cost of solar tower fields, PPA prices for solar thermal energy, coal prices, and loan interest rates all have less and less of an impact on the primary criterion over time. If the PPA price of solar thermal power drops and the price of coal rises, it will be necessary to seek out low-interest financing from banks in order to maintain profitability. This is why improving solar tower technology should come first. The levelized cost of electricity (LCOE) may rise due to the incorporation of solar tower fields, while CO 2 collection costs are reduced in comparison to the case of conventional coal-fired power stations.

Mokheimer, Esmail & Dabwan, Yousef (2019) [7] As more and more facilities build heat and power cogeneration plants to generate heat and electricity to run absorption refrigeration systems or steam for industrial operations, this study provides the findings of a thermo-economic analysis of integrating solar tower (ST) with these facilities. Different gas turbine and solar collector area sizes and their effects on the yearly performance of an integrated solar-tower gas-turbine cogeneration power plant (ISTGCPP) was analyzed and reported. Different ISTGCPP integration configurations were evaluated thermodynamically and economically using the Thermoflex + PEACE software packages. The appropriate size of the integrated solar field has been determined, and it is predicted how much $CO_2$ emissions may be cut by including the ST system. The research found that the economic viability of integrating solar energy is greater for ISTGCPPs with gas turbines with electric power production capacities smaller than 50 MWe for the studied cogeneration plant (which is needed to generate 81.44 kg/s of steam at 394 °C and 45.88 bars). For gas turbines with electric power generating capacities of less than 50 MWe, the levelized electricity cost (LEC) for the (ISTGCPP) ranged from $0.067 to $0.069/kWh. The research also showed that the LEC for the ISTGCPP is decreased by 50-60% compared to the LEC for a standalone ST power plant, making it a more economically viable option. In addition, this work presents a conceptual technique for determining the best settings for the ISTGCPP.

Musi, et al (2017) [8] An essential statistic, the levelized cost of electricity (LCOE) is simply the lifetime expenses divided by the lifetime output of a certain electricity producing system. The assumptions that underpin the seeming simplicity of this method may have a major impact on the final outcome. Although several LCOE analyses have been published, their underlying assumptions are seldom made clear. All necessary assumptions and formulae for comparing studies are provided in this analysis. This research shows that the CSP LCOE is decreasing significantly over time and that the SunShot 6/kWh 2020 objective is achievable in the correct market and location. The CSP market and the further reduction of LCOE need more industry collaboration. The findings also suggest that the market develops differently depending on whether an established CSP technology is installed in a new nation or a new technology is used in a country with an established CSP market.

Nathan & Parilla et al (2018) [10] In this study, we describe the results of a techno-economic analysis and performance simulations of a modular dispatchable solar power tower. Our novel setup places thermal storage and a power block right atop a tower receiver, making use of a heliostat field and power block three orders of magnitude smaller than traditional solar power towers. Heat transfer from a latent heat thermal storage tank to a Stirling engine is regulated by a valved thermosyphon, making the system dispatchable. The modular layout reduces overall system costs, allowing for quick realization of economies of scale at large deployment rates. We find that the system may be competitive in terms of levelized cost of electricity compared to both natural gas peaking plants and other dispatchable renewables by combining performance simulations with techno-economic analyses.

## III.DESCRIPTION OF THE PROJECT/PROJECT JUSTIFICATION

For emerging powers like India and China, energy is the engine that drives their economies. The rising price of fossil fuels and their fast depletion have sparked a greater exploration of renewable energy options. Researchers have thus focused extensively on alternative energy sources. Due to rising energy needs, environmental consciousness, and fossil fuel shortages, solar power has reached a new zenith in the 21st century. Carbon-free power production, resolving pollution concerns, and climate change mitigation may all be achieved via the use of solar energy. Another potential device that makes advantage of both direct and diffuse sunlight is the solar chimney power plant, often known as the solar updraft tower (SUT) plant. This is another power technique on a wide scale that eliminates the release of greenhouse gases into the atmosphere. One viable strategy for implementing carbon-free electricity production was a solar power plant. Materials for the absorber, collector cover, and chimney in big plants should be chosen based on their thermophysical qualities [9]. These include ground, free-iron soda lime glass and reinforced concrete. Polycarbonate chimneys with aluminum or copper absorber plates may boost performance in facilities of any size. The ambient Temperature (Ta) and annual Solar Radiation (I) data should be used to determine the best location for the plant. The temperature of the surrounding environment is the single most important factor in maximizing the system's efficiency. In terms of geometry, the height of the chimney was the most important factor in determining performance. Solar updraft tower (SUT) plants, diverging chimney solar updraft tower (DC-SUT) plants, and solar vortex engine (SVE) plants will all be analyzed in this effort to determine their economic viability and performance in deployment.

## IV.RESEARCH METHODOLOGY

### A. Solar updraft tower (SUT) plant:

The collector cover, absorber plate, and chimney are the SUT plant's three fundamental parts. In order to transform the incoming solar radiation into usable stored energy in the air, the solar collector acts as a heat exchanger. As the governing equations are solved iteratively, the thermo-fluidic behavior of flowing air is anticipated at various sites [11].

### B. Governing equations:

Rayleigh's number (Ra) may be used to quantify the vigor of a flow, and its value is found using the following formula:

$$Ra = \frac{g\beta\Delta T L^3}{\vartheta\alpha} = Gr \times Pr \quad (1)$$

Where L is the characteristic length, β is the thermal expansion coefficient, ΔT= (T-To), To is the operating temperature, g is the acceleration due to gravity, ϑ is the kinematic viscosity, and is the thermal diffusivity. In mathematics, Gr denotes the Grashof number and Pr the Prandtl number. The calculated value of Ra is more than $10^9$. This causes a turbulence in the flow.

Using the finite volume approach and the ANSYS® Fluent® software package, we solved the mass, momentum, energy, and RTE conservation equations repeatedly for various material characteristics and boundary conditions. The absorber plate is made of copper because of the metal's strong thermal conductivity and high heat capacity. High-transparency glass is used for the solar collector. The advantages of polycarbonate as a chimney material are its low weight, its resistance to temperatures up to 150 degrees Celsius, and its great stability under wind flow conditions. In order to have air take part in the radiation, we use a fluid in which the density variation is supposed to follow the Boussinesq approximation. Materials' tabulated thermophysical characteristics are shown in Table 1.

Table 1: Materials' thermophysical characteristics

| **Thermophysical properties** | **Air** | **Copper** | **Glass** | **Polycarbonate** |
|---|---|---|---|---|
| Specific heat, ($C_p$) J/kgK | 1006 | 381 | 840 | 1170 |
| Thermal conductivity, (k) W/mK | 0.0242 | 387 | 0.78 | 0.185 |
| Density, (ρ) kg/$m^3$ | 1.125 | 8972 | 2705 | 1210 |
| Thermal expansion coefficient (β) | 0.00333 $K^{-1}$ | -- | -- | -- |
| Thermal diffusivity (α) | $2.137\times10^{-5}$ $m^2/s$ | -- | -- | -- |
| Absorption coefficient, (a) $mm^{-1}$ | -- | -- | 0.03 | -- |
| Transmittance | -- | -- | 0.9 | -- |

### C. Divergent chimney solar updraft tower (DC-SUT) plant:

Material qualities and boundary conditions: BCs were added based on real flow conditions to analyze the flow physics in the domain. For the numerical analysis, we use the same material and boundary conditions as in table 1 above for the SUT plant's thermo-physical attributes.

### D. Power plant using Solar Vortex Engine (SVE):

Similar to the atmospheric vortex engine (AVE) and the solar chimney plant with short diffuser (SPD), the solar vortex engine (SVE) is an alternative energy idea. Create and maintain an artificial convective vortex structure using AVE, which is based on the notion of a vortex generator.

**E. Material properties and boundary conditions:**

The flow phenomena within SVE were simulated and predicted using computational fluid dynamics (CFD). The boundary conditions for AES and the bottom hole are velocity inlet. As the outflow boundary conditions, we were provided the EBS outlet. A no-slip boundary condition and a constant wall temperature were used to maintain the cylinder's rigid walls. Both the bottom and top plates of the EBS were kept at a fixed wall temperature while a convection boundary condition was employed for the wall [12].

Study Area

This research makes use of the commercial software ANSYS Fluent v16.0 to provide a 3D numerical solution for a cylindrical chimney SUT (CC-SUT) facility. Warangal (Telangana, India; 18°00' N, 79°35' E) serves as the starting point for this study. The National Institute of Technology (NIT) in Warangal, Telangana State, India, created the first working model of the SUT plant. The Centre for Advanced Materials (CAM) in NIT Warangal, India, is home to the SUT establishment. In Fig. 2, you can see the results of utilizing the commercial program Design modeler of ANSYS fluent 16.0 to create five distinct versions (with various θch) of 3D domains.

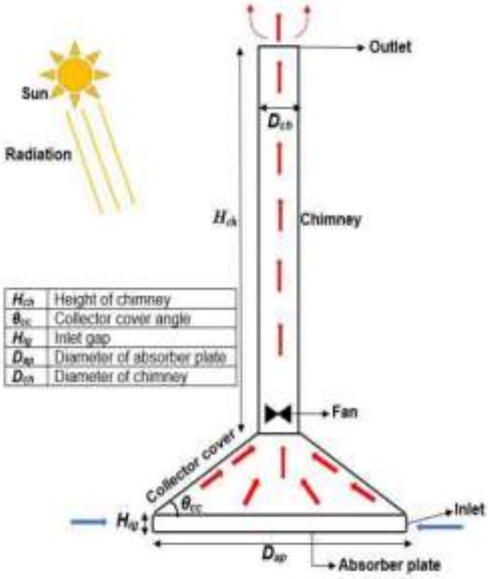



Figure 1: Layout of the CC-SUT plan in schematic form

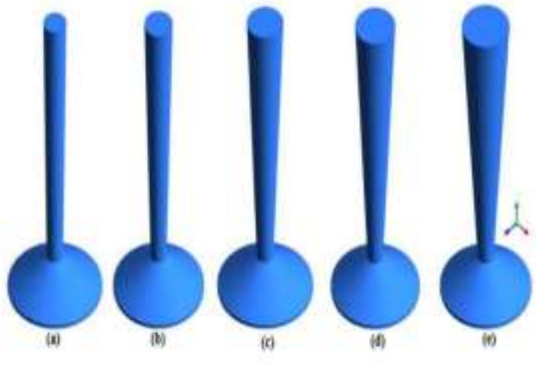



Figure 2: Domains of computation for the DC-SUT plant at (a), (b), (c), (d), and (e) 1°, 2°, 3°, 4°, and 5°, respectively.

TES materials

The insulating plate in the shape of a circle was filled with TES materials. Various sizes of rock gravels, sand, and pebbles were used to create the TES layers. These components are accessible and low-cost. And compared to other materials, such as reinforced concrete (0.8 kJ/kgK), cast iron (0.56 kJ/kgK), soil (clay) (0.88 kJ/kgK), and dry bricks (0.84 kJ/kgK), rock and sand combination (1.3 kJ/kgK) has a greater heat storage capacity.

Chimney or solar tower and strings

The chimney is an essential component of every SUT setup. The material used for a chimney is crucial, since it determines the chimney's durability, steadiness, and safety. The majority of the research reports that polycarbonate was used for the chimney, but PVC and concrete were also mentioned. When compared to other lightweight materials like PVC and polyester, polycarbonate has a better thermal fluid carrying capacity since it can resist fluid temperatures of up to 150°C.

Research Design
To determine how the surface temperature of the absorber plate (Tap) varied, thirteen RTD sensors were employed (Labfacility, DIN EN 60751 class A PT 100, UK). One sensor was placed in the middle of the absorber plate (#C) and three were placed on the East (E), West (W), North (N), and South (S) sides. Uncertainty analysis was carried out with the intention of quantifying and documenting the mistakes connected to the collected data.]

## V. RESULTS AND DISCUSSION

### 1. Solar updraft tower (SUT) plant

- **Flow parameters estimation and analysis on SUT:**

The measurements were used to create a model of the SUT, and numerical simulations were run in ANSYS fluent. Assuming an input air temperature of 303 K, and a solar irradiation of 750 W/m$^2$ falling on the collector cover (glass), we get the following results. As can be seen in Fig. 3(a), there is a dramatic increase in air speed just before the entrance due to the collector's canopy-like cover. Figure 3 (b) shows the whirling motion of the buoyant air within the chimney. In addition, a section through the collector-chimney interface is obtained at a high magnification, and the rotating flow is shown close to the collection canopy. The air velocity within the chimney is 0 at the wall due to the no-slip boundary condition and gradually climbs to its maximum value (2.32 m/s) near the central axis, resulting in a parabolic flow profile. Maximum air velocity was measured at 2.32 m/s [13], with average velocities calculated at 1.994 m/s at the chimney exit and 0.515 m/s at the collector intake.
The domain's estimated pressure distribution is represented as a contour diagram. The pressure within the setup is -4.65 Pa, but it gradually rises to 0.24 Pa (positive) towards the chimney's output (static gauge pressure is shown in this figure). As illustrated in Fig. 3 (c), we pick a slice close to the chimney-collector interface and zoom in on it. Figure 3(d) displays an expected temperature contour inside the SUT facility. At its hottest (315 K) in the middle, the temperature progressively declines to its coolest along the walls, where it registers at about 304.2 K.

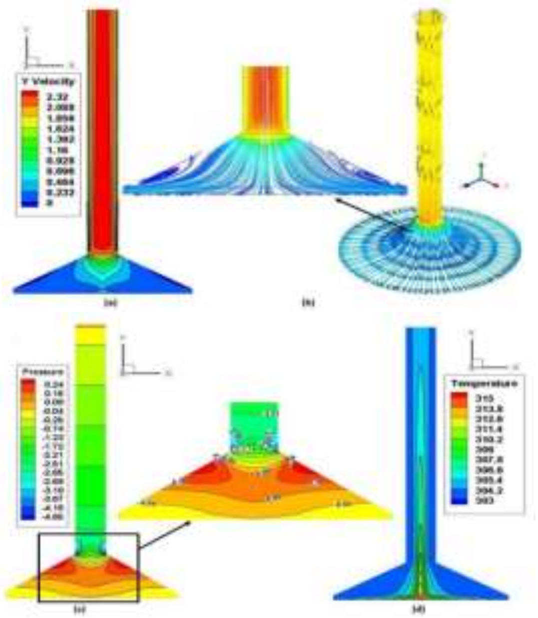
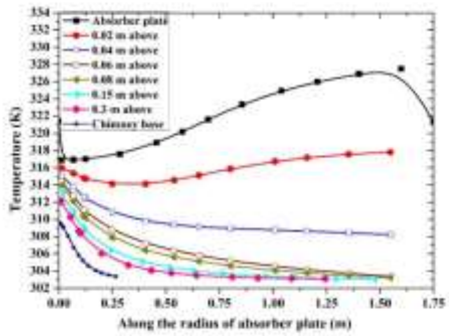


**Figure 3: Multiple contour maps of air velocity (a), streamlines (b), and pressure (c) at the flow domain midpoint of SUT. (d) The air temperature in kelvin**

Using the local heights of 0.02, 0.04, 0.06, 0.08, 0.15, and 0.3 m above the absorber plate, a temperature profile is computed and shown in Fig. 4 (a). Figure 4 (b) displays the temperature profile of the air between CB and 5.55 m above CB, where the chimney exit is located. As CB is moved closer to the chimney's outflow, the temperature drops (Fig. 4 b). Convection heat transfer from the absorber plate and direct sun radiation warm the air.

(a)




(b)

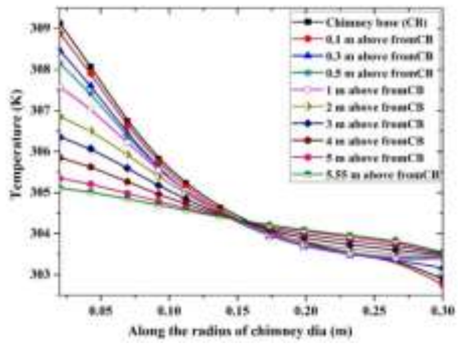



**Figure 4: Distribution of temperatures along the flow domain's radius (a) from absorber plate to CB and (b) from CB to chimney outlet**

## 2. DC-SUT solar power facility with a divergent chimney solar updraft tower

- **Divergent chimney's effects on many performances' metrics:**

Table 2 displays the results of an analysis of the impact of θch on several system performance metrics. As θch climbs from 1° to 2°, the volume flow rate and pressure drop also rise, elevating Pt and Pact. When θch is greater than 2 degrees, the pressure gradient decreases, causing Pt and Pact to fall. As may be shown from Eq. (2) (Pt = ΔP×Q), it is also generally accepted that Pt is proportional to pressure gradient. The system's o saw a similar pattern. The range of possible values for pact is from 0.63 W up to 1.07 W.

$$\nabla.(I_\lambda(\vec{r},\vec{s})\vec{s}) + (a_\lambda + \sigma_\varepsilon)I_\lambda(\vec{r},\vec{s}) = a_\lambda n^2 I_{b\lambda} + \frac{\sigma_s}{4\pi}\int_0^{4\pi} I_\lambda(r^{\to}, s^{\to})\emptyset(s^{\to} \cdot s^{\to})d\Omega \qquad (2)$$

This may be written as a simple equation: a = {ln (100/%τ)}/ t; where t is the thickness of the medium (collector cover thickness) and is the transmittance.

Table 2: Effect of I and θch on DC-SUT performance metrics

| (For I = 900 W/m$^2$, $T_a$ = 303 K, $\eta_{tur}$ = 66.7%, $H_{ch}$ = 7 m, $(D_{ch})_i$ = 0.6 m, $D_{ap}$ = 3.5 m, $\theta_{cc}$ =30º and $H_{ig}$ = 0.1 m) | | | | | |
|---|---|---|---|---|---|
| $\theta_{ch}$ (°) | 1º | 2º | 3º | 4º | 5º |
| $P_t$ (W) | 0.95 | 1.61 | 1.56 | 1.42 | 1.29 |
| $P_{act}$ (W) | 0.63 | 1.07 | 1.04 | 0.95 | 0.86 |
| ηo (%) | 0.0073 | 0.0124 | 0.012 | 0.0109 | 0.0099 |

Performance metrics (Table 2) show that at θch = 2º, ηo, Pt, and Pact are all at their highest values. As a result, we know that the best value for θch is 2º, and that value has been utilized in subsequent research (for example, to examine the impact of I and Ta).

## 3. Solar vortex engine (SVE) plant

- **Top-hole diameter's impact on flow parameters**

The top hole on the top plate allows air to escape from the SVE. The impact of this top-hole diameter (Dth) on flow characteristics was determined. Dth values of 0.2, 0.3, 0.4, and 0.5 m were used in the various SVE configurations. For the simulation, the inlet air velocity was set at 0.7 m/s. The rest of the environmental and geometrical factors were kept unchanged.

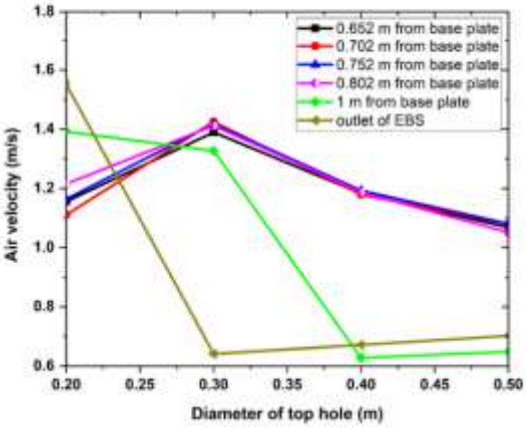



Figure 5: Variation in velocity at various top-hole diameters

Figure 5 depicts the change in air speed caused by a shift in Dth. As Dth was raised, the air's velocity went up, then down. The heights 0.652 m, 0702 m, 0.752 m, and 0.802 m all followed this pattern. At Dth = 0.2 m, the air speed was measured to be 1.11 m/s, and at Dth = 0.3 m, it was 1.42 m/s. The estimated impact of Dth on dynamic pressure is shown in Fig. 6, where it can be seen that the dynamic pressure drastically decreases with increasing Dth throughout the board. As was previously noted, [14, 15] Fig. 5 shows that the drop in dynamic pressure is due to the decrease in air velocity with the rise in Dth.

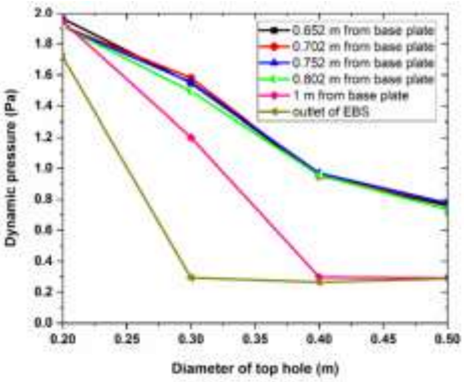



**Figure 6: Variation in dynamic pressure as a result of changing top-hole diameter**

When the flow characteristics (velocity, temperature, and pressure) are examined, it becomes clear that a Dth of 0.3 m has a greater impact than other Dth. In addition, considering all the local heights, it is recommended that a turbine be installed at 0.702 m (0.1 m from top-plate) from the base of SVE, where it can draw the most power from the vortex.

## 4. Economic analysis

The financial analysis of the power project takes into account four different scenarios, including (i) a pre-tax scenario, (ii) a post-tax scenario, (iii) a pre-tax scenario with equity, and (iv) an off-site scenario with equity. The 25-year lifespan of the plant is included into the economic analysis. In a pre-tax scenario, project financial performance is calculated before any taxes or fees are taken into account. The Warangal solar power facility is subject to no taxation for the first ten years, and then just four percent per year after that. Also, after the first decade, depreciation is only estimated at 1.33% compared to the first 7%. Loans from financial institutions at an interest rate of 11.75 percent are taken into account, with an equity portion of 70 percent of the total investment. The World Bank's terms and interest rate for the loan will be used. The study also incorporates a further financial flow, namely the loan's annual payment (Table 3) [15].

Table 3: Economic analysis for proposed solar tower plant (Price in million INR)

| Analysis | Pre-tax | | Post-tax | | Pre-tax with equity | | Post-tax with equity | |
|---|---|---|---|---|---|---|---|---|
| | On site | Off site | On site | Off site | On site | Off site | On site | Off site |
| NPV @ 10% | 119.52 | 249.78 | 108.39 | 238.49 | 135.30 | 211.37 | 124.09 | 200.16 |
| NPV @ 15% | −142.48 | 3.39 | −147.76 | −1.95 | −17.36 | 60.24 | −22.67 | 54.93 |
| IRR (%) | 11.88 | 15.10 | 11.88 | 14.94 | 14.18 | 18.92 | 13.91 | 18.64 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Simple payback period (years) | 7.73 | 6.29 | 7.73 | 6.29 | 10.39 | 6.27 | 10.39 | 6.27 |
| Discounted payback period (years) @ 10% | 15.53 | 10.14 | 15.53 | 10.14 | 15.21 | 9.65 | 15.44 | 9.65 |
| Discounted payback period (years) @ 15% | Never | 17.18 | Never | 17.50 | 26.33 | 13.24 | 28.61 | 13.24 |

Four financial situations (pre-tax analysis, post-tax analysis, equity analysis pre-tax, and equity analysis post-tax) are examined using financial performance indicators (Internal Rate of Return [IRR], Net Present Value [NPV], and payback periods). Due to the high cost of land in urban areas, an off-site solar tower plant generating alternative is preferable.

## VI.CONCLUSION

SUT, DCSUT, and SVE plant flow and performance characteristics were estimated by a series of numerical simulations. The impact of different geometric arrangements on SUT plants was studied. It was found that θcc shouldn't be higher than the location's latitude +12 degrees (thus 30 degrees for Warangal). We analyze the effects of divergence angle (θch), Solar Flux (I), and ambient temperature (Ta) on the DCSUT plant's flow and performance characteristics. At a temperature of 2ºC, DCSUT plant output and flow were found to be at their highest. Computational analysis of the viability of using an SVE plant to generate electricity. Small-scale CFD tests on SVE plant are used to depict flow and performance metrics in the current study. The predicted output parameters are little since the input velocity range was small. Guide vanes may be added to the SUT system to improve its performance by using the nozzle effect. The SVE plant might have been used to replace the SUT plant's chimney, increasing the efficiency of the latter. The following are the further investigations:

i. More research on commercial-scale plants is needed to determine yearly power potential in light of current geographical and metrological circumstances.
ii. It is necessary to pinpoint the obstacles hindering the plant's commercialization and take steps in that regard.
iii. For more precise forecasts, numerical studies under stress are required.
iv. The plant's size must be determined by testing optimal small-scale models in the lab.
v. To make the SUT plant more economically competitive, more thermo-economic analysis is needed.

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