This paper updates the ongoing research, by simulation and experimentation for a sustainable low-energy method to heat or cool and ventilate affordable housing. Renewable sources are used to heat or cool water which is circulated to low temperature (22-25°C) radiators (LTRs) on inside faces to make houses as thermally comfortable as caves. In cool (15°C annual average temperature) Melbourne, Australia, water from 100m-deep VGHEs has been measured at 22-24°C. Using the 25-30°C increase in ground temperature per kilometre depth given by the International Panel on Climate Change, the depth should be about 200m. Most of the inhabited places have annual average temperature of more than 0°C, and the estimated depth would be less than 1 kilometre. Literature review is included in the introduction and discussion. Method for heating (experimental house/s in Melbourne, Australia) is grouped with Climate Change, the depth should be about 200m. Most of the inhabited places have annual average temperature of more than 0°C, and the estimated depth would be less than 1 kilometre. Literature review is included in the introduction and discussion. Method for heating (experimental house/s in Melbourne, Australia) is grouped with Climate Change. In hot places, the primary renewable coldness for water is radiation to night sky, which in Kuching, Malaysia, has, 22-24°C and 15-22°C thermally stabilise water to 22-24°C for circulation, directly to LTRs. The depth is about 200m to 1km (25-30°C). The first preferred renewable heat for cool to cold places is the vertical ground heat exchanger (VGHE) that can be integrated into the inside metal that clads structural insulated panels and housing would be affordably constructed. Funding is sought for an experimental house in cool/cold climates with LTRs heated by a 23°C-bottom temperature VGHE.

* Corresponding author.
E-mail address: koon.ooi@unimelb.edu.au
1. Introduction

This paper reports the latest in an ongoing use of simulation and experimentation to find a sustainable method to cool or heat, and ventilate affordable housing. Renewably-heated or renewably-cooled water is circulated to low temperature (about 22-25°C) radiators (LTRs) on inside surfaces to make houses as thermally comfortable as caves.

Figure 1 shows cool/cold places with annual average temperature (AAT) of 15°C/0°C and 30°C for hot places.

The first preferred renewable heat for cool to cold places is the vertical ground heat exchanger (VGHE) that can thermally stabilise water to 22-24°C for circulation, directly to LTRs. The depth is about 200m to 1km (25-30°C temperature increase/km depth, Intergovernmental International Panel on Climate Change, IPCC 2008 [1]). Measurements at 100m-deep (Ooi K., and Masa Noguchi 2016 [2]) and 50m-deep (Ooi K. et al 2015 [3]) VGHE in cool Melbourne Australia, which has an annual average temperature of 15°C, gives hotter water of 22-24°C and 15-17°C respectively. The cost of VGHE without heat pumps could be comparable with GHE with heat pumps studied by P.M Congedo et al. 2012 [4] and Xiong Z. et al. 2015 [5].

In hot places, the primary renewable coldness for water is radiation to night sky, which in Kuching, Malaysia has, since June 2015, cooled water to less than 25°C. Simulated and June 2017 experiment results are later discussed.

Below are three pieces of information that support this ongoing research, followed by a literature review.

**Nomenclature**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTR</td>
<td>Low temperature radiators on inside faces e.g., wall-LTR</td>
</tr>
<tr>
<td>VGHE</td>
<td>Vertical Ground Heat Exchanger i.e., water flow through U-tubes in vertical boreholes in the ground</td>
</tr>
<tr>
<td>PV/T</td>
<td>Photovoltaic (PV)/Thermal. i.e., PV cooled by air or water. This increases the efficiency of PV.</td>
</tr>
</tbody>
</table>
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات