PASSIVE ANALYTICS

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MONITORING HOME PERFORMANCE

The rapid evolution of sensing technology means it is now possible to accurately measure indoor air quality at very low cost. Moreover, the "Internet-of-Things" means that sensors can readily communicate with the cloud, allowing remote monitoring and logging. We are offering to provide devices to homes (both Passive Houses and standard homes) that monitor indoor air quality conditions, while also using the data to build an understanding of how homes currently perform in Australia.

WHAT CAN WE MEASURE?

The system can measure the following characteristics:

- Temperature
- Relative and Absolute Humidity
- Carbon dioxide (CO_2)
- Particulate matter (PM1.0, PM2.5, PM10).

WHY WOULD I BE INTERESTED IN THESE MEASUREMENTS?

These measurements are related to how comfortable and healthy our homes are. Given we spend well over 80% of our time inside it is reasonable to expect that our indoor environments are healthy.

Temperature

The perception of a comfortable indoor temperature is dependent on many factors, but the World Health Organisation generally recommend temperatures in the range of 18 to 25 °C for health, with temperatures below 16 °C being associated with respiratory problems among the sick, very young and elderly.

Humidity

Indoor relative humidity should generally be between 30% and 50%. Below this range the air will tend to feel dry and is associated with an increased risk of catching viruses and dry skin conditions. High relative humidity can support the growth of dust mites and mould, which can contribute to asthma and allergies. Absolute (as opposed to relative) humidity is closely related to temperature; at 50% relative humidity air at 25 °C there is about 12 g/m^3 of water vapour in the air. At 15 °C and 50% relative humidity there will only be 6 g/m^3 in the air. As cold air can carry less water vapour than warm air, and because most forms of heating extract water vapour from the air, there is a greater risk of low humidity in winter than in summer in most Australian climates.

Carbon dioxide

Carbon dioxide is an indicator of how *fresh* the indoor air is; at higher concentrations it can feel stuffy and, over time, can lead to feelings of lethargy and impaired decision making. The accepted threshold for good indoor air quality is that carbon dioxide concentrations should remain below 1,000 parts per million. This will normally be achieved in a home by opening windows and relying upon leaks in the building in combination with wind and convection-driven air movement.

Particulate matter

Particulate matter (PM) is a measure of the small particles such as dust and smoke that are present in air. PM is classified into groups based on the diameter of the particles; PM10 includes particles with a diameter of up to 10 micrometres (μm, or 0.000001 m) and PM2.5 is only finer particles up to 2.5 μm in size. These particles can come from many natural sources but are also produced by human sources as a result of combustion (for example wood fireplaces or using gas heating or cooking in a building) and in urban areas from motor vehicles including

tyre and asphalt particles and from brake pads. Prolonged exposure to finer particles can be particularly hazardous to health as they tend to penetrate more deeply into the lungs. The World Health Organisation recommend that average 24-hour PM2.5 concentrations should be below 25 $\mu g/m^3$ and for PM10 should be below 50 $\mu g/m^3$.

HOW MUCH DOES IT COST?

The sensors are provided for the cost of the hardware and online subscription fees only on the basis that the data collected can be used by Passive Analytics for research purposes. Individual premises will not be identified as part of this analysis. Costs are provided below. Several options are available depending on the application.

Sensors	Power	Cost
Temperature / Relative Humidity	4x AA batteries	$70
Temperature / Relative Humidity, CO_2	Mains power	$150
Temperature / Relative Humidity, PM	Mains power	$140
Temperature / Relative Humidity, CO_2, PM	Mains power	$200
IoT subscription (12 months)[1]	n/a	$10
Postage	—	$10

[1] One required per device.

HOW CAN I ACCESS THE DATA?

The data will be uploaded automatically to the internet every 10 minutes from where you will have access to an online dashboard showing current and past conditions. The data will provide insights into how well your home is performing now, and how well it reacts under different situations – for example, how effective opening a window may be in maintaining indoor air quality – or what the impact of cooking or using your fireplace may be on indoor conditions. An example snapshot of a typical display is shown below and a demo is at https://bit.ly/2F8SJcD.

WHAT WILL WE USE THE DATA FOR?

Passive Analytics will use the data to improve our understanding of how typical dwellings and Passive Houses perform in the Australian climate. The data will be anonymised such that only the general locality (i.e. suburb, town or region) will be identified. It is intended that an analysis of the data will be made publicly available to support improving the efficiency and design standards of Australian homes.

HOW HARD ARE THE SENSORS TO INSTALL AND CONFIGURE?

Easy! They need to be plugged in and then connected to the Wi-Fi using a smartphone, tablet or PC that is also connected to the Wi-Fi network.

HOW MANY SENSORS SHOULD I GET?

Entirely up to you! A typical setup may consist of:

- one sensor with temperature, relative humidity and CO_2 in the master bedroom,
- one sensor with temperature, relative humidity, CO_2 and PM in the living room,
- temperature / relative humidity sensors located in other rooms as desired.

CAN YOU MEASURE VOLATILE ORGANIC COMPOUNDS (VOCs) SUCH AS FORMALDEHYDE ETC?

In short, no. There are sensors and consumer-grade devices available that claim to be able to measure the many compounds that constitute volatile organic compounds. However, doing so with any reliability is exceptionally difficult – despite the claims that are sometimes made to the contrary. In our assessment these sensors are, at the moment, more likely to be misleading than helpful. Moreover, most sensors measuring volatile organic compounds report a "total" concentration of all VOCs in the air. This is not necessarily helpful either, as some VOCs will be far more hazardous than others.

WHERE SHOULD I PLACE THE SENSORS?

It is recommended that the sensors be positioned such that they are as representative as possible of the conditions within the room in which they are cited. In a bedroom this may mean on a bedside table, and in a living room it may be on a bookshelf. The sensors should be positioned at a height of around 0.5 to 1.5 m to best represent the air quality to which occupants will be subject. They should be positioned out of direct sunlight, as this will adversely affect the temperature readings.

Devices with a particulate matter sensor make a high-pitched whirring noise that may be disturbing if positioned next to a bed. In these situations it may be best to use a device without a particulate matter sensor, or position it sufficiently far away that it is not disturbing.

The sensors with carbon dioxide or particulate matter monitoring require access to mains power and Wi-Fi**.** The temperature and humidity sensors are lower power, and so can operate off batteries for 6 – 12 months. Alternatively, they can be mains powered if convenient.

WHAT HAPPENS AT THE END OF THE RESEARCH?

You will continue to have ownership of the sensor hardware. Ongoing technical support and access to the online data portal may continue at the discretion of Passive Analytics.

WHAT ONGOING SUPPORT WILL BE PROVIDED?

Limited technical support will be available as required. The initial subscription period is for a period of 12 months. It is very likely the service will be provided ongoing for the foreseeable future, although this cannot be entirely guaranteed. There would be a small annual fee (in the order of $10 per device) to cover the annual online data service costs.

HOW DO I FIND OUT MORE?

To order or find out more contact Cameron Munro on cameron@passiveanalytics.com.au.