



## ANALYSIS OF SOLAR UPDRAFT TOWER APPLICATIONS FOR GENERATING ELECTRICAL ENERGY IN UZBEKISTAN

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**Annotation.** In line with the implementation of the Paris Agreement on Climate Change (COP-21 of the UNFCCC) adopted on December 12, 2015, the Republic of Uzbekistan has formulated and approved a national energy development strategy for the period 2020–2030. This strategic plan envisions the annual commissioning of 3 GW of wind and 5 GW of solar power generation capacity. Renewable energy sources (RES) will produce electricity alongside conventional thermal power plants, contributing to the unified power grid.

However, the integration of RES with thermal power generation presents a challenge: the inherent intermittency of solar and wind energy requires the availability of backup power capacity. As the share of RES in the energy mix increases, so do system-related operational costs.

Unlike conventional renewable sources, the **Solar Updraft Tower (SUT)** represents an alternative that offers more stable energy output. This reduces the need for standby capacity and enhances compatibility with centralized energy systems. The article examines the potential and feasibility of deploying Solar Updraft Tower technology in the context of Uzbekistan's environmental and energy conditions.

**Key words:** wind generator, renewable energy source, PV panel, unified energy system, generating capacity, thermal plant, storage battery, Solar Updraft Tower (SUT).

### Introduction

The current methods of electricity generation using coal, oil, and natural gas are harmful to the environment, financially unsustainable, and unaffordable for many developing nations [1]. Therefore, an effective approach to widely implementing renewable energy should meet the following criteria:

- it must be straightforward and dependable
- accessible to countries with lower levels of technological development
- should not depend on additional water resources for cooling purposes
- must avoid generating waste and prioritize environmentally friendly production using renewable or recyclable materials.

The Solar Updraft Tower (SUT) project aligns well with these requirements and offers a promising pathway toward a global transition to solar-based energy systems. Economic assessments grounded in current expertise and prior experience [2] indicate that large-scale SUT installations ( $\geq 100$  MW) can deliver electricity at costs comparable to those of traditional fossil fuel plants. As energy demand continues to rise sharply, the cost disparity is expected to diminish and eventually reverse.

Another compelling argument in favor of the SUT is the onset of global climate change between 2018 and 2020, which has intensified the urgency of moving away from

hydrocarbon-based energy generation toward renewable alternatives, regardless of fluctuating oil prices. We believe that in the near future, the SUT project will play a vital role in addressing one of the most critical global challenges: producing reliable, sustainable, and affordable energy.

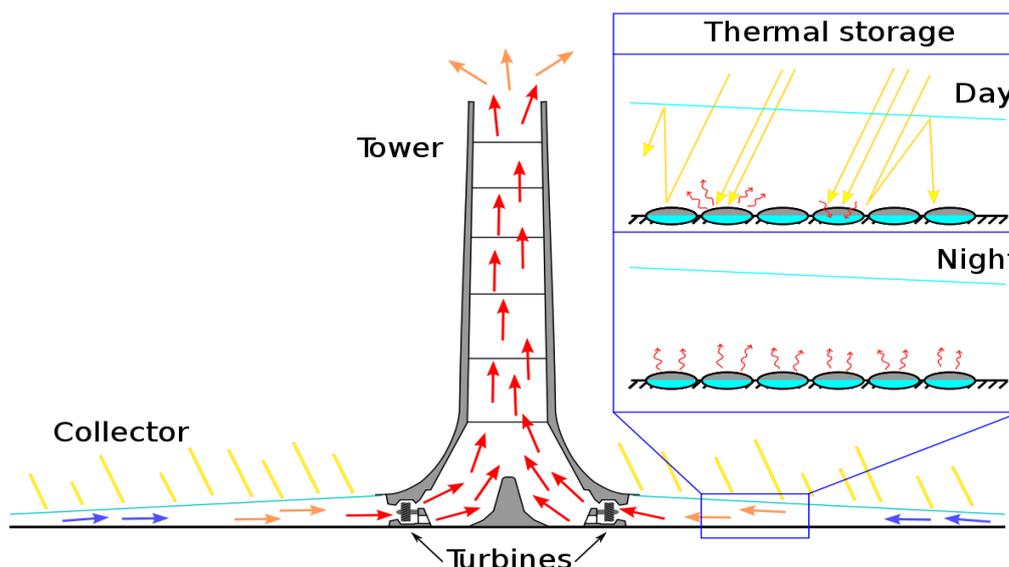
As noted by the World Energy Association (WEA), a 50 MW solar tower was constructed in Australia under the guidance of S.N.B. The Enviromission Commission currently has two 200 MW facilities under development in the Arizona desert, each using 32 turbines rated at 6.25 MW and featuring a collector field covering 10 square kilometers beneath a 730-meter-high tower. These systems may include thermal mass storage—such as salt ponds—beneath the collector area to allow electricity generation even at night.

Previously, a 50 kW prototype of this technology operated in Spain from 1982 to 1989. In China, a 27.5 MW solar tower is under construction in Jinshawan [3]. The projected cost of electricity from SUTs ranges from €0.05 to €0.25 per kilowatt-hour (US\$0.07 to \$0.34), depending on land cost and financing conditions. For comparison, conventional gas-fired power plants can generate electricity at approximately €0.05 per kWh.

Furthermore, SUT-based projects offer added value by supporting additional applications such as agriculture, water extraction or distillation, and urban air quality improvement.

### Research Method

The technology behind generating electricity through a Solar Updraft Tower (SUT) is relatively straightforward: sunlight heats the air beneath a large, transparent glass canopy [4]. Due to the greenhouse effect, the temperature of the air under the canopy (known as the collector) becomes significantly higher than the surrounding ambient air, creating a pressure differential. This pressure drives a continuous airflow that rises through a tall central cylindrical tower, or chimney. As the warm air ascends, it passes through turbines installed inside the chimney, causing them to rotate and produce electricity.



**Fig 1. Basic parameters of the SUT**

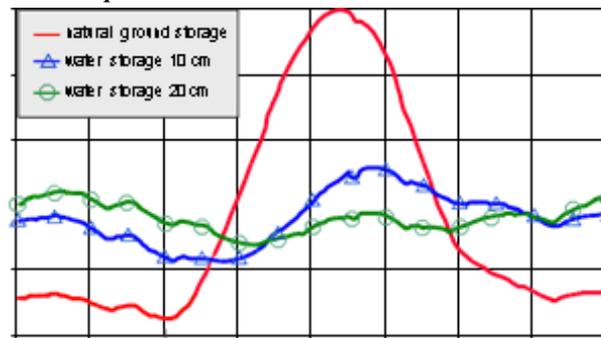
Since the ground beneath the collector functions as a natural thermal storage system, Solar Updraft Towers (SUTs) are capable of operating continuously for 24 hours using only solar energy, though with reduced output during nighttime hours. To enhance this effect,

basic water pipes are installed on the surface under the collector. These pipes absorb heat during the day, warming the water inside them. At night, the stored heat is gradually released, helping to warm the air and maintain the necessary pressure under the collector for continued operation.



**Fig 2. Accumulation of thermal energy in the SUT system**

Throughout the day, solar radiation causes the water in the pipes to absorb and store heat (Fig. 2a). At night, the process reverses, with the stored heat being released from the water into the surrounding air (Fig. 2b). The amount of water used in the system is selected to correspond to a water layer depth ranging from 5 to 20 centimeters, depending on the desired power output and performance requirements.



**Fig.3 Change in the power generated by SUT within 24 hours.**

The amount of electricity generated by a solar updraft tower is directly related to the volume of air within the tower and the size of the collector area. In essence, increasing the collector's surface area while reducing the tower height can yield similar output to increasing the tower's height while reducing the collector area.

Based on the solar radiation map, Uzbekistan lies within a climatic zone receiving between 1900 and 2100 kWh/m<sup>2</sup> annually, making it a suitable candidate for the Solar Updraft Tower (SUT) project. In assessing the project's viability, key economic factors such as land and labor costs play a significant role. In Uzbekistan, land suitable for the project is relatively affordable, estimated at around \$1–1.5 per square meter. Additionally, the country has an abundant labor force, with labor costs considerably lower than the €5 per hour benchmark presented in Table 1.

Moreover, the relatively low cost of construction materials in the region further reduces project expenses. Altogether, these factors suggest that the total cost of implementing the SUT could be reduced by approximately 25–30% compared to the reference data in Table 1.

Given these favorable conditions, we propose constructing a 100 MW Solar Updraft Tower in the Yangiariq district of the Khorezm region, Uzbekistan. This district is home to around 110,500 residents, most of whom are concentrated in the southern part of the area. Current electricity consumption stands at roughly 8 million kWh per month, totaling 96

million kWh annually. A land survey identified a 200-hectare sandy area that is not being used for agricultural purposes, making it a viable location for the proposed installation.



**Fig.4. Photo of the site for the placement of the SUT complex in the Yangiaryk district, Khorezm region.**

Currently, active work is underway on the project, taking into account the standards developed by the Ministry of Innovation of the Republic of Uzbekistan.

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