

# 2013 臺灣國際科學展覽會 優勝作品專輯(國外作品)

作品編號 100048

參展科別 工程學科

作品名稱 Geo Air

得獎獎項 四等獎

國 家 Canada

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# ABSTRACT OF EXHIBIT

## TAIWAN INTERNATIONAL SCIENCE FAIR

### 1. Purpose:

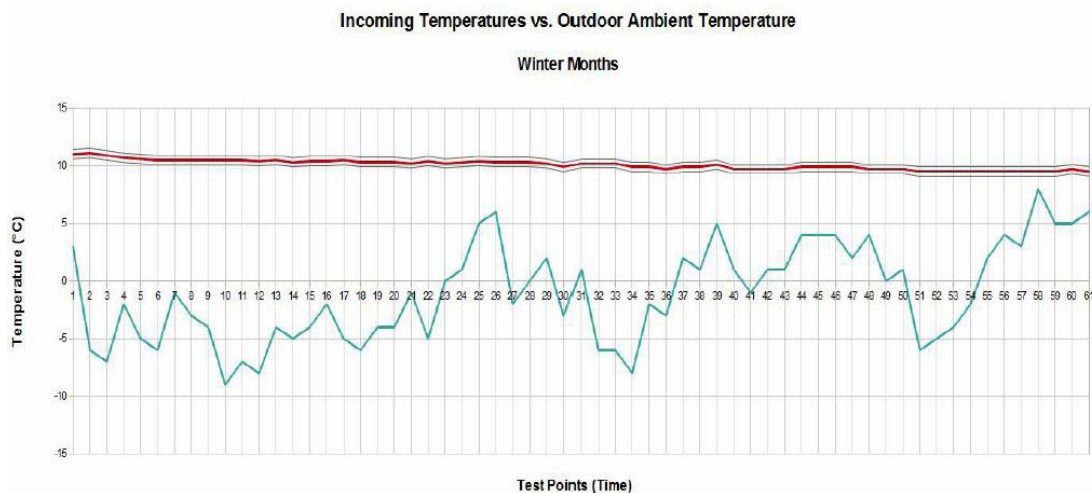
The purpose of this project was to design a theoretical tempered-air system to be integrated into an existing heating system in a home equipped with an air-to-air heat pump. This was to overcome the cost and environmental challenges of heating in cold climates as well as provide an environmentally friendly air-conditioning system in the summer at little to no cost.

### 2. Procedure:

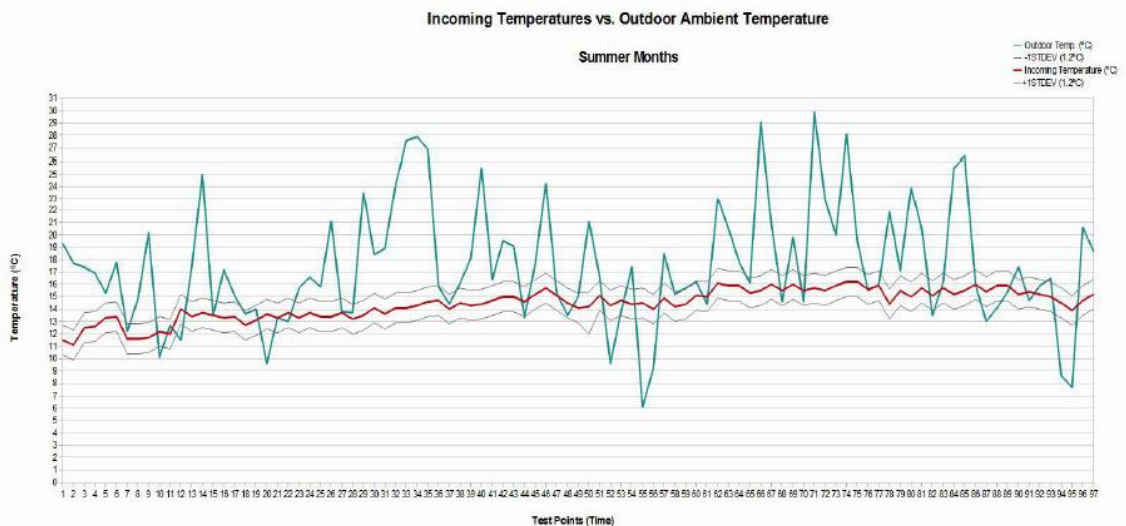
In the winter of 2010 an underground high-density polyethylene (HDPE) pipe (10cm diameter, and 30.5m length) was buried 2.5m underground around the footings of a new residential project. A fan with a flow of  $3.4\text{m}^3/\text{min}$  was attached to the pipe outside, and used to push air underground through the pipe and into the house. The ambient and incoming air temperatures as well as the date and time were recorded daily using a temperature probe with an error margin of  $\pm 0.1^\circ\text{C}$  throughout the summer and winter seasons of 2011. This data was then plotted and analyzed. A number of options to best extract thermal energy for potential use for heating and cooling were examined.

Design components were selected to create an air chamber for an air-to-air heat pump to increase its coefficient of performance (COP).

### 3. Data:



Graph 1



Graph 2

Winter Graph (Graph 1): The blue line represents the outdoor ambient temperature and the orange line represents the temperature of the tempered air. These are both arranged chronologically. The grey lines represent one standard deviation on either side of the incoming temperatures. The ambient temperatures vary dramatically, while the incoming temperatures remain quite stable. The lowest recorded temperature was about  $-9.0^{\circ}\text{C}$ , at which point the temperature exiting from the underground pipe was about  $10.5^{\circ}\text{C}$ .

Summer Graph (Graph 2): With dramatically varying ambient temperatures, the temperature of the incoming air consistently stays between  $11.1$  and  $16.2^{\circ}\text{C}$ . The highest recorded outdoor temperature was about  $30.0^{\circ}\text{C}$ , while the incoming temperature at that point was about  $15.5^{\circ}\text{C}$ . This cold air was used as air conditioning.

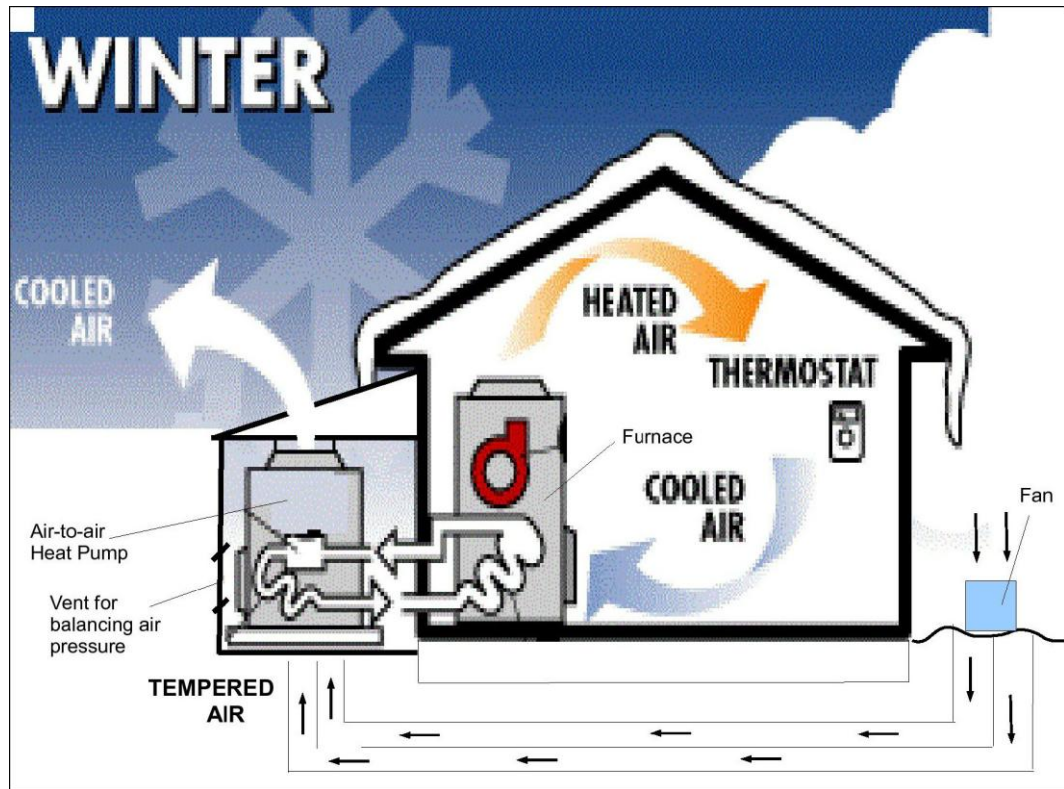


Figure 1

Figure 1 illustrates how the air would flow through a fan, and get pushed underground in several short HDPE pipes. This tempered air would then be fed into a small, insulated air chamber built against the home that contains an air-sourced heat pump. The walls of this chamber would have small vents to balance air pressure, and an exit near the top for cooled exhaust air. When the temperature outdoors is in the coldest stage of winter (daily average of  $-3.0^{\circ}\text{C}$ ), the tempered air being brought into the chamber would simulate an outdoor ambient temperature of about  $10.0^{\circ}\text{C}$ , allowing a heat pump to operate with a COP of  $\sim 3.79$  (based on data from Goodman Air Conditioning and Heating).<sup>2</sup> This means that for every unit of energy put into the heat pump, 3.79 units of energy are extracted.

#### 4. Conclusions:

In building an enclosed air chamber for around an air-sourced heat pump, it was found that it is possible to simulate a  $10.0^{\circ}\text{C}$  climate in the coldest parts of winter through air tempering. This will allow the heat pump to run substantially more efficiently throughout the year. This system could be used effectively to heat a home in the winter, as well as cool a home in the summer.

## 評語

研究具未來可行性，但創新性尚不足，應需多增加科學與技術討論。