RP1001

AIR HANDLING SOLUTION, INTEGRATION APPROACHES AND BUILDING DESIGN CONSIDERATION FOR A PARTICULAR PHOTOVOLTAIC THERMAL AIR ROOFING

Research Question

1. What are the real outputs of the BlueScope Steel BIPV/T air system on a house in Sydney?
2. What are the optimum designs for BIPV/T air systems in Australian major cities? How sensitive are these designs?
3. What are the best suited residential building typologies and air handling system for the above BIPV/T air system?

Figure 1: BlueScope Steel BIPV/T Air System on a House in Sydney

Methodology

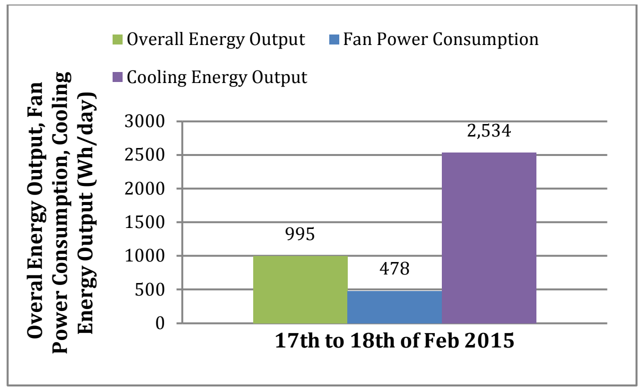
In order to answer the first question, monitoring equipment was installed to measure the actual outputs of the BIPV/T air system shown at Figure.1. The performance of the system was monitored in summer and winter. To answer the second question, a mathematical model was built to optimise key parameters of a generic PV/T air system and validated against the experimental data from the BIPV/T air system.

To answer the third question, this particular BIPV/T system was modelled in TRNSYS and compared the model outcomes with the experimental data to validate the model. In addition, different types of residential buildings were modelled. Combining building models with the BIPV/T model and considering various air handling systems, will provide answers for the third question in near future.

Results

Figure 2 shows the measured radiative cooling output of the BlueScope Steel BIPV/T air system on the house in Sydney over a night in Feb 2015.

Figure 2: System overall output in a typical night with clear sky in Feb 2015

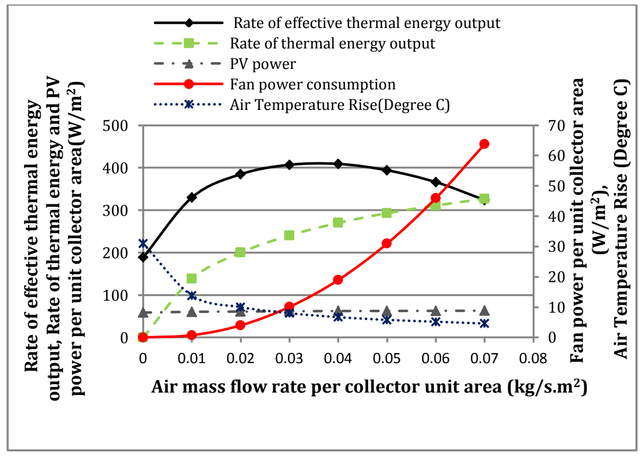


The following equation is used to calculate the net output of the system during the night:

$$Overall\ Energy\ Output = (Cooling\ Energy\ Output - 3.22\ Fan\ Power\ Consumtion)$$

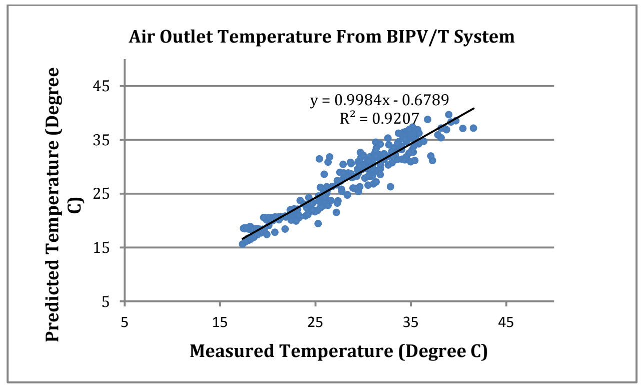
Figure 3 demonstrates the result of BlueScope Steel air mass flow rates optimization and the sensitivity analysis of the rate of energy outcomes across a wide range of air mass flow rates in Sydney. It can be seen that for the current BIPV/T collector profile the rate of air mass flow rate per collector unit area should be selected between 0.02 to 0.06 kg/s.m^2.

Figure 3: Sensitivity Analysis of Rate of Energy Outputs and Air Mass Flow Rate optimization of BlueScope Steel BIPV/T System



We have modelled the above mentioned BIPV/T air system in TRNSYS. The results of the simulation were compared against the experimental data from the house. Figure 4 shows that there is a good agreement between simulated data and measured data.

Figure 4: TRNSYS BIPV/T Air System Validation



Conclusions

In conclusion, the outputs of the particular BIPV/T air system were measured in summer and winter. Also, the optimal design of the system was identified for the climate of Sydney. Additionally, the BIPV/T air system model was built in TRNSYS and validated against the experimental data.

Anticipated impacts

The results will be useful for researchers, government departments, and companies utilizing BlueScope Steel BPV/T air system design and integration to buildings. This system is capable of generating electricity, heating and cooling (night radiative cooling) for a potential house and impacts on the electricity and gas consumptions.

Integration of a Particular Photovoltaic Thermal Air System into Various Buildings in Australia

Further information

For further information Please contact A/Prof. Alistair Sproul who is the program leader.

Contact

Name: Mehrdad Farshchimonfared (PhD Student)

Supervisor: A. Professor Alistair Sproul

Organization: UNSW

Email: m.farshchimonfared@unsw.edu.au

a.sproul@unsw.edu.au