SOLAR THERMAL COOLING SYSTEMS: A FEASIBLE OPTION FOR THE MALDIVES

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Abstract

This poster presents the potentiality of utilizing solar and converting thermal energy to cool buildings in the Maldives. A thermal model of a typical building showing the annual cooling load is presented which was used to run a simulation model of a solar thermal cooling system. Simulation data shows that it is possible to use a solar thermal cooling system to cool the buildings effectively.

Introduction

- Climate change is as result of manmade activities resulting global temperature rise due to excess greenhouse gases.
- CO2 is the primary source of excess greenhouse gas causing global warming, ultimately increasing sea level to rise.
- The Maldives lies on the equator about 1m above sea level, facing challenges in it's survival due to the increase in sea level(Brown, et al., 2019).
- It lies on the equator receiving plentiful of sunlight annually having an average temperature of 31°C (Maldives Meteorological Service, 2020.
- Fossil fuel is now used as a primary source of energy.
- Electricity generation contributes around 53% of the country's CO2 emissions. Around 40% of electricity is used for air conditioning – conventional air conditioners (Bernard, Khelil, Pichon, & Tissot, 2010).
- Sunlight is free and can be harnessed to generate electrical and thermal energy.
- Reduce emissions, lower energy bills and less expense on fossil fuel.
- Solar thermal cooling can be the best option for the Maldives – an alternative method to cool buildings.

Solar Thermal Cooling Process

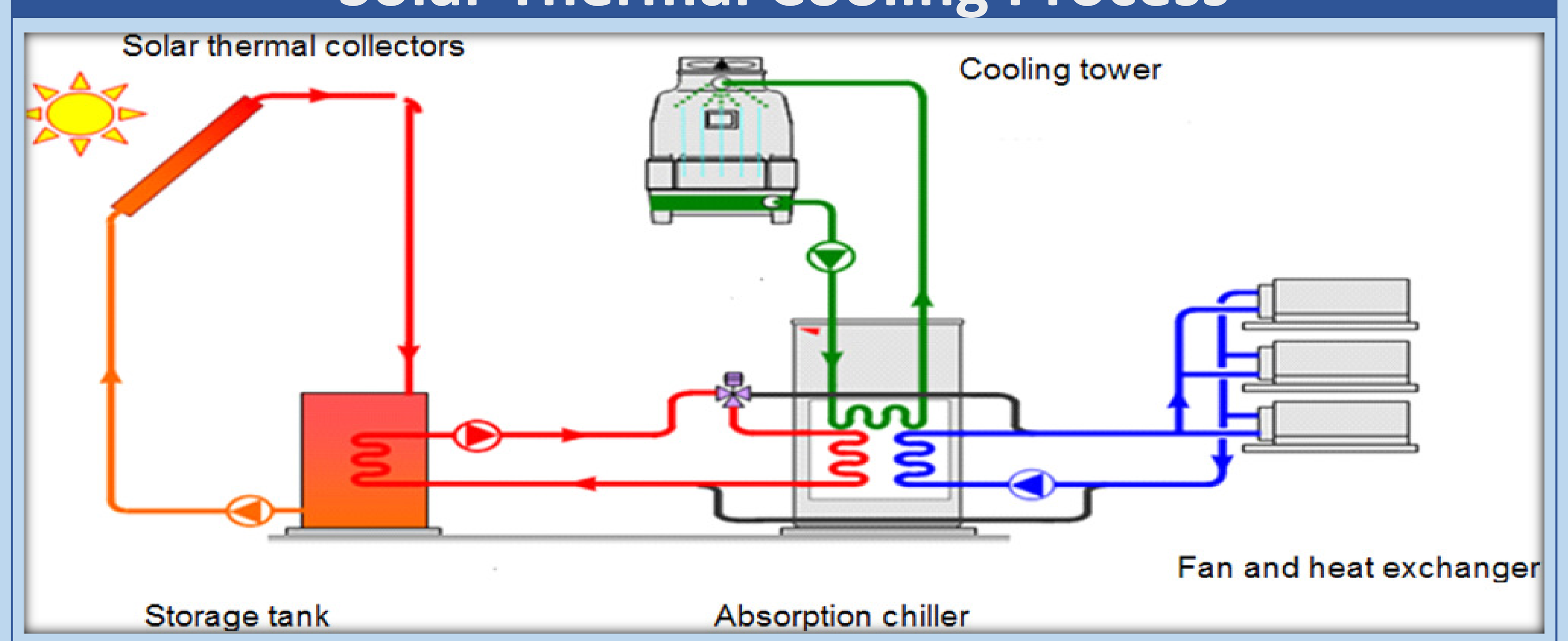

Figure 1: Solar thermal cooling system (Hussain, S., 2021)

Energy Model and Simulation

- Building Location – Hulhumale', Maldives
- Building Type – Office building
- Building area = 140m2, 50% roof area to be used for solar collectors
- Colling season = 52 weeks
- Internal set temperature = 23°C.
- Internal & External heat gains considered
- Building energy model – Autodesk Revit
- System simulation – Polyson software
- Lithium-Bromide/Water (LiBr-H2O) – working fluid in absorption chiller acting as the absorbent.
- Water acts as the refrigerant

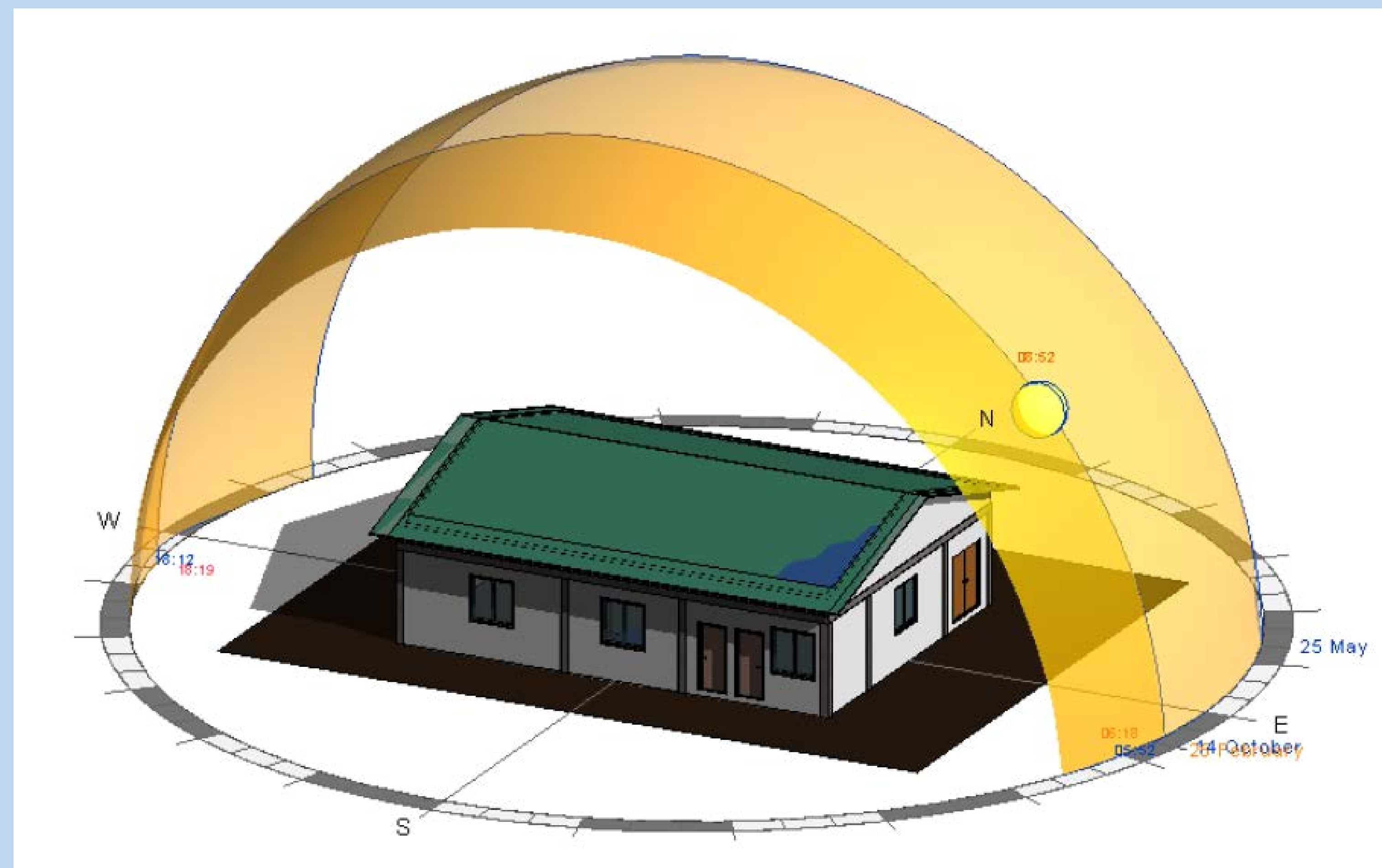

Figure 2: Building Model (Fathhee & Jiang, 2021)

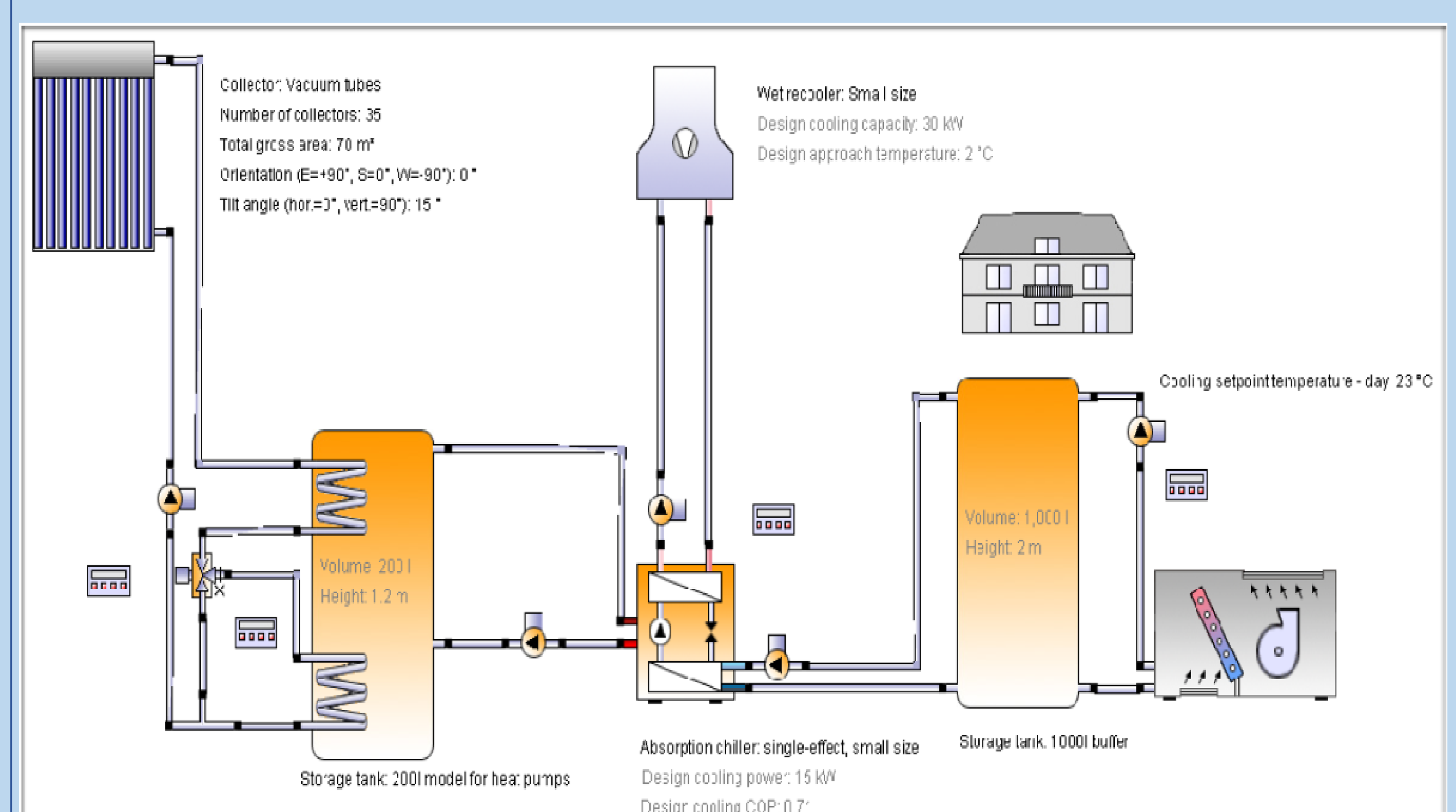

Figure 3: Solar thermal cooling system simulation model (Fathhee & Jiang, 2021)

Results

- Outside temperature varied between 26 - 31°C
- Peak cooling load is approximately 16.1kW and peak month is April.
- Approximately 93% of heat gains through sensible heat gains.
- Energy model shows high potential of solar receiving on building roof.
- Absorption chiller requires 90°C or above to run the system
- Between 12:00 PM and 04:00 PM, temperature has reached up to 116°C.
- Total solar thermal energy produced is approximately 33.39 kW.

Conclusions

- Annual cooling load demand is 50,238 kWh
- Solar thermal collectors generated around 33% of energy required to run the system.
- Internal heat gains were more, thus requiring more energy to cool the building.
- Utilize full roof coverage for solar thermal collectors – will increase the total amount of solar generation.
- It shows that traditional AC system generated about 3,874 kgCO2 of carbon emissions and using solar thermal system emission was about 491 kgCO2.
- Using solar thermal was able to save running cost to about 87%.
- Minimizing internal heat gains and using additional solar collectors with additional storage tanks could make the system more efficient.
- High potential of using solar cooling, reducing carbon emission, saves running cost; thus better option for the Maldives.

References

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