

Comparative Study of Solar Still Technology and Conventional Methods for Salt Production on the South Coast of Sukabumi

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Abstract

The development of salt production on the South Coast of Sukabumi faces distinct geographical and hydrometeorological challenges, including cliff topography, limited flat land, high waves, as well as fluctuating humidity and rainfall. This study aims to provide a general comparative evaluation between closed solar still technology and traditional open solar evaporation methods for salt production in this region. The comparative analysis reveals that solar still technology offers key advantages, including significantly higher thermal efficiency compared than conventional methods, complete protection against rainwater dilution and external contamination, and the ability to simultaneously produce high-purity salt and desalinated fresh water. Furthermore, the modular design of solar stills eliminates the need for extensive flat land, making it well-suited for South Sukabumi's rugged coastal terrain. Conversely, the main limitations of solar still technology lie in its higher initial capital investment for composite panel materials and system components, alongside the necessity for modular scaling to achieve high-volume production. Overall, solar still technology provides a more technically viable and climate-resilient alternative to conventional open evaporation in southern coastal environments, driving salt center diversification beyond the traditional Pantura region.

Abstrak



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Introduction

Salt is a strategic commodity that plays a crucial role across various sectors of human life, ranging from daily food consumption and chemical industrial raw materials to manufacturing processes and the national pharmaceutical sector. For decades, Indonesia's salt supply has been heavily concentrated in and reliant upon the Northern Coast of Java (Pantura) and parts of the Nusa Tenggara region, which offer relatively dry climates and extensive flat land. However, over-reliance on a single geographic zone introduces severe strategic vulnerabilities, particularly when confronted with global climate change threats, weather anomalies that shorten the dry season, and the rapid conversion of coastal land in Pantura into industrial and residential zones. Consequently, accelerating the diversification and establishment of new salt production centers in non-traditional

coastal regions has become an imperative agenda to ensure the long-term sustainability and independence of the national salt supply. One coastal area holding abundant yet underutilized marine potential is the South Coast of Sukabumi.

Despite boasting a promising seawater salinity potential, salt production development along the South Coast of Sukabumi is constrained by a complex set of highly specific geographic and hydrometeorological characteristics that starkly contrast with Pantura. Topographically, this southern West Java coastline is dominated by rugged cliff terrain, hilly landscapes, and an extreme scarcity of flat land along the shore. Furthermore, the dynamics of the Indian Ocean trigger extreme hydrometeorological conditions, including continuous high wave exposures, highly fluctuating daily air humidity, and localized rainfall that can occur unexpectedly throughout the year. These dynamic and physically challenging environmental factors directly hinder the effectiveness of traditional salt production systems, which typically demand stable climatic conditions and vast, flat land expanses.

The traditional open solar evaporation method long relied upon by conventional salt farmers exhibits significant adaptability limitations when applied to the landscape of Southern Sukabumi. This conventional approach requires constructing vast, segmented earthen evaporation ponds to gradually evaporate seawater under direct solar radiation until reaching the saturation point for crystallization. In the specific context of Southern Sukabumi, this open system is exceptionally vulnerable to re-dilution caused by sudden precipitation events, which drastically compromise the salinity concentration of the brine. Additionally, the lack of enclosure leaves open ponds highly susceptible to foreign particle contamination, such as dust, beach sand, and environmental pollutants, ultimately degrading the overall purity and quality of the resulting salt crystals.

To overcome these physical constraints and operational vulnerabilities, the application of enclosed solar still technology offers an adaptive and highly efficient technological approach. Solar still technology utilizes an isolated greenhouse effect mechanism that optimizes solar radiation absorption within an enclosed chamber to accelerate the seawater evaporation rate. The fundamental advantage of this technology lies in its significantly higher thermal efficiency compared to conventional open evaporation, allowing it to maintain a stable evaporation process despite micro-climatic fluctuations. The enclosed construction provides complete protection against rain dilution and external contamination, while simultaneously enabling the crystallization of high-grade salt. Moreover, this multifunctional technology captures desalinated water vapor as a clean freshwater

byproduct of high economic value. With its flexible modular design, solar stills do not require vast flat land areas and can be adaptively installed on steep coastal contours.

The open solar evaporation method bases its operation on free mass and heat transfer between an open seawater surface and the ambient atmosphere. Deprived of physical insulation or enclosures, direct solar radiation heats shallow layers of seawater held within expansive earthen ponds. The evaporation rate in this system is heavily governed by macro-meteorological conditions, including solar irradiance, relative air humidity, ambient temperature, and atmospheric wind speed that transports water vapor away from the surface. Seawater is sequentially routed through reservoir ponds, evaporation ponds, and crystallization beds as the density of the brine increases until reaching NaCl saturation within the range of 25–29°Bé.

The theoretical framework of open evaporation highlights significant thermodynamic vulnerabilities stemming from high heat loss rates through free atmospheric convection and conduction into the underlying soil. The lack of protective structures leaves the energy balance highly fragile to weather disruptions; sudden rainfall events immediately compromise brine salinity through dilution, severely delaying or completely aborting the crystallization cycle. Furthermore, direct atmospheric exposure makes the crystallization process highly susceptible to physical contamination from the surrounding environment, resulting in salt products with inconsistent purity and clarity that remain tightly bound to local climate stability.

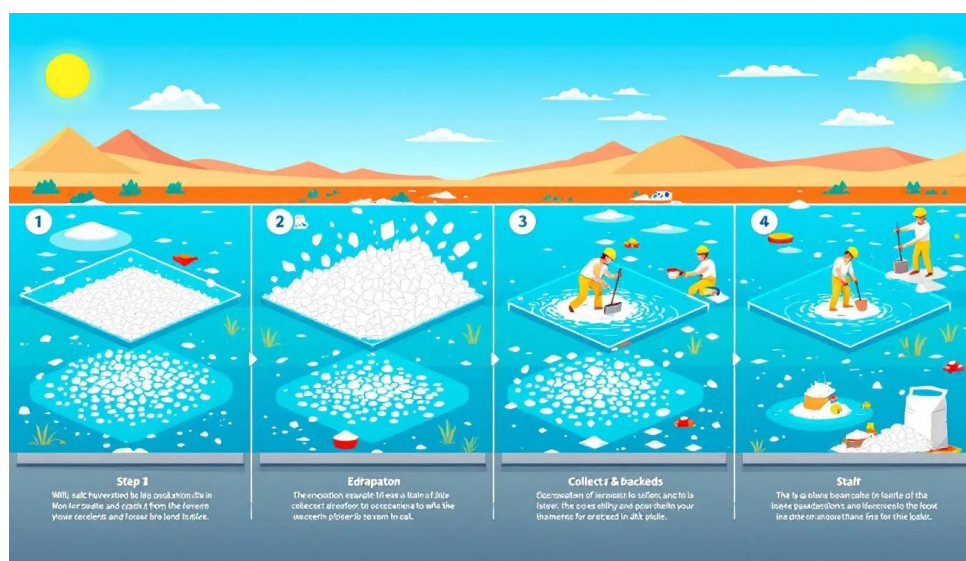


Fig 1. Open Solar Evaporation (www.hanpumachinery.com)

Enclosed solar still technology operates on the principle of solar distillation within an isolated

micro-ecosystem that mirrors the natural hydrological cycle. Shortwave solar radiation penetrates a transparent cover (such as glass or polycarbonate) and is absorbed by a dark absorber layer at the base of the basin, converting radiative energy into thermal energy to elevate the seawater temperature. This heating process triggers continuous internal evaporation, causing pure water vapor to rise and condense upon contact with the cooler inner surface of the transparent cover. The condensed vapor flows down as clean freshwater distillate, while the remaining seawater solution at the bottom gradually increases in salinity until reaching saturation point for salt crystallization.

Thermodynamically, a solar still leverages a trapped greenhouse effect that minimizes convective and radiative heat losses to the ambient environment, thereby yielding significantly higher thermal efficiency than open systems. Heat and mass transfer within the chamber occur simultaneously through convection, internal radiation, and vapor phase changes, allowing the evaporation process to remain stable even amid ambient temperature fluctuations. This physical enclosure provides complete protection against rainwater intrusion and external particulate contaminants such as dust or beach sand, while enabling dual output functionality: high-purity salt crystals at the basin floor and desalinated freshwater in the vapor collection channel.

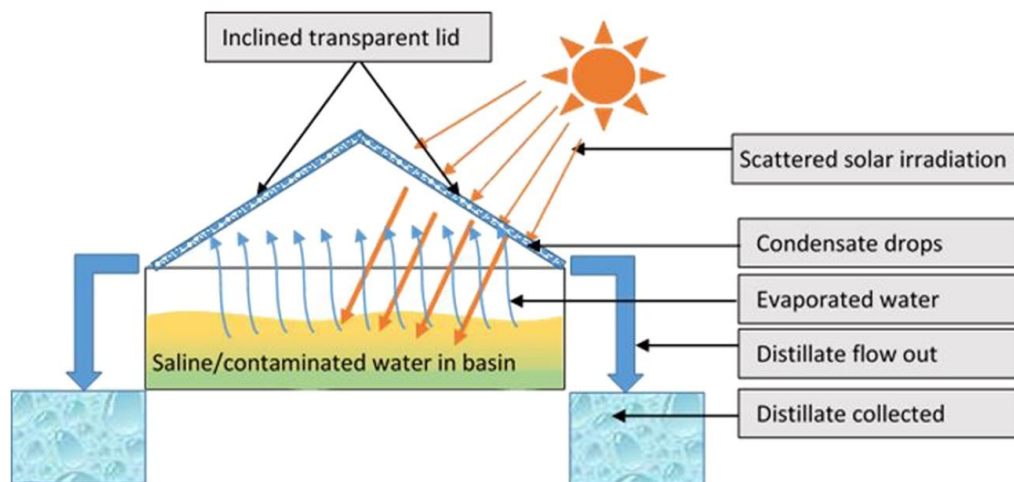


Figure 2. Solar Still Design (Wing Sum Choong, et al.)

Based on the background and innovation potential, this study aims to conduct a comprehensive comparative analysis between enclosed solar still technology and conventional open evaporation methods for salt production on the South Coast of Sukabumi. This comparative study focuses on evaluating thermal efficiency, weather protection levels, land utilization flexibility across extreme topographies, and the quality of the resulting products. Furthermore, the study examines technical and economic challenges, including the high initial capital expenditure for composite panel

materials and the necessary unit scale-up schemes required to achieve economically viable daily production volumes. The findings of this research are expected to contribute valuable scientific insights and practical recommendations regarding the technical and operational feasibility of solar still technology as a reliable alternative for accelerating the diversification of national salt production centers beyond the Pantura region.

Research Methodology

This study employs a descriptive qualitative approach utilizing comparative analysis to examine the implementation potential, technical advantages, and operational limitations of enclosed solar still technology versus conventional open solar evaporation methods. The research focuses on evaluating the adaptability of both technologies to the unique geographical and hydrometeorological characteristics of the South Coast of Sukabumi, such as cliff topographies, limited flat land, and fluctuating rainfall patterns. Through this approach, the study refrains from quantitative experimental testing, focusing instead on a holistic assessment of technical and operational feasibility.

The comparative analysis framework is structured around three core pillars: implementation potential, technical advantages, and operational limitations and challenges. Evaluation indicators encompass land-use flexibility on steep terrains, resistance to rainwater dilution and external contamination risks, dual-output potential generating desalinated freshwater, and estimated capital expenditure (CAPEX) and operational expenditure (OPEX) requirements. This evaluation aims to clearly map the comparative advantages and technological adoption barriers for local coastal communities.

Results and Discussion

A. Spatial Topography and Land-Use Flexibility

The qualitative findings reveal that the rugged coastal geology of Southern Sukabumi characterized by dramatic coastal cliffs, rocky promontories, narrow beach fringes, and a severe scarcity of contiguous flat land, serves as a fundamental structural bottleneck for conventional open solar evaporation methods. Traditional salt production relies inherently on a massive horizontal land footprint, where extensive series of shallow, interconnected earthen basins (comprising reservoir ponds, evaporation beds, and crystallization pans) are constructed across thousands of square meters of flat alluvial soil. This expansive flat terrain is essential to facilitate gravity-fed brine transfer and

maintain the uniform, shallow water depths required for passive solar heating across sequential concentration stages. In the context of Southern Sukabumi, where steep topography meets the ocean and coastal cliffs rise sharply above high-tide zones, attempting to excavate, level, or grade vast contiguous earthen ponds into rocky, elevated landscapes is technically unfeasible and economically prohibitive. Furthermore, modifying these fragile cliff contours for open earthworks introduces severe coastal erosion risks and structural instability, making traditional open-pond infrastructure inherently unviable along this southern coastal corridor.

In stark contrast, enclosed solar still technology overcomes these spatial constraints through a compact, modular, and footprint-agnostic engineering paradigm. Because individual solar still units are self-contained micro-systems, they do not require extensive land clearing, soil compaction, or flat earthen acreage to function efficiently. These modular units offer exceptional spatial deployment versatility: they can be arranged in terraced steps along steep cliff contours, anchored directly onto unlevel rocky shorelines, mounted on elevated structural platforms above high-wave spray zones, or integrated onto the rooftops of existing coastal facilities. This non-invasive structural flexibility preserves the natural geology of the coastline while maximizing effective solar collection area per square meter. Ultimately, by liberating salt production from the requirement of vast flat land, solar stills transform geographically challenging coastal margins, such as barren rocky headlands and steep terrain into highly productive, decentralized centers for salt and freshwater generation, establishing a spatially superior alternative perfectly tailored to Southern Sukabumi's extreme landscape.

B. Hydrometeorological Resilience and Climate Dynamics

From a hydrometeorological perspective, the salt production potential along the South Coast of Sukabumi is dictated by the intense and unpredictable atmospheric dynamics of the Southern Indian Ocean. Unlike the prolonged, predictable dry seasons typical of traditional salt-producing regions in Northern Java (Pantura), the southern coast of West Java is characterized by high and shifting ambient relative humidity, strong coastal wind gusts, and sudden, hyper-localized rainfall events that occur unexpectedly throughout the year. In conventional open solar evaporation systems, this climatic instability poses an existential threat to operational continuity. Because open earthen ponds present an unprotected liquid surface directly exposed to the atmosphere, any sudden downpour causes immediate, uninhibited rainwater intrusion into the concentrated brine (bittern). This influx of freshwater drastically dilutes the solution, causing the brine density to plummet far below the

crucial sodium chloride crystallization threshold of 25° Bé. The resulting osmotic imbalance causes any pre-crystallized salt beds at the bottom of the pan to rapidly re-dissolve back into solution. Consequently, a single unpredicted rain event can flush away weeks of cumulative solar energy input, destroying saturated bittern stocks and forcing salt farmers into a costly, complete reset of the evaporation cycle.

Conversely, sealed solar distillation systems generate an isolated thermal microclimate that effectively decouples internal phase-change dynamics from ambient meteorological disturbances. The sloped, light-transmissive enclosure acts as a total physical shield against rainfall, windblown debris, and convective heat loss that typically cools open water surfaces. Within this sealed environment, absorbed solar radiation steadily heats the basin solution, maintaining high internal humidity alongside a steep temperature differential between the warm brine and the cooler cover interior. This localized greenhouse mechanism sustains a high vapor pressure gradient, driving continuous evaporation and condensation regardless of external rainstorms, sudden thermal drops, or elevated ambient humidity. By offering comprehensive hydrometeorological protection, the enclosed solar still transforms salt harvesting from a high-risk, weather-dependent activity into a dependable, year-round operation, ensuring yield security along volatile coastal corridors.

C. Thermal Engineering, Process Efficiency, and Salt Purity

Comprehensive literature synthesis and qualitative thermodynamic assessments consistently indicate that enclosed solar stills deliver markedly superior process efficiency and thermal performance when compared to traditional open evaporation ponds. At the core of this advantage is the trapped greenhouse mechanism established within the sealed chamber: incoming shortwave solar radiation freely penetrates the sloped, highly transmissive transparent cover and is absorbed by a high-absorptivity, low-emissivity dark coating on the basin floor. This absorbed radiation converts directly into thermal energy, rapidly raising the temperature of both the basin absorber plate and the overlying seawater layer. Because the chamber is structurally sealed and thermally insulated at its base, the generated heat remains localized, elevating internal water and air temperatures significantly above ambient atmospheric levels. In contrast, conventional open solar ponds suffer from massive thermal dissipation, losing a substantial portion of captured solar energy to ambient wind turbulence via forced convection, to the open sky through uninhibited longwave thermal radiation, and into the underlying moist earth through downward conduction. By minimizing these ambient heat losses, solar stills maintain an elevated internal thermal state that

accelerates the specific evaporation rate and optimizes energy utilization per unit of evaporated water.

Beyond thermal gains, the physical isolation afforded by enclosed solar distillation plays a transformative role in dictating the visual clarity, physical hygiene, and chemical purity of the resulting salt product. In open evaporation systems, the exposed liquid surface and raw earthen pond floors inevitably introduce severe contamination; windborne beach sand, atmospheric dust, airborne particulates, agricultural runoff, and organic debris freely settle into the brine, while soil and clay from unlined basin floors become physically embedded within the forming crystal matrix. Enclosed solar stills eliminate these contamination pathways entirely by providing a sterile, sealed crystallization environment. The complete exclusion of airborne pollutants and soil contact ensures that salt crystals precipitate onto a clean, inert absorber surface, yielding a product with exceptional optical transparency, superior whiteness index values, and an absence of insoluble impurities. Furthermore, the controlled evaporation environment enables precise monitoring of brine density, allowing for optimized fractional crystallization that maximizes the concentration of pure sodium chloride (NaCl) while suppressing unwanted co-precipitates like calcium and magnesium sulfates. Consequently, salt harvested from enclosed solar stills consistently meets stringent premium food-grade and industrial quality benchmarks, offering a high-purity product that commands significantly greater economic value than raw, open-pond salt.

D. The Dual-Output Paradigm: Desalinated Water and Economic Synergies

The primary strategic advantage of deploying solar stills in Southern Sukabumi is their native capability to operate as a dual-output system, generating both high-purity salt and desalinated freshwater simultaneously. In conventional open evaporation, pure water vapor escapes freely into the atmosphere, representing a complete loss of latent thermal energy and freshwater potential. In an enclosed solar still, water vapor rises to the cooler inner surface of the transparent cover, undergoes phase-change condensation, and trickles down the inclined surface into dedicated distillate collection troughs. For coastal communities in Southern Sukabumi that frequently experience severe potable water scarcity due to seawater intrusion into shallow coastal aquifers and the high costs of piping freshwater through rugged cliff terrains, this desalinated freshwater byproduct holds immense socioeconomic value. The continuous production of clean freshwater alongside commercial-grade salt diversifies the economic returns per unit of solar collection area, transforming an environmental management challenge into a valuable community asset.

Financial and operational risk analysis reveals a distinct trade-off between initial capital investment and long-term operational viability. Building an array of solar stills requires a relatively high initial Capital Expenditure (CAPEX) to procure durable, corrosion-resistant materials, including tempered glass or UV-stabilized polycarbonate sheets, composite frame structures, food-grade thermal insulation, selective absorber coatings, and high-grade sealants. In contrast, conventional open solar ponds demand minimal initial capital, relying primarily on basic land clearing, earth-moving labor, simple dikes, and low-cost plastic floor liners. However, when evaluated on an Operational Expenditure (OPEX) and business risk basis, solar stills demonstrate far greater financial resilience. Because solar stills operate passively without grid electricity or fuel requirements and are immune to rain-induced crop destruction, their operational costs remain low and predictable. Open evaporation ponds bear extremely high indirect operational costs due to frequent rain-driven harvest failures, labor-intensive pond reconstruction, and low product market values caused by salt contamination. Over a multi-year lifecycle, the high harvesting reliability and dual-product revenue of solar stills offset their higher upfront capital requirements.

E. Modular Scalability, Maintenance Protocols, and Community Adoption

Scaling production capacity while fostering widespread social adoption constitutes a crucial operational dimension for the real-world deployment of solar distillation technology in coastal regions. In traditional open-pond salt farming, capacity expansion is achieved almost exclusively through horizontal spatial growth a land-intensive model that demands the acquisition, clearing, and leveling of vast contiguous earthen plots. In the topographically constrained, cliff-dominated landscape of Southern Sukabumi, this land-dependent scalability model encounters an insurmountable geographical limit. Conversely, enclosed solar still technology operates under a flexible modular array paradigm, wherein production scales linearly through the parallel interconnection of standardized units. By integrating individual solar stills into unified networks via shared brine feed pipelines, continuous distillate collection manifolds, and concentrated bittern drainage lines, a cluster of modular stills functions as a single, high-throughput processing hub. This modular architecture fundamentally democratizes capital investment, enabling smallholder coastal cooperatives and local fishing families to initiate production at a modest scale and progressively expand their operational footprint as revenues accrue, entirely free from the burdens of large-scale land acquisition. However, translating this technical modularity into long-term, community-level success requires establishing rigorous operational maintenance frameworks

alongside structured socio-technological capacity building. While open earthen ponds rely heavily on manual labor for soil preparation and dike maintenance, solar stills demand precise micro-system care to maintain high optical efficiency and continuous condensate yield. Daily operational protocols must account for environmental factors like airborne dust, sand accumulation, and dried salt-spray residue on the transparent covers all of which degrade solar transmissivity as well as the periodic formation of insoluble mineral scale (CaSO_4 and CaCO_3) on the absorber basin floor, which reduces conductive heat transfer over time. Successfully transitioning traditional salt workers and local fishing communities to this technological paradigm requires comprehensive vocational training, community-led cooperative governance, and ongoing institutional extension support. By empowering local stakeholders with standardized maintenance routines, basic troubleshooting capabilities, and cooperative supply chain management, coastal communities can ensure high operational throughput, protect their capital assets, and achieve true self-sustained management along the southern coast.

F. Strategic Synthesis and National Salt Supply Diversification

Synthesis of these comparative findings unequivocally positions enclosed solar still technology as a highly adaptive, resilient, and strategically vital technical solution for salt production along the South Coast of Sukabumi. Historically, traditional salt farming remained virtually unviable across southern West Java due to a convergence of severe physical constraints, including rugged cliff topographies, extreme ocean-driven weather volatility, and acute localized freshwater scarcity. Solar still technology directly resolves these longstanding geographical and meteorological barriers through an integrated suite of engineering capabilities. Its compact modular footprint bypasses the requirement for expansive flat land, its total hydrometeorological enclosure insulates crystallization processes from sudden rain dilutions, and its trapped greenhouse mechanism maximizes thermal efficiency under fluctuating microclimates. Furthermore, the system's native dual-output capability simultaneously generating high-purity sodium chloride crystals and desalinated potable water transforms a harsh, geographically challenging coastline into a highly efficient, dual-revenue production environment that addresses both economic development and basic human water security.

Although the requirement for substantial initial capital expenditure (CAPEX) and structured community-level capacity building present initial adoption hurdles, the overarching long-term strategic dividends far outweigh these temporary constraints. Deploying solar still arrays along the

Southern Sukabumi coastline offers a scalable, reproducible blueprint for establishing climate-resilient salt production centers in non-traditional coastal regions across the Indonesian archipelago. This strategic geographical diversification plays a critical role in safeguarding national salt security, effectively insulating the national supply chain against regional climate anomalies, extreme monsoon disruptions, and rapid industrial land conversion currently eroding traditional salt hubs along Northern Java (Pantura). Ultimately, transitioning to decentralized solar distillation not only diversifies national salt infrastructure, but also drives grassroots economic empowerment, fosters local technological self-reliance, and enhances water security across vulnerable coastal communities throughout southern Indonesia.

CONCLUSIONS

This study concluded that closed solar still technology is a highly adaptable, reliable, and superior technical solution compared to conventional open solar evaporation methods for salt production on the southern coast of Sukabumi. The topography of the southern coast of Sukabumi dominated by steep coral cliffs, coastal hills, and a scarcity of flat land, fundamentally limits the application of conventional open evaporation ponds, which require large-scale, well-organized alluvial land areas. In contrast, solar still technology frees the production process from dependence on flat land through its compact and flexible modular design. Solar still units can be installed non-invasively on terraced land, limestone surfaces, and even the roofs of coastal facilities without damaging the local geological landscape, making them highly suitable for the extreme landscapes of the southern region.

From a hydrometeorological and thermal engineering perspective, enclosed solar stills offer absolute weather protection and significantly higher process efficiency amid the fluctuating climatic dynamics of the Indian Ocean. In conventional methods, sudden local rainfall immediately dilutes the brine (bittern), lowering salinity below the crystallization threshold of 25 ° Bé and disrupting the harvest cycle. In contrast, the enclosed chamber of the solar still creates an isolated microclimate that harnesses the trapped greenhouse effect to consistently maintain the internal operating temperature above the ambient temperature. This not only accelerates the specific evaporation rate and prevents contamination from beach dust but also produces salt crystals with superior sodium chloride (NaCl) purity and whiteness. Furthermore, the dual-output capability capturing desalinated water vapor as clean freshwater provides significant socioeconomic benefits for coastal communities that often face clean water shortages.

Although the adoption of solar stills faces higher initial investment (CAPEX) barriers due to the procurement of corrosion-resistant materials and the need for maintenance of modular units, an analysis of operating costs (OPEX) indicates better business sustainability because the system operates passively and avoids the risk of losses due to post-rain crop failures. Production capacity can be increased through a parallel expansion of modular units, managed through maintenance training and local cooperative institutions. Overall, the implementation of solar stills in the Southern Coast of Sukabumi provides a strategic blueprint for accelerating the diversification of national salt production centers beyond the traditional Pantura region. This step is vital for strengthening the resilience of the national salt supply against the threat of global climate anomalies while promoting economic self-reliance and the availability of clean water in non-traditional coastal areas.

REFERENCES

- Alaian, W. M., Elnegiry, E. A., & Hamed, A. M. (2016). Experimental investigation on the performance of solar still augmented with pin-finned absorber plate. *Desalination*, 379, 10–15. <https://doi.org/10.1016/j.desal.2015.10.007>
- Arunkumar, T., Jayaprakash, R., Ahsan, A., Denkenberger, D., & Okundamiya, M. S. (2016). Effect of water losses on the performance of a solar still. *Desalination*, 380, 61–67. <https://doi.org/10.1016/j.desal.2015.11.022>
- Hansen, R. S., Narayanan, C. S., & Murugavel, K. K. (2018). Performance analysis on modified solar still with different flat plate absorbers and stepped absorbers. *Desalination*, 442, 41–51. <https://doi.org/10.1016/j.desal.2018.05.011>
- Kabeel, A. E., & Abdelgaied, M. (2016). Improving the performance of solar still by using PCM as a thermal energy storage medium. *Energy Conversion and Management*, 112, 436–442. <https://doi.org/10.1016/j.enconman.2016.01.050>
- Kabeel, A. E., Hamed, A. M., El-Agouz, S. A., & Abdelgaied, M. (2018). Performance enhancement of a solar still using tubular absorber and phase change material. *Desalination*, 428, 132–138. <https://doi.org/10.1016/j.desal.2017.11.029>
- Kumar, A., Prakash, O., & Kaviti, A. K. (2022). Comprehensive review on performance enhancement of solar stills using stepped absorber plates and phase change materials. *Environmental Science and Pollution Research*, 29(15), 21340–21362. <https://doi.org/10.1007/s11356-021-17855-y>

- Modi, K. V., & Modi, D. L. (2019). Performance evaluation of double basin single slope solar still with and without thermal energy storage material. *Solar Energy*, 188, 700–712. <https://doi.org/10.1016/j.solener.2019.06.059>
- Omara, Z. M., Kabeel, A. E., & Younes, M. M. (2017). Enhancing the productivity of solar stills using different techniques: A review. *Renewable and Sustainable Energy Reviews*, 79, 846–859. <https://doi.org/10.1016/j.rser.2017.05.075>
- Panchal, H. N., & Patel, S. (2017). An extensive review on different design concepts of solar still. *International Journal of Ambient Energy*, 38(4), 430–440. <https://doi.org/10.1080/01430750.2015.1136364>
- Panchal, H., Sathyamurthy, R., Kabeel, A. E., Patel, S. K., & Arunkumar, T. (2021). Annual performance analysis of single-slope solar still with sand-filled basin: A comparative study. *Applied Water Science*, 11(2), 34–42. <https://doi.org/10.1007/s13201-021-01362-5>
- Parsa, S. M., Rahbar, N., Cole, P. J., & Javadi, D. (2021). Fresh water and salt co-production using a novel solar distillation system: Experimental and economic evaluation. *Desalination*, 518, 115282. <https://doi.org/10.1016/j.desal.2021.115282>
- Rabhi, K., Raach, H., Ben Brahim, A., & Ben Bacha, H. (2020). Experimental study of a modified solar still integrated with a condenser and pin fins absorber. *Desalination*, 491, 114561. <https://doi.org/10.1016/j.desal.2020.114561>
- Sharon, H., & Reddy, K. S. (2018). A review of solar energy-driven desalination technologies. *Renewable and Sustainable Energy Reviews*, 82, 4088–4118. <https://doi.org/10.1016/j.rser.2017.09.076>
- Sharshir, S. W., Peng, G., Wu, L., Yang, N., Kabeel, A. E., Zang, J., & Khedr, M. A. (2017). Enhancing the solar still performance using nanofluids and glass cover cooling: Experimental and economic study. *Energy Conversion and Management*, 148, 1470–1477. <https://doi.org/10.1016/j.enconman.2017.06.084>
- Suraparaju, S. K., & Natarajan, S. K. (2020). A detailed review on solar still integrated with phase change materials for freshwater production. *Journal of Energy Storage*, 32, 101899. <https://doi.org/10.1016/j.est.2020.101899>