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INVESTIGATION OF AN UNGLAZED TRANSPIRED SOLAR COLLECTOR IN DIFFERENT CLIMATES USING TRNSYS SOFTWARE

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Abstract. Solar energy is a widely recognised renewable energy source that offers a sustainable and infinite energy supply. Unglazed transpired solar collectors (UTSCs) have emerged as an effective, eco-friendly solution for harnessing solar radiation. This study examines the performance of UTSCs across various climatic conditions using TRNSYS software. Five cities reflecting different climatic zones have been selected for the UTSC modelling: Kampala (tropical climate), Riyadh (desert climate), Madrid (Mediterranean climate), Vilnius (continental climate), and Svalbard (polar climate). The analysis showed that UTSC efficiency varied depending on the climate. It performed best in tropical and desert regions with consistent solar radiation, such as Kampala and Riyadh, where it provided year-round heating and cooling. Mediterranean climates like Madrid operate well seasonally, while in continental regions like Vilnius, it is mainly beneficial for winter heating. This technology has various applications in buildings and the drying industry, leading to various results. By analysing the performance of UTSCs in tropical, desert, Mediterranean, continental, and polar climates, this research contributes to the advancement of climate-resilient technologies and sustainable energy planning.

Keywords: renewable energy, simulation, solar energy, TRNSYS, unglazed transpired solar collectors.

1. Introduction

The need to switch to renewable energy sources has grown globally during the last few years. Fears of environmental sustainability, energy security, and climate change are driving this urgency. One well-known renewable energy technique that produces a sustainable, endless energy supply is solar energy (El-Sebaii & Shalaby, 2012). Solar energy significantly reduces greenhouse gas emissions, mitigating climate change (Hasan et al., 2023). In addition, it is a clean energy source with minimal environmental impact compared to fossil fuels.

Solar collectors are devices that capture and convert solar energy into thermal energy. They are broadly categorised into non-concentrating (flat plate) and concentrating collectors. Each type has its own subcategories and specific applications. The Unglazed Transpired Solar Collector (UTSC) is a type of solar air collector that makes use of a perforated absorber plate with high solar absorptivity to absorb the radiation and transfer the heat to the air stream (Hall et al., 2011). Usually, UTSCS are mounted on the south side of the building. The UTSC (Figure 1) is made of metal cladding with perforations, installed at several centimetres from a building wall, creating a cavity that allows fresh air to warm up (Croitoru et al., 2016). The air in the atmosphere is drawn through perforations with a blower, which absorbs the heat in the absorber and delivers hot air to the blower exit (Leon & Kumar, 2007). The perforation location, plate temperature, and velocity distribution are key design considerations for UTCs, and correlations among these flow features are essential for predicting performance (Parimita Panigrahi et al., 2022). When UTSC is used for heating buildings, it is necessary to pay attention not only to solar radiation and air flow rate but also to heating degree days and wall thermal transmittance, as these variables have an impact on the heat transfer process (Fawaier et al., 2021).

These collectors have demonstrated the potential to achieve high thermal efficiencies, often exceeding 35 %,

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under optimal conditions. Guillon et al. (2016) experimental results with unglazed solar collectors showed that thermal efficiencies varied between 43 % and 54 % in a warm climate. Additionally, they are used for preheating ventilation air and in agricultural drying processes, where efficiencies of around 38.41 % have been observed under specific conditions (Bandara et al., 2018). However, some studies showed that the UTSC thermal performance could differ under real wind conditions in contrast to laboratory conditions (Shemelin & Matuška, 2023). In addition, UTSC can be integrated with other renewable energy technologies to increase their efficiency, e.g. air source heat pumps (Januševičius et al., 2016), PV cells (Quesada et al., 2012) (see Table 1).

Table 1. UTSC integration with other technologies

Integration Type	Reference	Efficiency Improvement	Climate Studied
Air Source Heat Pump (ASHP)	Januševičius et al. (2016)	Increased COP by preheating the air	Cold climate (Lithuania)
Photovoltaic (PV) Panels	Quesada et al. (2012)	PV cooling improved efficiency by ~5%	Temperate climate (Canada)

Different research strands, including numerical simulations, experimental evaluations, and mathematical modelling, can analyse the thermal characteristics of UTSC. However, to compare the performance of the technology in different climates, it is advisable to assess by simulation or analytical calculation, which would allow for a practical assessment of the use of UTSC. For this purpose, the TRNSYS software has been chosen as it has an extensive library of components (Types), including the UTSC. This study aims to analyse the use of UTSC in different climatic zones and the potential for further evaluation of this technology.

2. Research object and methodology

This study analyses an Unglazed Transpired Solar Collector (USTC) application. One example of its application is at Vilnius Gediminas Technical University (VILNIUS TECH), Faculty of Environmental Engineering. The UTSC hangs on the eight-story and runs from the third floor to the flat roof parapet. Roughly 100 square meters make up the collector's total surface; its width is around 6.0 meters, and its height is 16.6 meters. Metal barriers define the three separate vertical sections of the construction with different widths. Each section has airflow controls linked to a plenum for hot air collection and varying widths of air-collecting ducts. Roughly 0.6 mm-thick trapezoidal, perforated, profiled aluminium panels comprise the UTSC (Piskulov & Streckienė, 2023), as shown in Figure 1.

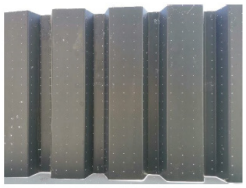


Figure 1. Perforated section of the profiled aluminium sheet (Piskulov & Streckienė, 2023)

The sun's solar radiation heats the metal coating, and ventilation fans create negative pressure in the perforated panel cavity to extricate the solar-heated air. Due to air temperature gradients in the cavity, the air is typically extracted at the top of the wall. This ensures that all the solar heat is collected and distributed throughout the structure via the ventilation system (Croitoru et al., 2016), as shown in Figure 2.

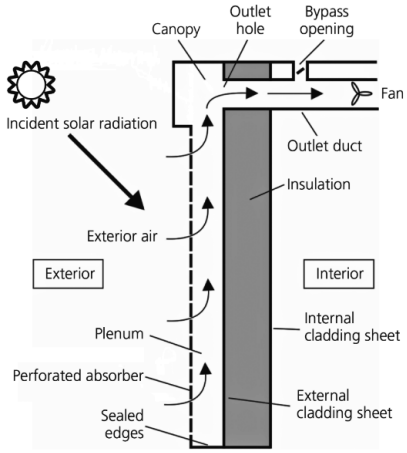


Figure 2. Unglazed transpired solar collector principle (Hall et al., 2011)

The UTSC at VILNIUS TECH is positioned 10–15 cm from the brick wall of the structure, forming an air gap that is insulated and sealed with polyurethane foam as shown in Figure 3. This construction guarantees optimal thermal insulation and effectively avoids any heat dissipation.

The system comprises a plenum for gathering heated air, fitted with air inlets and associated ducts. Airflow regulation mechanisms control each segment. The hot air is collected in the plenum and subsequently directed via three galvanised sheet steel ducts of varying sizes, which merge into a larger duct insulated with stone wool insulation shells and topped with aluminium foil. The duct is linked to an air handling unit (AHU) with a counter-flow plate heat exchanger. The AHU serves the purpose of ventilating and heating interior spaces (Piskulov & Streckienė, 2023).

a)



(b)



(Figure 3. USTC in VILNIUS TECH:
(a) side view; (b) plenum for gathering heated air
(Piskulov & Streckienė, 2023)

In order to investigate how such a UTSC would perform in different climates, the TRNSYS simulation software is chosen for the study. It allows the modelling of UTSCs and other types of solar collectors. Modelling in TRNSYS consists of several steps, namely:

1. Data collection;
2. Model development;
3. Determination of simulation and component parameters;
4. Creation of links among components;
5. Creation of outputs and results analysis.

2.1. Data collection

Data collection focuses on obtaining reliable climatic variables to analyse the UTSC's performance in diverse locations (Kampala, Riyadh, Madrid, Vilnius, Longyearbyen). The different locations were chosen to reflect a wide range of climatic conditions. Key variables include:

1. Solar Irradiance: Establishes the energy input for collecting using solar irradiance;
2. Ambient temperature ($T_{ambient}$): Influences heat transfer efficiency;
3. Wind speed: It determines convective heat losses;
4. Humidity.

The following databases were used to obtain climatic data:

– PVGIS (Photovoltaic Geographical Information System) (PVGIS 2024);
– Repository of Building Simulation Climate Data (Climate.OneBuilding.Org, 2024).

One hour of climate data is used for simulations.

2.2 Model development

TRNSYS (*Transient System Simulation Tool*) was selected for model development because of the flexibility and effectiveness of the dynamic simulation of large-scale energy systems. It has precise heat transfer and airflow simulation features that make it appropriate for analysing the performance of Unglazed Transpired Solar Collectors (UTSCs). TRNSYS uses weather data for specific locations to adapt to different climates, which provides accurate insights into system performance. The components can be customised to make it possible to create a more detailed model of UTSCs and how they interact with other systems, such as building ventilation. Also, TRNSYS supports dynamic modelling over time for analysing the outlet temperature, thermal efficiency, heat gains, and overall performance of UTSCs across different climates. The simulation will determine the thermal performance and heat gain of UTSC in tropical, temperate, and polar environments and help evaluate its effectiveness. It will also show how the system's operational efficiency and energy output change with a changing climate.

System configuration and components (types)

In the TRNSYS model, the fundamental component UTSC is selected, and its main parameters are:

– Slope of surface: 90° (vertical position);
– Azimuth of surface: 0° (south-facing for optimal solar exposure in the Northern Hemisphere);
– Total collector area: 100 m²;
– Fluid specific heat (C_p): 1.007 kJ/kg·K (air);
– Flow rate: 2000 kg/hr (airflow through the collector);
– Thermal resistances and losses: Back material resistance: 3.6 m²·K/W; Top loss convection coefficient: 5.555 W/m²·K; Back loss convection coefficient: 4.167 W/m²·K;
– Heat transfer coefficient: 200 W/m²·K.

The TRNSYS model must also specify the required output to compare the unit's performance in different climatic conditions. The following values are analysed: outlet air temperature (Tout) and useful energy gain. Type 561 (Unglazed Air Heating Collector) simulates the UTSC.

The TRNSYS model also uses other components, called Types, which allow the complete behaviour of the system to be analysed. The components used to simulate are listed as follows:

1. Type 15-3 (Energy+ Weather Files EPW): This is for inputting climatic data such as solar radiation and ambient temperature of the location. PVGIS or Climate.OneBuilding.org was used.

2. Type 57 (Unit Conversion Routine): to convert units to ensure compatibility with other components
3. Type 65 (Online Plotter with File): real-time visualisation and data logging for simulation results.

The UTSC Model layout, as shown in Figure 4, illustrates the connections and various components integrated to simulate the UTSC system. It covers collecting unglazed air heating, connecting, processing weather data, using a unit converter, calculating equations, and using an online printer. The system's effectiveness depends on every component, which also helps improve energy collection under different environmental circumstances.

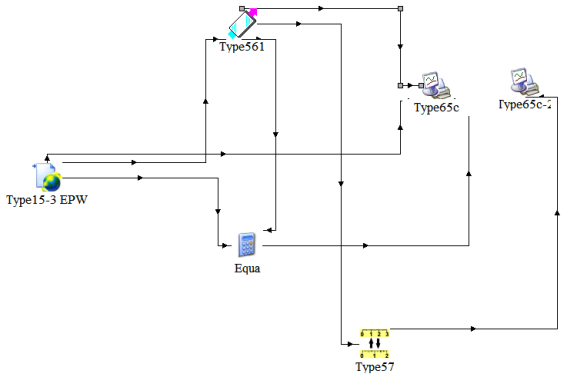


Figure 4. UTSC Model in TRNSYS

The simulation parameters are set to simulate one typical year in one-hour time steps. The simulation results are analysed and compared under different climates.

3. Results and discussion

This section discusses the simulation results obtained for different climates, starting with the hottest (Kampala) and ending with the coldest (Svalbard). Table 2 gives a brief comparison of these climates.

Table 2. Analysed climates

Climate Type	Characteristics	Example Regions
Tropical	High heat & humidity, year-round rainfall, minimal seasonal changes, lush vegetation.	Amazon Rainforest, Southeast Asia, Central Africa
Desert	Extreme dryness, infrequent rainfall, and high temperature fluctuations	Sahara, Arabian Desert, Atacama
Mediterranean	Hot, dry summers; mild, wet winters; supports diverse agriculture	Southern Europe, California, Coastal Australia

End of Table 2

Climate Type	Characteristics	Example Regions
Continental	Hot summers, icy winters, strong seasonal contrasts	Russia, Canada (inland), Midwest USA
Polar	Year-round cold, ice-covered landscapes, minimal vegetation	Antarctica, Arctic, Greenland

The average solar radiation in tropical and desert regions is about 218 W/m², and ambient temperatures range from 17.5 °C to 31.1 °C. In temperate areas, such as Madrid city, the average solar radiation is 206 W/m², while in continental regions, such as Vilnius, the average solar radiation is about 117 W/m².

Kampala, Uganda – Tropical climate

The simulation evaluates the efficiency of an unglazed transpired solar collector (UTSC) in Kampala, Uganda's tropical climate, with constant temperatures and solar radiation year-round. Using Kampala as the benchmark, Figure 5 shows the performance of a UTSC in a tropical environment. With just minor daily and seasonal fluctuations in sun irradiation, the outlet air temperature (T after UTSC) shows a consistent increase over the year. Kampala's generally constant ambient temperatures reflect those of tropical areas devoid of seasonal fluctuations. Because of its ability to generate consistent temperature fluctuations (ΔT) and its efficiency in heating air, the UTSC is a perfect choice for tropical settings.

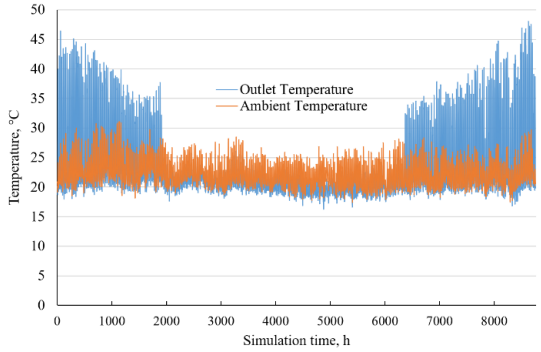


Figure 5. Outlet temperature from UTSC, Kampala

The UTSC's thermal efficiency is constant; it peaks under ideal conditions and with moderate sun radiation. Notwithstanding the occasional drop in efficiency brought on by less solar input during gloomy or wet circumstances, common in tropical climates, the system maintains continuous operation. The constant solar radiation makes the year-round operation and UTSC system demonstration for tropical environments in Kampala clear. The sound energy from the UTSC was notably

low from March to September, which can be attributed to the rainy season and persistent cloud cover.

Riyadh, Saudi Arabia – Desert climate

Riyadh, Saudi Arabia, is characterised by a desert climate with significant daily temperature fluctuations, high solar radiation, and minimal seasonal variations in sunlight. This climate presents challenges and opportunities for the UTSC, particularly in extreme heat during the day and cooler temperatures at night.

Figure 6 shows, for a dry environment best represented by Riyadh, the operation of a UTSC. Over the day, the system experiences a notable rise in heat gain from solar radiation, which increases the temperature differential (ΔT) and generates higher air temperatures (T after UTSC). Arid areas, on the other hand, show notable nocturnal cooling, which causes somewhat large temperature fluctuations. The ambient temperatures in Riyadh, which can reach 40°C during the day and drop below 20°C at night, magnify the system's daily temperature and efficiency fluctuations. In Riyadh's clear, arid environment, the UTSC uses the city's year-round high sun radiation. Climatic occurrences like dust storms create problems by reducing solar radiation and calling for regular maintenance to maintain efficiency.

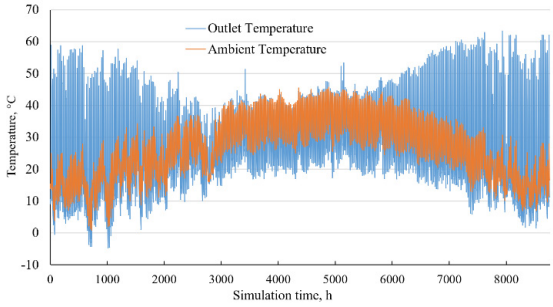


Figure 6. Outlet temperature from UTSC, Riyadh

Riyadh experiences high temperatures during the day, and cooler temperatures influence daily performance at night. Seasonal patterns are maintained by the consistent availability of sunlight throughout the year. UTSC offers excellent advantages for energy harvesting, considering external variables such as temperature swings and dust accumulation, which are addressed for consistent operation, particularly during long, sunny days in the desert climate.

The simulations show that functional energy gain performance in a desert climate is significantly higher, particularly during the winter, due to the abundant solar radiation and minimal cloud cover characteristic of such regions. The region gains as much as 20kW of sound energy from November to February.

Madrid, Spain – Mediterranean climate

Madrid (Spain) has a Mediterranean climate with hot, dry summers and mild, wet winters. The climate experiences moderate seasonal temperature and solar radiation variations, presenting unique opportunities for the UTSC system.

Figures 7 and 8 illustrate the performance of a UTSC in Mediterranean climates using Madrid as a case study. The UTSC experiences significant heat accumulation because of the abundant solar radiation in the summer, leading to enhanced performance and high outlet air temperatures (T after UTSC). The UTSC retains thermal efficiency due to Madrid's moderate daytime temperatures, typically ranging from 5°C to 10°C. The UTSC operates effectively throughout the year owing to negligible seasonal temperature fluctuations. The temperature differential (ΔT) is more significant in winter due to high solar radiation and lessened in summer. However, it remains enough for heating due to the year-round moderate conditions.

The UTSC operates in a Mediterranean climate with stable performance during the warm summer and maintains consistency during the short, cooler winter days. Due to mild temperatures and prolonged daylight hours, the UTSC operates more efficiently during the winter months, which increases outlet air temperature and thermal efficiency compared to the summer. Due to these climatic benefits, the UTSC is a reliable year-round energy collection and heating system in Mediterranean climates.

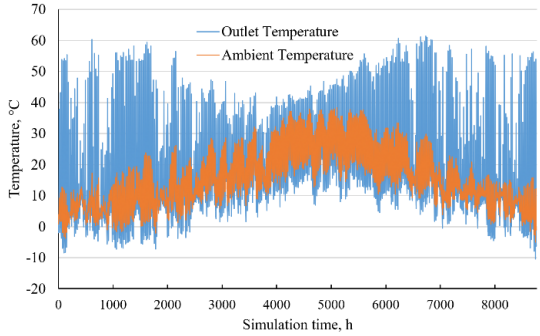


Figure 7. Graph of outlet temperature, Madrid

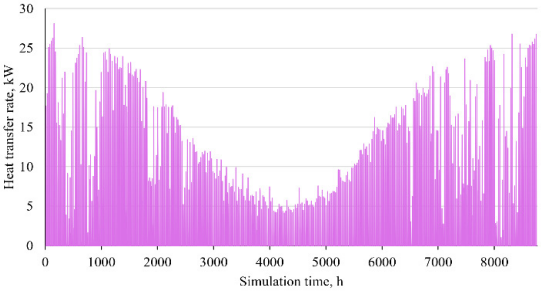


Figure 8. Useful energy gain, Madrid

The UTSC exhibits a noticeable valley due to high ambient temperatures during the summer months, which reduces the useful heat gain. In contrast, the UTSC displays a significantly high useful energy gain during the winter months, which ranges from 10 kW to 27 kW due to slightly lower temperatures and ideal operating conditions.

Vilnius, Lithuania – Continental climate

The characteristics of a continental environment are known for seasonal fluctuations, which create stability issues that can impact performance in summer and diminish efficiency in winter. The UTSC can provide sufficient heating and ventilation in the summer; however, it requires supplemental heating systems during the winter due to inadequate sun exposure.

According to the Koppen climate classification, Vilnius (Lithuania) has a continental climate. Vilnius has cold winters, mild summers, and seasonal variations in temperature and solar radiation. The climate in Vilnius presents challenges for the UTSC, particularly in the winter months when solar radiation is scarce, but it also offers opportunities during the summer months. Figure 9 shows the UTSC performance in a continental environment.

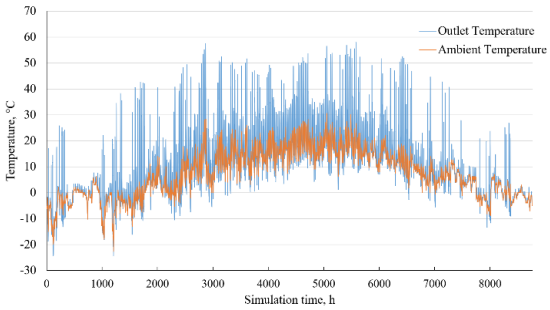


Figure 9. Graph of outlet temperature for Vilnius

The more extended daylight and solar radiation cause the UTSC to rise significantly in temperature in the summer. This increases system efficiency and outlet air temperatures (T after UTSC). Low ambient temperatures (between −5 °C and −10 °C), short daylight hours, and reduced solar radiation significantly lower the system's performance in winter, decreasing temperature differentials (ΔT) and heat transmission. However, during the winter, snow and overcast skies affect the UTSC, leading to a decline in efficiency and low heat addition. Conversely, clear skies and high temperatures (15 °C to 25 °C) increase summer efficiency and heat. The characteristics of a continental environment are known for seasonal fluctuations, which create stability issues that can impact performance in summer and diminish efficiency in winter. The UTSC can provide sufficient heating and ventilation in the summer; however, it requires supplemental heating systems during the winter due to inadequate sun exposure.

The UTSC in Vilnius operates at a much higher capacity during the summer months because of longer daylight hours and more solar irradiation. The useful heat energy gain gradually drops in winter due to shorter daylight hours, less solar availability, and lower ambient temperatures. In the case of Vilnius, however, heat is not needed for space heating in the summer period, so that other uses could be considered.

Svalbard, Norway – Polar climate

Svalbard is located in the Arctic region, with long winter nights and long summer days. The harsh conditions present challenges for the UTSC system, particularly in the winter when solar radiation is absent for long periods.

As shown in Figure 10, the output air temperature (T after UTSC) shows significant seasonal volatility, rendering the system inactive. Because of the low solar angle, the UTSC often receives diffuse solar radiation during the midnight sun period from late April to late August. However, heat accumulation is reduced relative to tropical areas.

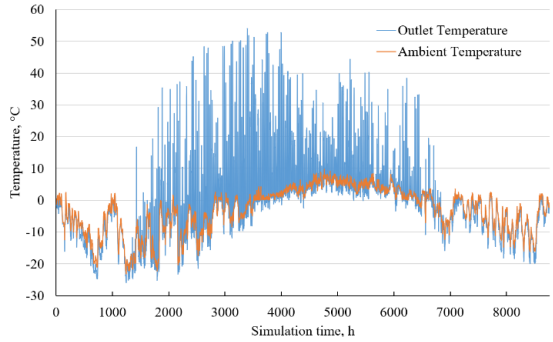


Figure 10. Outlet temperature and thermal efficiency of UTSC for Svalbard

Especially in winter, the ambient temperature of Svalbard, which ranges from −10 °C to −20 °C, dramatically affects the heating system's efficiency. Likewise, the temperature range greatly influences the heating system's efficacy in summer. Though limited by the sun's low elevation angle, temperature changes (ΔT) remain mild during the polar night but show notable increases throughout summer. Thermal efficiency varies with seasons; the UTSC performs poorly in winter because of inadequate solar input and shows improvement, but is still unsatisfactory in summer when a clear sky enhances efficiency. Like snowfall and cloud cover, weather patterns worsen winter inefficiencies and limit summer improvements. The strong seasonal fluctuations in Svalbard's Arctic environment cause instability in the

UTSC's performance, which causes total inactivity during winter and modest to poor efficiency in summer. The UTSC might be helpful in summer heating or ventilation, but it is much less efficient than in temperate conditions; hence, it is unsuitable for long-term energy collection in polar regions.

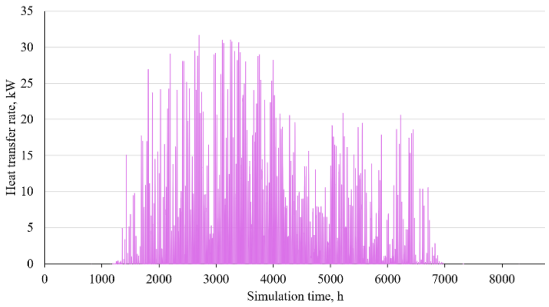


Figure 11. Useful energy gain from UTSC for Svalbard

The results illustrated in Figure 11 indicate that the UTSC's energy gain performance in Svalbard is significantly seasonal. During the summer, the system experiences moderate energy gains, benefiting from continuous daylight provided by the midnight sun despite the lower solar incidence angles. However, this performance declines dramatically during winter, reaching nearly zero due to the polar night conditions and the complete lack of solar radiation.

Discussion – Climate and Application Benefits by Location

Table 3 provides an overview of the performance of solar wall applications across various locations and climate types. The table categorises the data into four key columns: Location, Climate, Solar Wall Applications, and Key Benefits. This layout clearly explains how different climates influence the application and advantages of solar wall technologies, highlighting region-specific benefits such as increased energy efficiency, enhanced thermal comfort, and reduced heating costs.

UTSC perform quite variably depending on the climate. Consistent sun radiation helps the UTSC operate well year-round in tropical areas like Kampala, supplying enough cooling, water heating, and crop drying. In hot desert environments such as Riyadh, the UTSC is also quite efficient for both cooling in summer and space heating in winter, enabling agricultural drying. The UTSC performs well in Mediterranean climates like Madrid throughout the heating and cooling seasons, but suffers lower efficiency in the cooler months because of changing solar radiation. Though seasonal temperature fluctuations limit the system's efficacy, continental regions such as Vilnius gain from the UTSC for space heating in winter. The Arctic climate of Svalbard poses the most significant difficulty since polar darkness renders the UTSC useless in winter but can cause considerable heating during the summer.

Table 3. Climate and application benefits of UTSC by location

Location (Climate)	Solar Wall Applications	Key Benefits
Kampala, Uganda (Tropical)	Ventilation and cooling to manage high indoor temperatures (Ghamari & Sundaram, 2024). Supplementary energy for water heating (Kabano et al., 2022). Crop drying for agricultural produce to reduce moisture and improve storage life (Menya et al., 2024).	- Reduces cooling load by pre-cooling incoming air. - Provides eco-friendly, renewable energy sources. - Enhances crop preservation by drying efficiently.
Riyadh, Saudi Arabia (Desert)	Space heating during winter. Supplementary heating for water and other energy needs (Mohamad et al., 2019). Ventilation and cooling for summer months (Elsaid et al., 2023). Crop drying is used for long-term food storage in strong sunlight.	-Significantly lowers the winter heating load. - Cuts down on electricity for cooling in summer by pre-cooling air. - Supports crop drying with minimal energy consumption.
Madrid, Spain (Mediterranean)	Space heating in winter. Ventilation and cooling for the warm months. Water heating as a supplementary energy source (Stazi et al., 2011).	- Reduces heating demand during cooler months. - Improves indoor air quality through ventilation.
Vilnius, Lithuania (Continental)	Primary space heating in winter. Water heating to support conventional energy sources (Xu et al., 2020).	Reduces dependence on central heating. - Provides supplementary heating for hot water, reducing energy costs.
Svalbard, Norway (Polar)	Space heating for indoor areas. Hot water heating is a supplementary energy source (Tamrakar et al., 2019).	- Helps reduce heating costs and reliance on fuel-based heating. - Provides renewable energy during limited sun exposure in summer.

Ultimately, UTSC systems are ideally suited to tropical and desert conditions, where they can provide regular heating and cooling year-round in areas with consistent and plenty of sun radiation. In areas with significant seasonal variations, such as Vilnius and Svalbard, especially in winter when the sunshine is limited, the UTSC is less efficient. Mediterranean climes, including Madrid, allow for efficient seasonal use. However, the UTSC might need additional systems to offset declining efficiency in the winter. The local climate conditions broadly define the fit of UTSC technology. Its performance could thus be maximised in areas with high and constant solar radiation.

4. Conclusions

The study reveals that the effectiveness of unglazed transpired solar collectors (UTSCs) relies heavily on the local climate. These collectors work best in tropical and desert regions, where abundant solar radiation and stable temperatures allow them to operate efficiently year-round. Here, the average solar radiation is around 218 W/m² and the ambient temperatures range from 17.5 °C to 31.1 °C, a UTSC can heat the ambient air temperature to approximately 48 °C under peak conditions and as well in Riyadh, Saudi Arabia, where the average solar radiation is around 259 W/m² and the ambient temperatures range from 0.75 °C to 45.8 °C, a UTSC can heat the air temperature to approximately 63.3 °C under peak conditions.

In Mediterranean climates, UTSCs perform reliably, particularly in winter. However, their efficiency may drop in the summer due to higher temperatures, for instance, in Madrid, Spain, where solar radiation averages 206 W/m^2, UTSCs can raise ambient air temperature 6 °C to around 50 °C to 61.4 °C during winter.

In continental regions like Vilnius, UTSCs excel during the summer with an average solar radiation of 117 W/m². Average air temperatures can be increased from 18.5 °C to nearly 60 °C. However, due to reduced winter solar exposure, UTSCS often require additional heating systems. When the ambient temperatures fall below 0 °C, the efficiency of UTSCs is considerably reduced. In polar areas such as Svalbard, UTSCs struggle in winter when sunlight is scarce but can provide some heating during the summer months.

UTSCs thrive in areas with strong and consistent solar radiation, making them ideal for tropical and desert climates. However, combining UTSCs with other heating solutions is wise for regions with notable seasonal changes to maintain consistent performance. This research emphasises the need to consider local climate conditions when implementing UTSCs, providing valuable insights for optimising their use across different environments.

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NEĮSTIKLINTO PRATAKAUS SAULĖS KOLEKTORIAUS TYRIMAS SKIRTINGOMIS KLIMATO SĄLYGOMIS NAUDOJANT TRNSYS PROGRAMĄ

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Santrauka. Saulės energija – pripažintas atsinaujinančios energijos šaltinis, siūlantis tvarų ir neišsenkamą energijos tiekimą. Neskaidrūs pratakūs saulės kolektoriai (angl. *Unglazed transpired solar collectors*, UTSCs) tapo efektyvus ir ekologiškas sprendimas saulės spinduliuotei panaudoti. Šiame tyrime analizuojamas UTSC veikimas įvairiomis klimatinėmis sąlygomis, naudojant TRNSYS programą. UTSC modeliavimui pasirinkti penki miestai, atspindintys skirtingus klimatus: Kampala (tropinis), Rijadas (dykumų), Madridas (Vidužemio jūros), Vilnius (žemyninis) ir Svalbardas (poliarinis). Analizė parodė, kad UTSC efektyvumas priklauso nuo klimato – geriausi rezultatai pasiekti tropinėse ir dykumų vietovėse, pavyzdžiui, Kampaloje ir Rijade, kur kolektoriai užtikrino ištisus metus trunkantį šildymą ir vėsinimą. Vidužemio jūros klimato zonose, tokiose kaip Madridas, sistema veikė efektyviai sezoniškai, o žemyninėse vietovėse, tokiose kaip Vilnius, UTSC buvo ypač naudingas žiemos metu patalpoms šildyti. Šie skirtumai lemia skirtingas technologijos taikymo galimybes pastatų šildymo bei džiovinimo pramonės srityse. Analizuodamas UTSC veikimą skirtinguose klimatuose – nuo tropinio iki poliarinio – šis tyrimas prisideda prie klimato sąlygoms atsparių technologijų plėtros ir tvarios energetikos planavimo.

Reikšminiai žodžiai: atsinaujinanti energija, modeliavimas, neskaidrus pratakus saulės kolektorius, TRNSYS, saulės energija.