CANTERBURY
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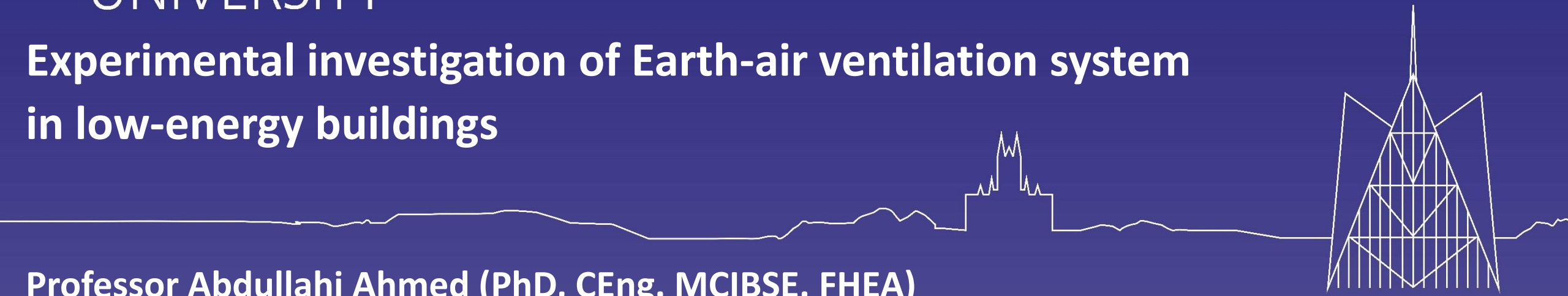
Experimental investigation of Earth-air ventilation system in low-energy buildings



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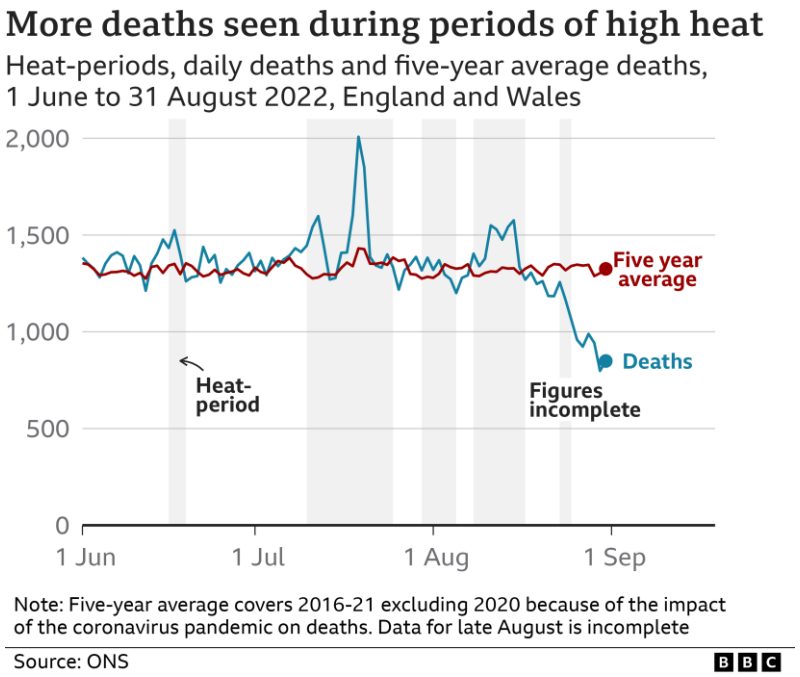
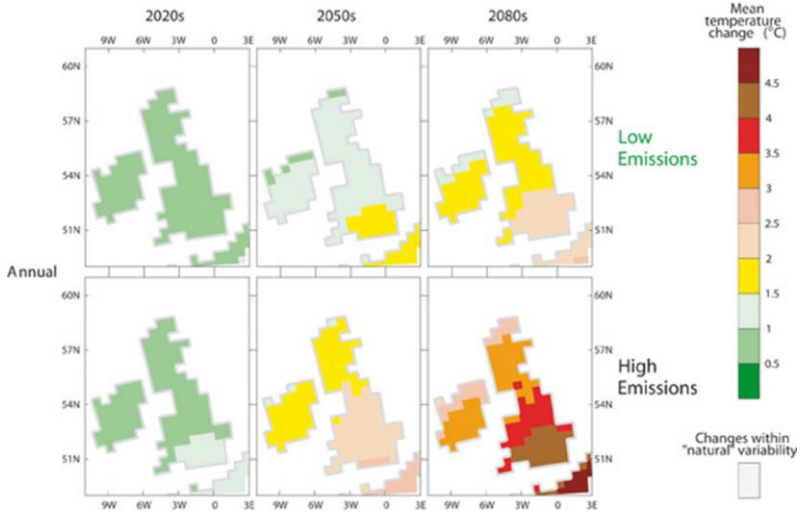
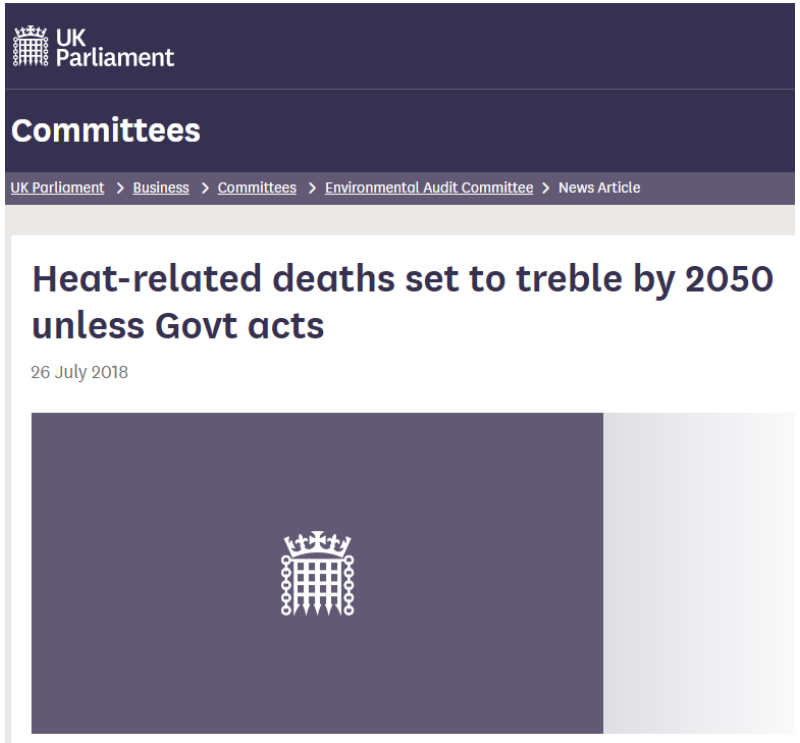
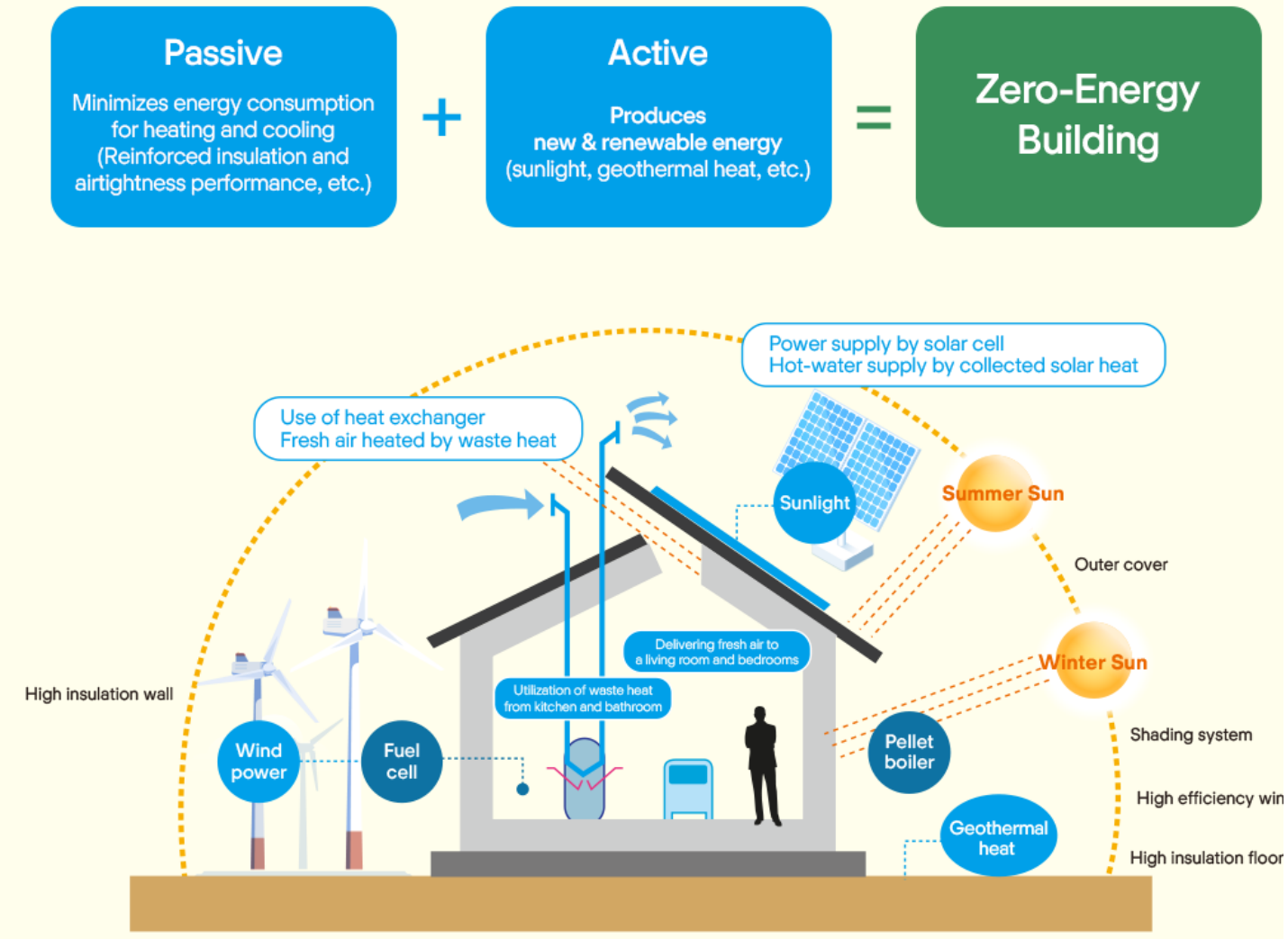
Climate Change Impact



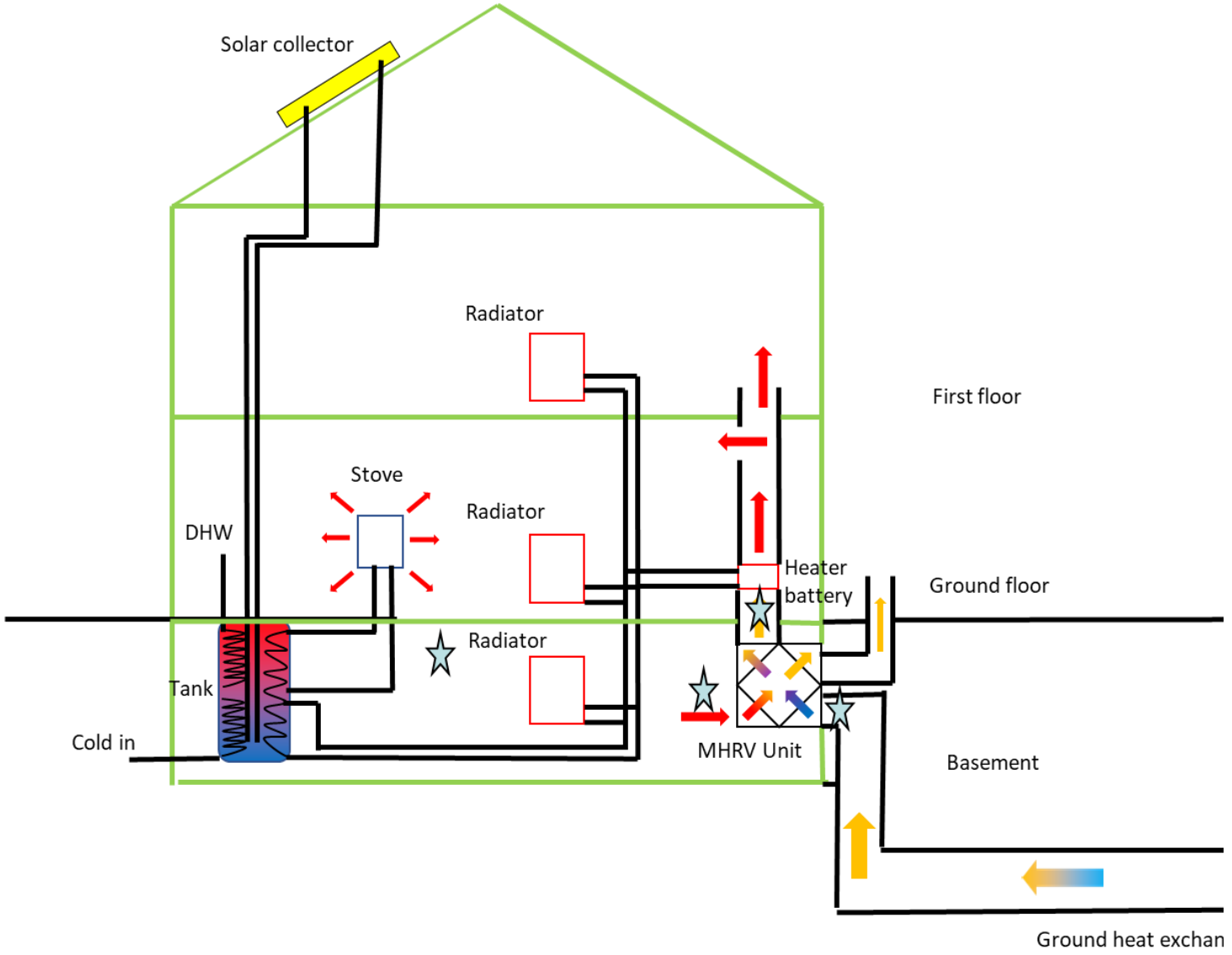




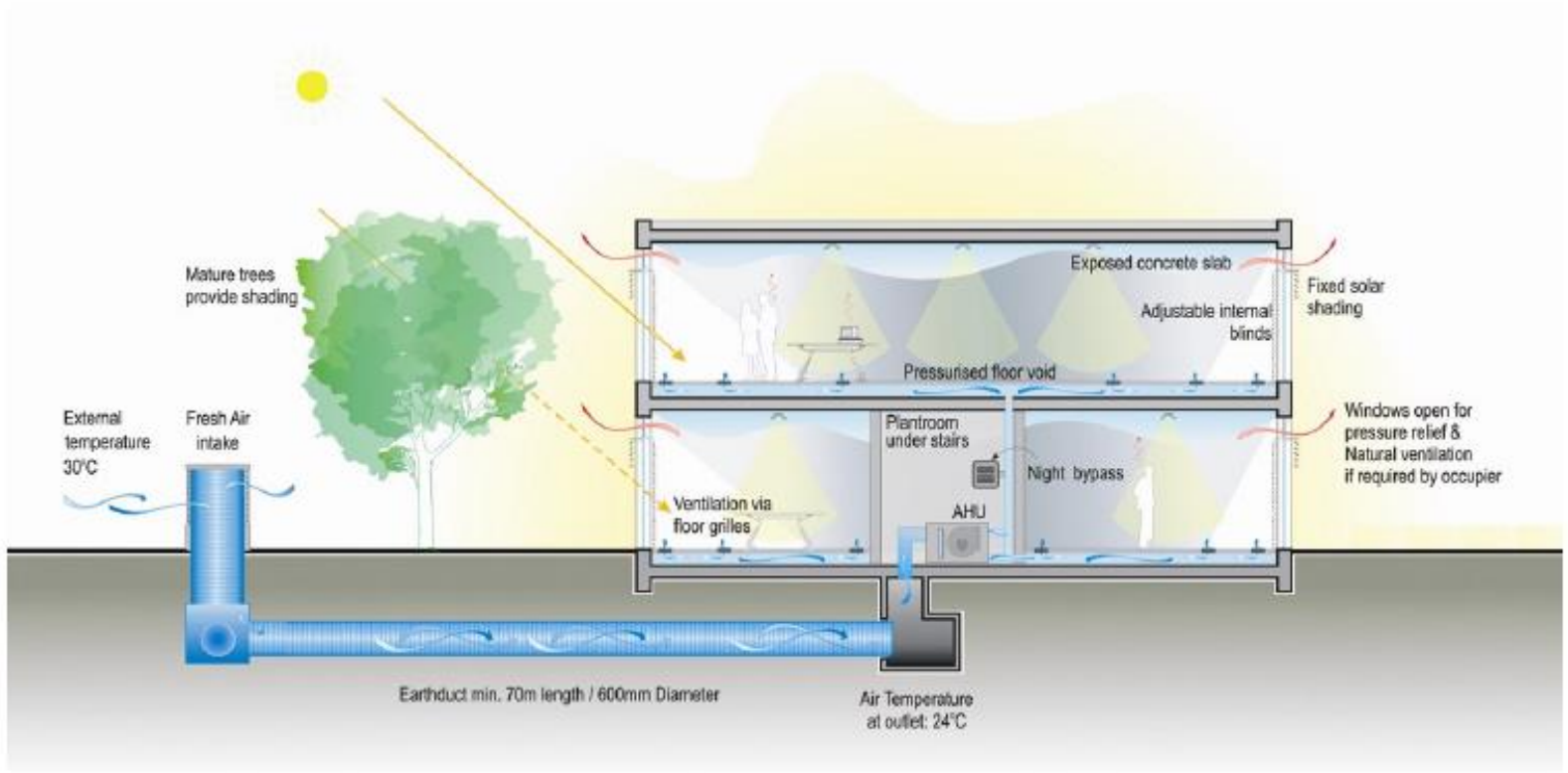
Achieving Net Zero Buildings



- **Building Energy Strategy**
  - Solar thermal Systems
  - Biomass heating systems
  - Mechanical Ventilation and Heat Recovery System
  - Earth-Air heat exchanger
  - Highly insulated thermal storage store;
  - Rain-Water Harvesting System;



- The Earth-Air Heat Exchanger (EAHX) is a subterranean cooling system that consists of network of pipes buried below the ground surface, through which ventilation air supply is circulated

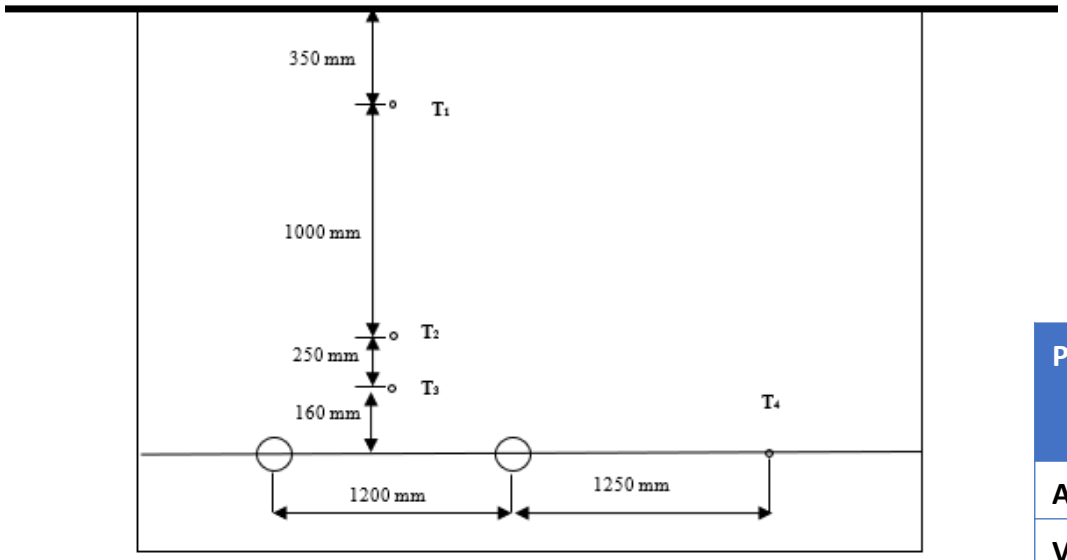


Case Study Systems

Monitoring

Parameter	Monitoring approach
External weather conditions: air temperature, relative humidity, wind speed and direction, solar radiation, rainfall	Weather station – Mounted horizontally on a post attached the solar chimney. The weather station has been located at high level above the building to minimise the risk of over-shading by the building and surrounding vegetation. Pyranometer – Mounted on the same vertical post as the weather station.
Soil temperature	4 K-type Thermocouples were used at different locations in the surrounding soil both vertically and horizontally to establish soil temperature variation with depth and horizontal distance from the pipe surface. The horizontal distance between the parallel pipes has been shown to be the main cause of thermal interference.
Inlet and Outlet air temperature	2 K-type thermocouples were used at both the inlet and outlet of the ducts shaded from direct solar gain to give heat transfer effectiveness of the earth-duct for heating and cooling ventilation air.

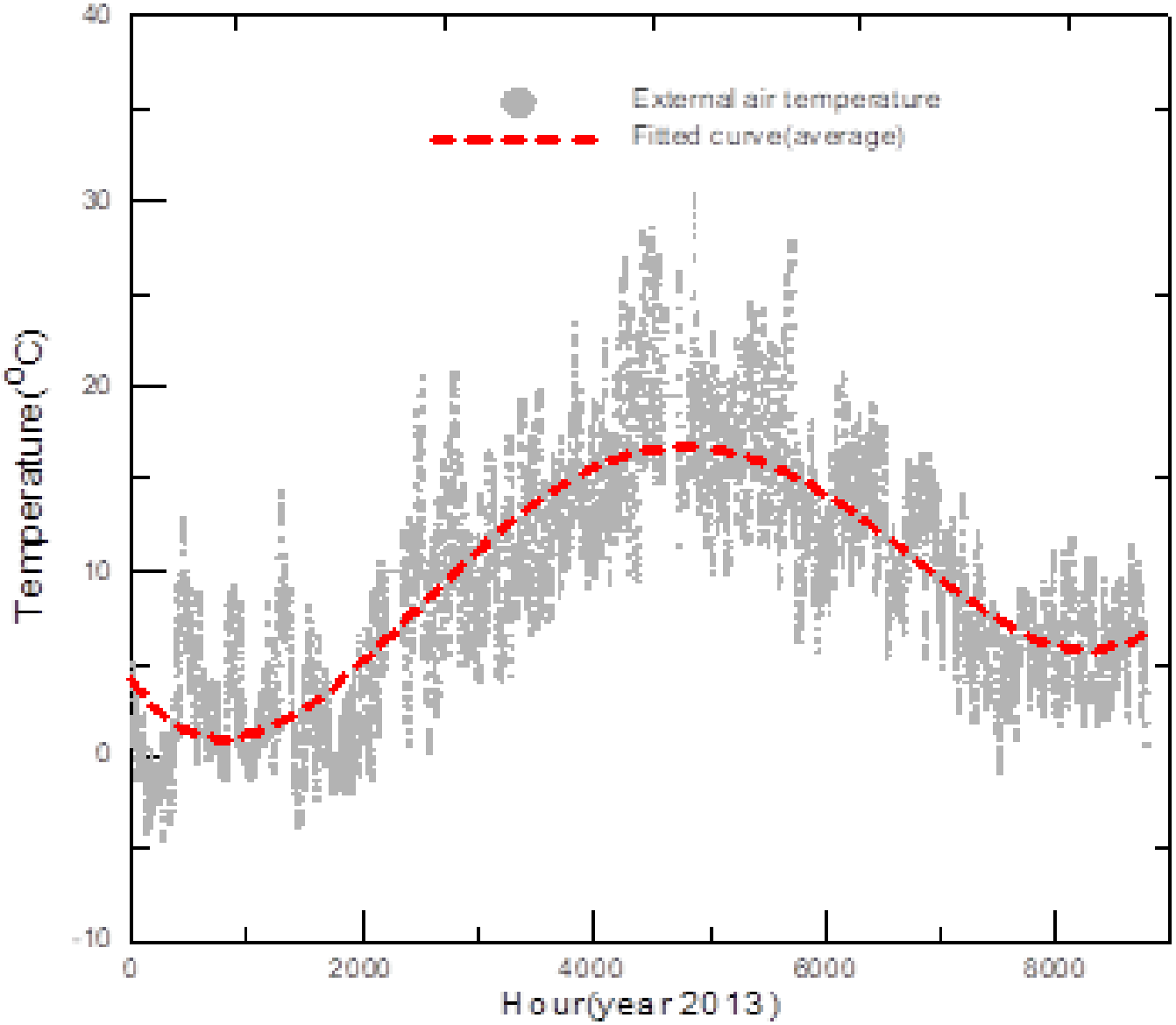
Monitoring



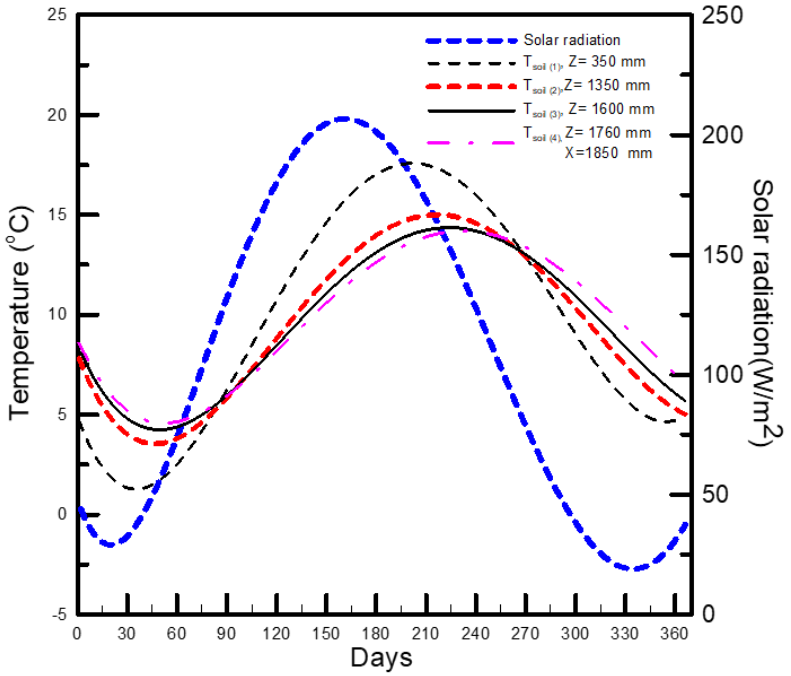
Parameters	Speed Setting 1 (00:00 - 07:00 am)	Speed setting 2 (07:00am -23:59pm)	Speed setting 3 (party mode)
Air velocity (m/s)	1.4	2.5	3
Volumetric flow rate (m3/h)	200	350	450
Estimated pressure loss (duct) (Pa)	6	21	29
Estimated pressure loss (air intake to MVHR) (Pa)	8.5 Pa	30	40Pa

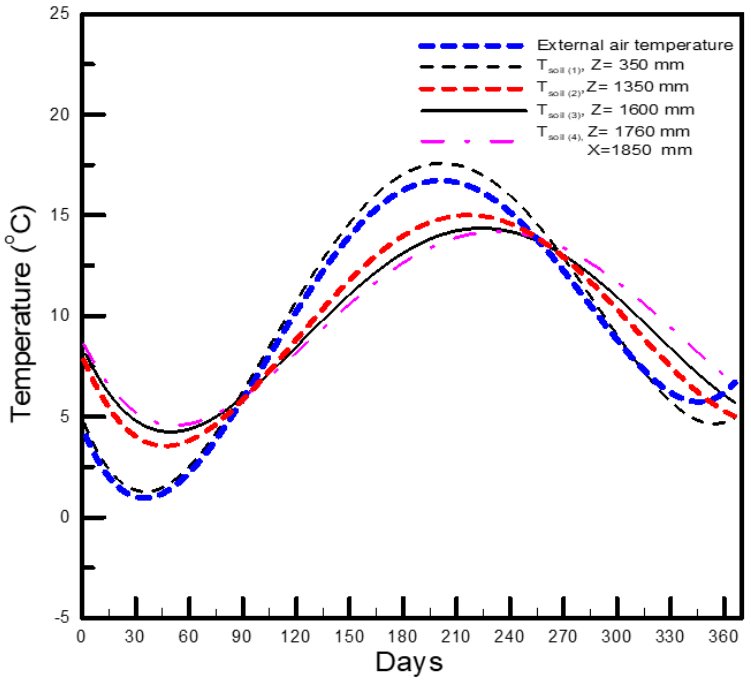
Results and Analysis

External air temperature



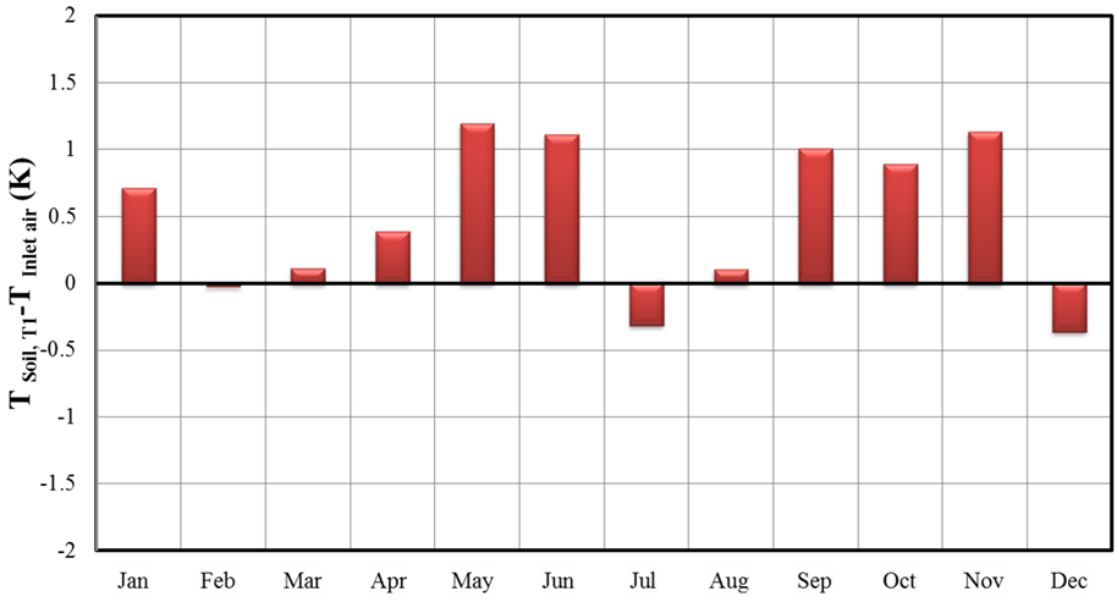
Dynamic annual changes in daily average soil temperature at various depths



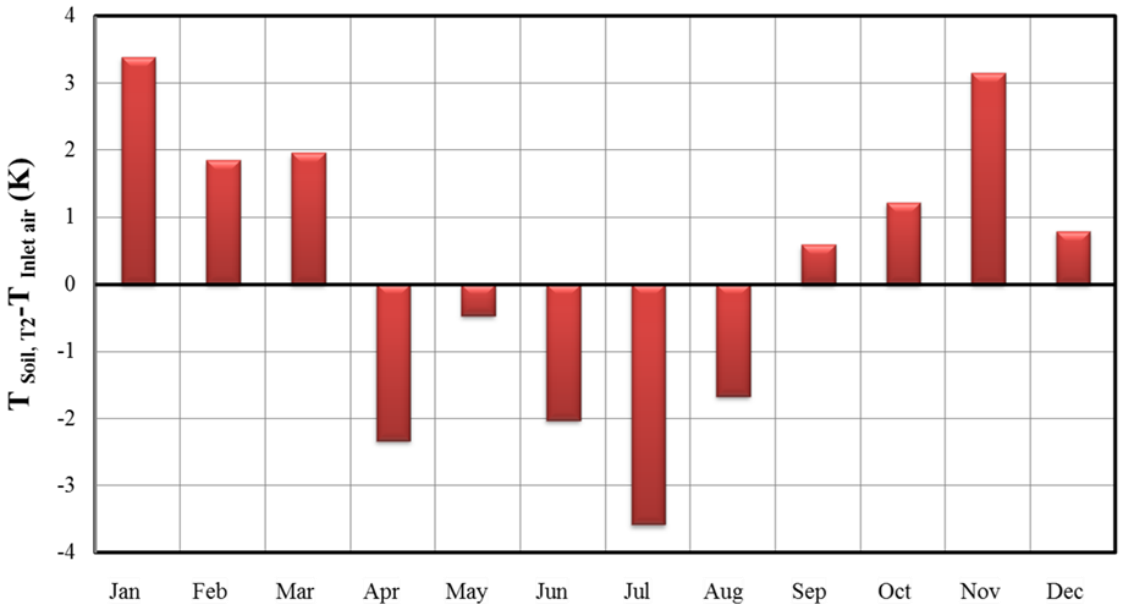


	Winter Lag Time	Summer lag time
Solar radiation	Day 16 (Minimum winter temperature)	Day 155 (Maximum summer temperature)
Soil temperature (350mm)	16	40
Soil temperature (1600 mm)	30	70
Soil temperature (1760 mm)	30	70

Monthly average thermal potential

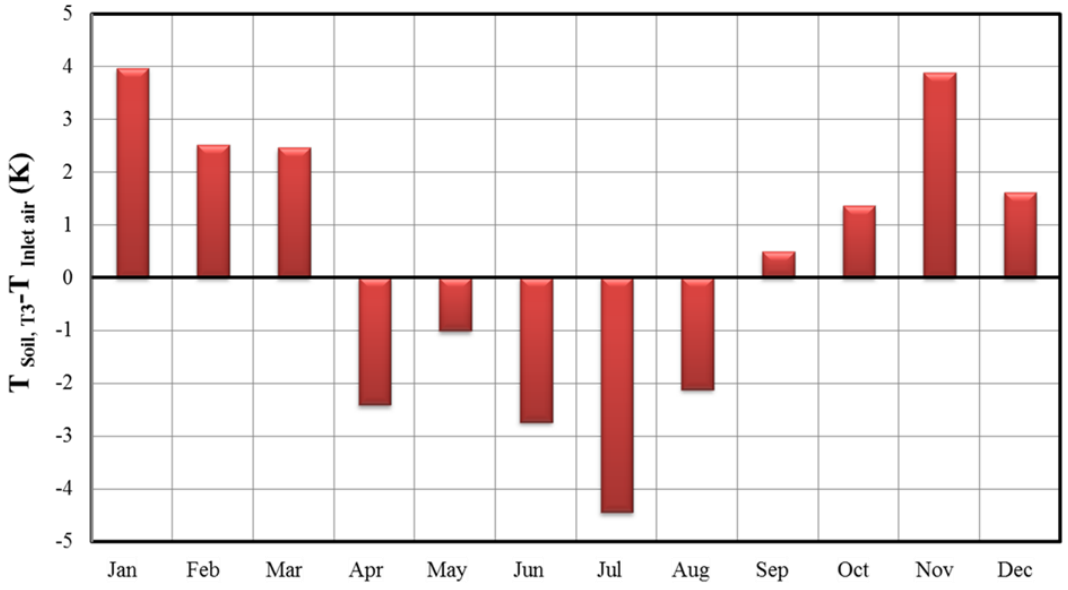


Monthly average thermal potential of ETAHE system at 350mm depth

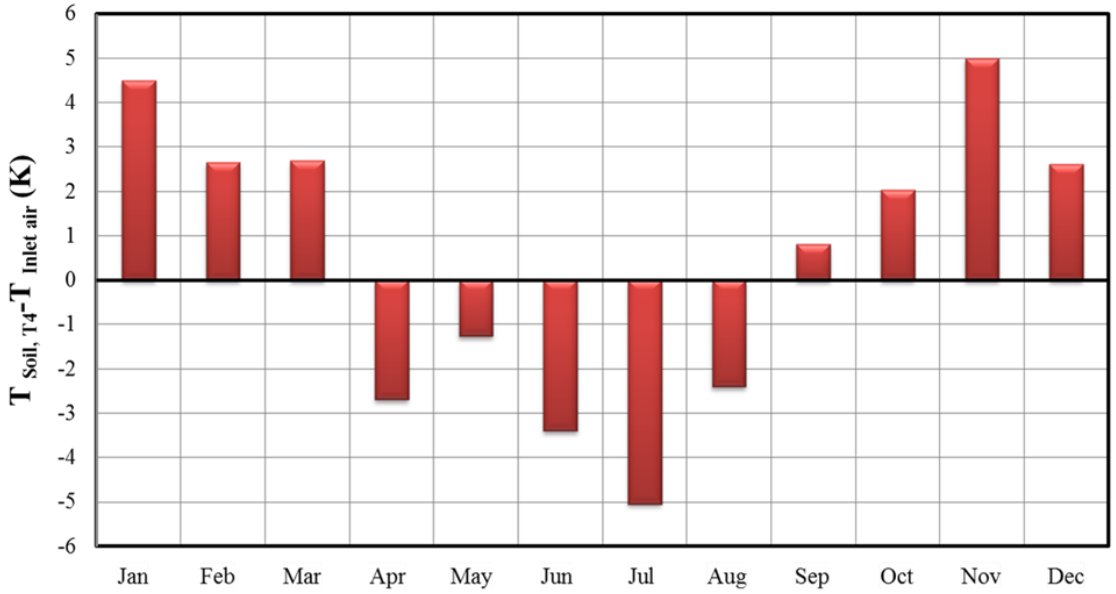


Monthly average thermal potential of ETAHE system 1600mm depth

Monthly average thermal potential of ETAHE

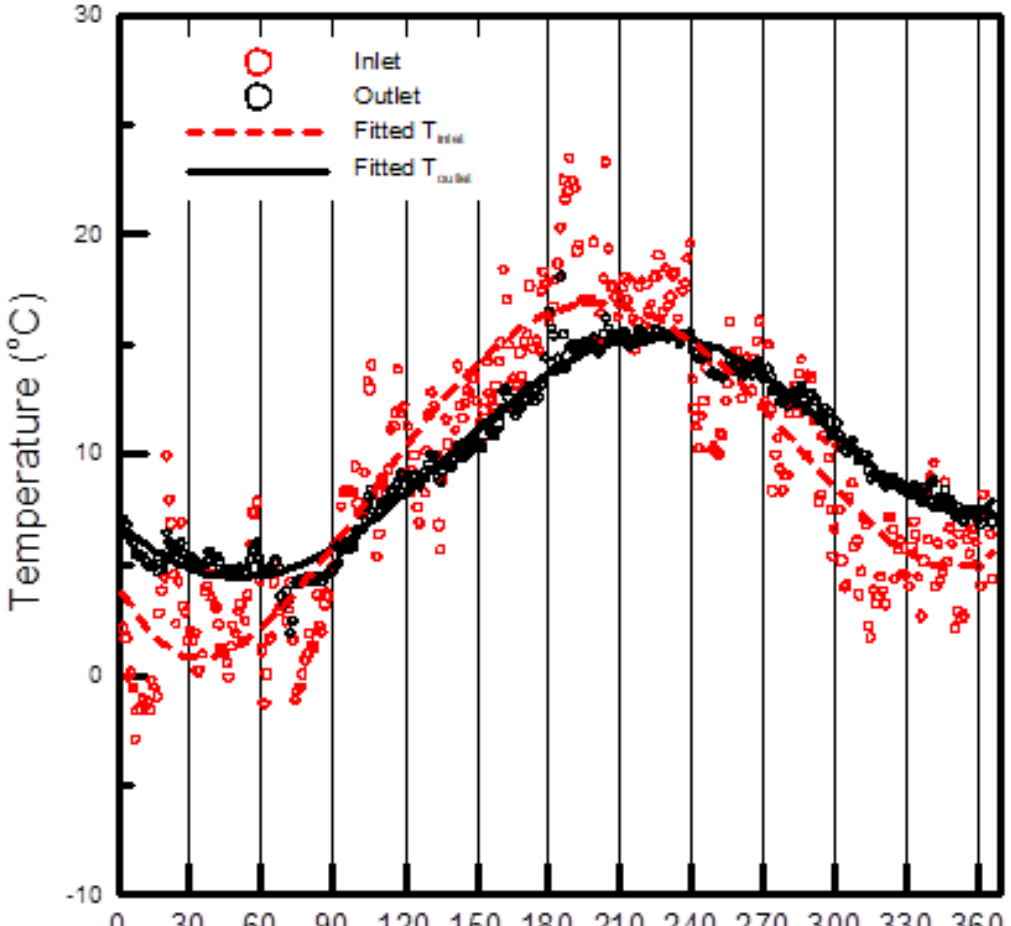


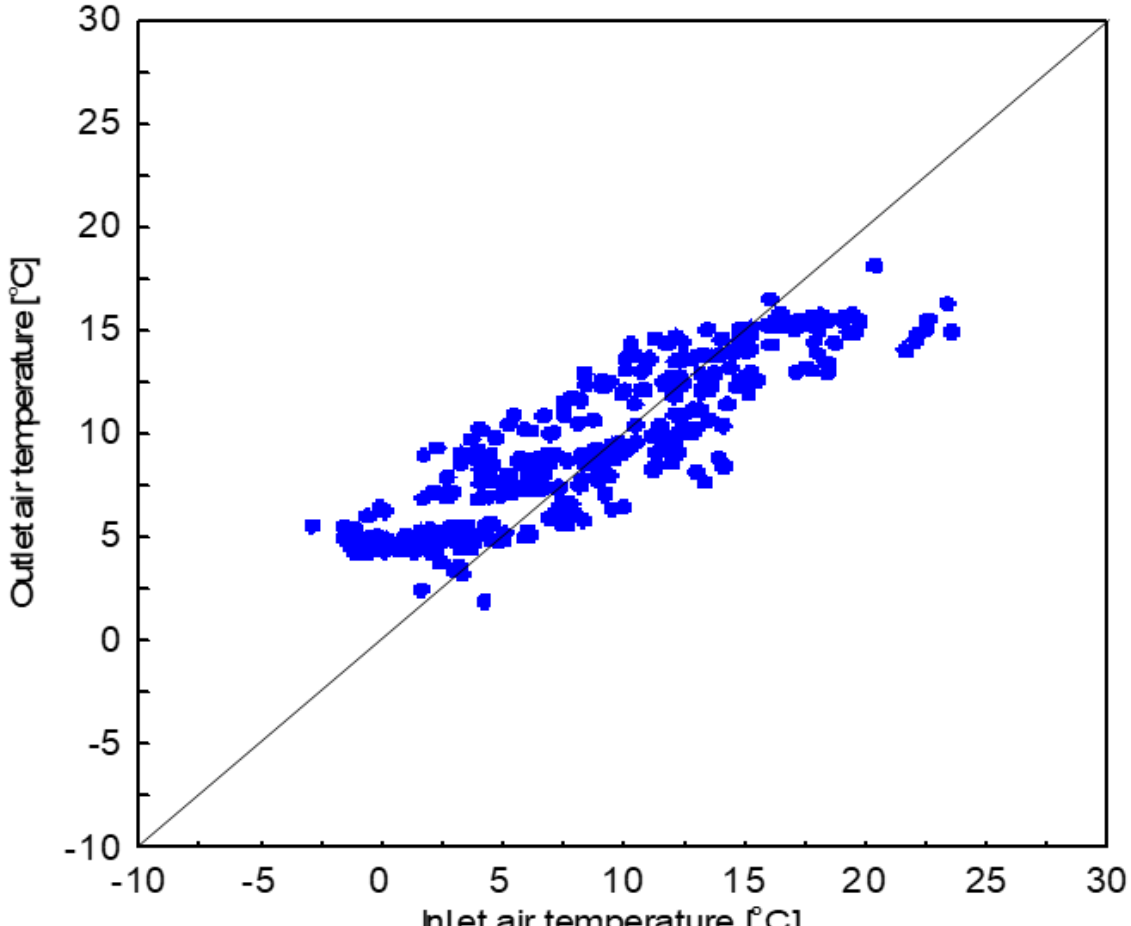
Monthly average thermal potential of ETAHE at 1760mm depth (600mm from duct surface)



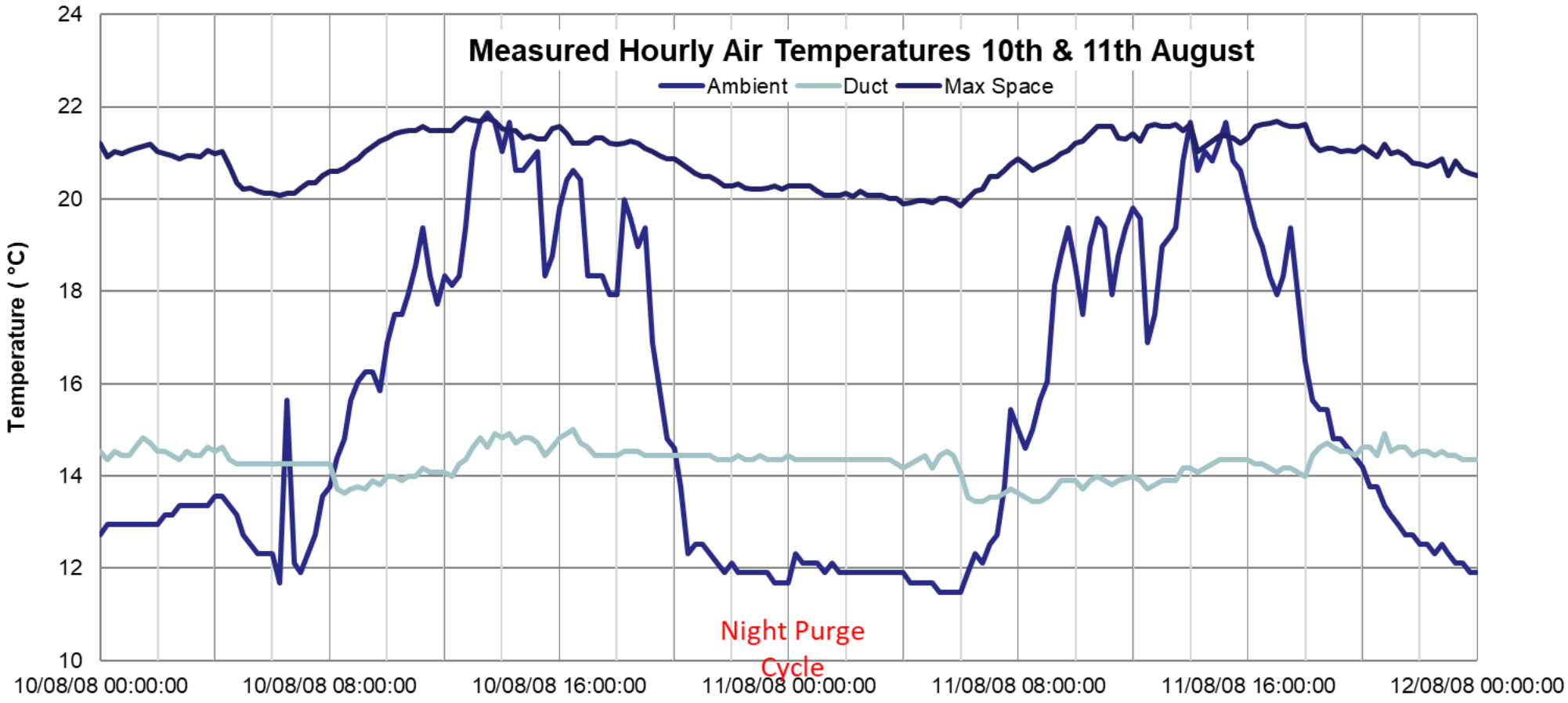
Monthly average thermal potential of ETAHE at 1760mm depth (1850 from duct surface)

Relationship between inlet temperature and outlet temperature





Night Purge potential



Conclusion

Technical Issues

Depth is critical – below 1 meter for reasonable soil-air temperature difference;

Reduce the risk of frost on MVHR system;

Avoid temperature stratification – soil temperature increase + drying near the pipe;

Effective integration with other heating and ventilation system

Non-technical

Cleaning and Cover – dust/rodent;

Control strategy