Solar Air Heating in Classrooms

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Background

Warm, dry home improves health (less wheeze, doctor visits, reduced hospitalisation, IAQ), plus reduced school absenteeism

Does improving classrooms improve health, IAQ and absenteeism?

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Classroom problems

NZ has 30,000 classrooms of mixed stock and quality; mostly single storey, single glazed, natural ventilation,

Little known about the classroom environment, except;

- NZ Classrooms are under ventilated and too cold in winter
- Teachers typically don't open windows until lunch time in winter
- Classrooms have high winter bacteria levels

Energy in Schools

Energy expenditure capped in school at 2010 levels.

2/3 of energy used for space heating.

Energy efficiency are measures required or ventilation problems will increase as a cost saving measure.

Possible solution

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School day is closely aligned with solar availability.

The Team:

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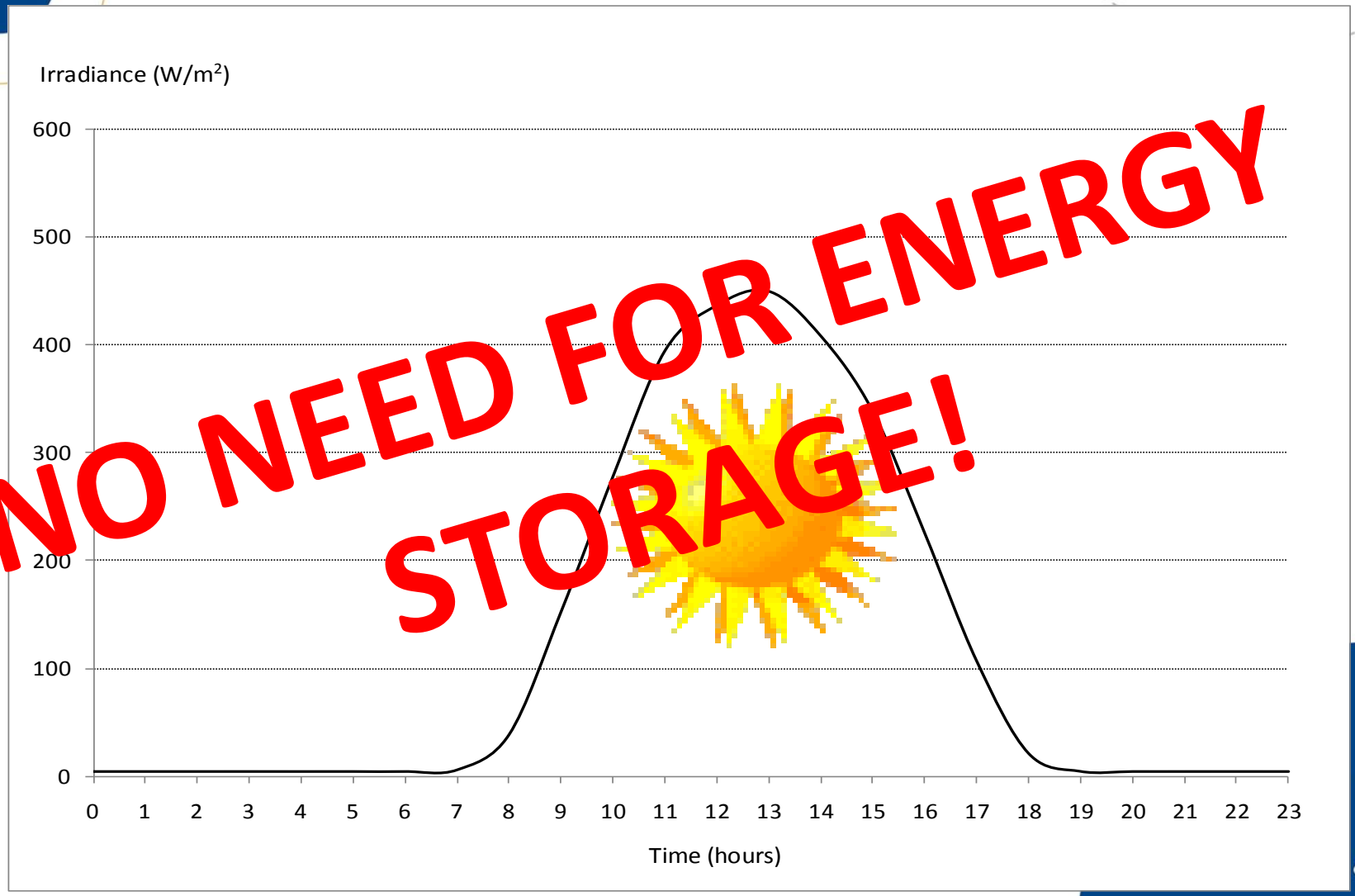
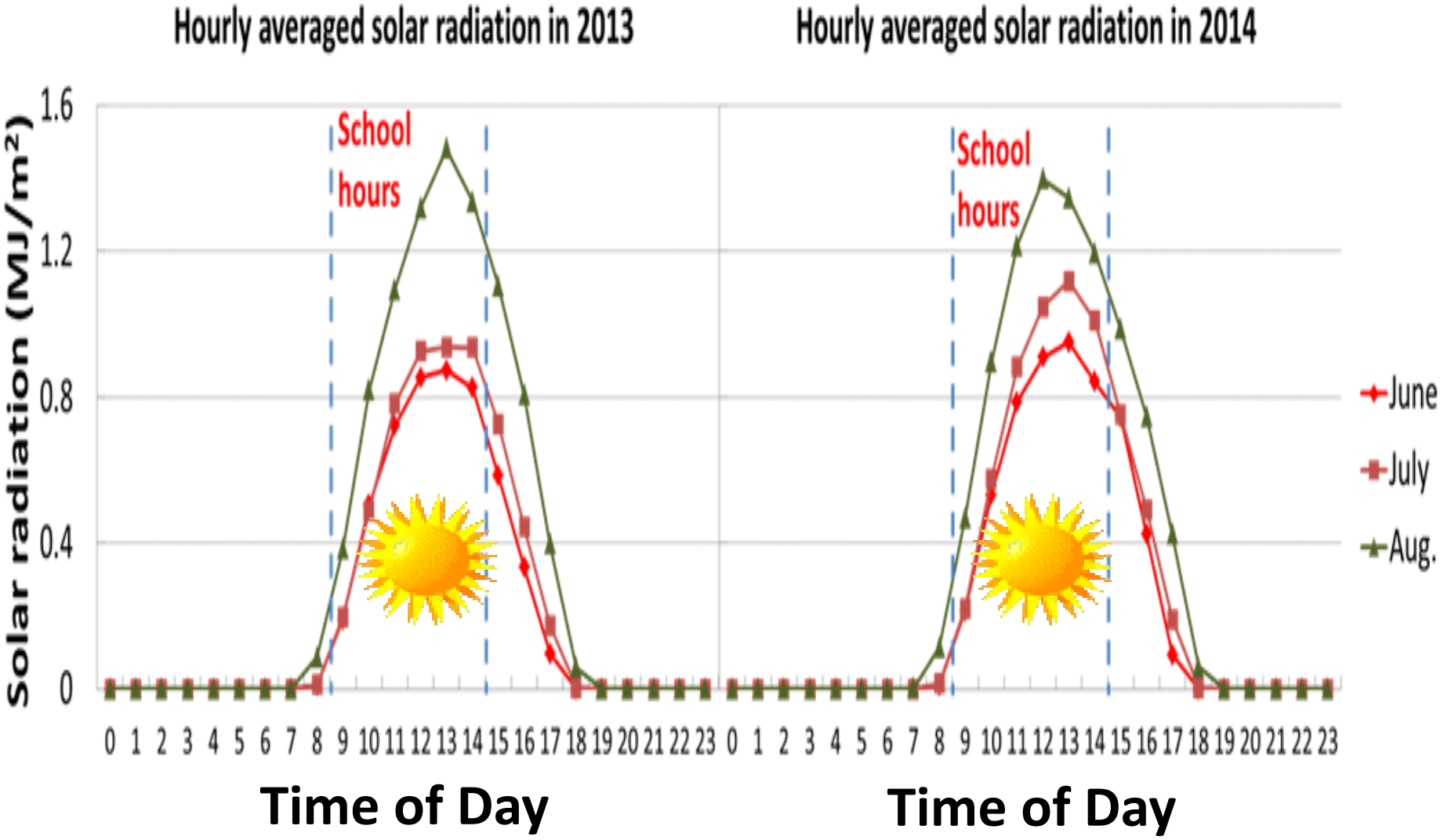
Solar energy at school ?



The hourly averaged solar radiation in winter 2013 and winter 2014 in Palmerston North



Solar air heating

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Palmerston North School Trial

- 6 pairs of classrooms – same construction, orientation, heating, ventilation, solar access.
- All classrooms were fitted with a solar air heater - control/treatment, crossover design for two winters.
- Measured temperature, relative humidity, CO2, particulates, air velocity in supply duct, airborne bacteria, bacteria in child's throat, absenteeism for respiratory infection and heater use


solar collector
control classroom
treatment classroom

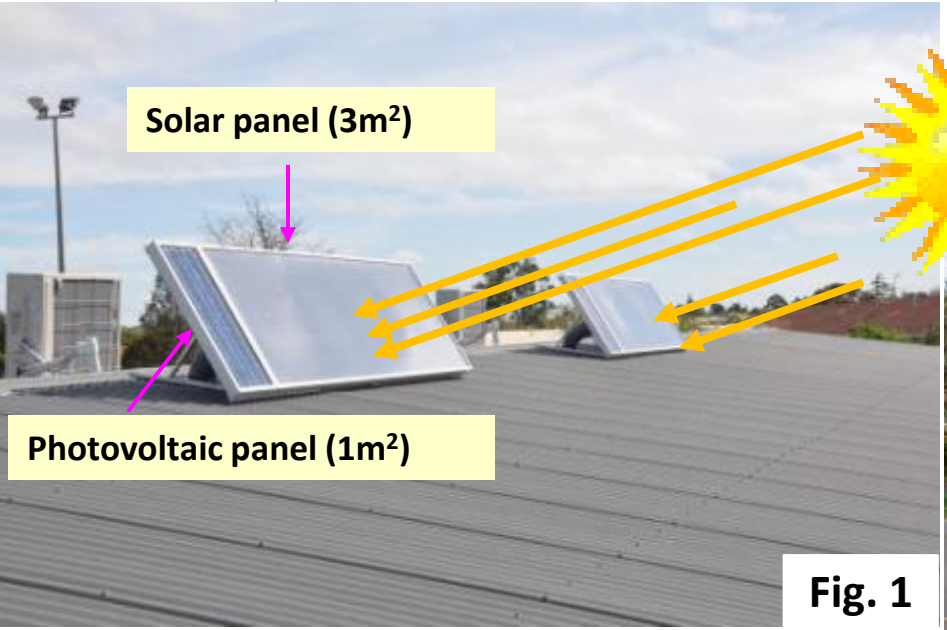


Fig. 1

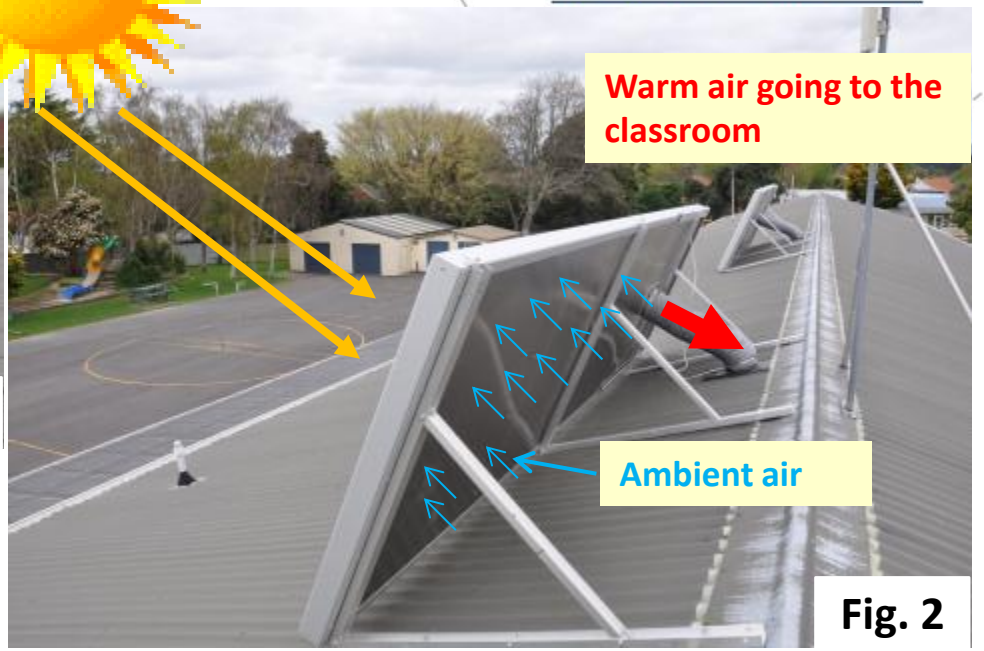


Fig. 2

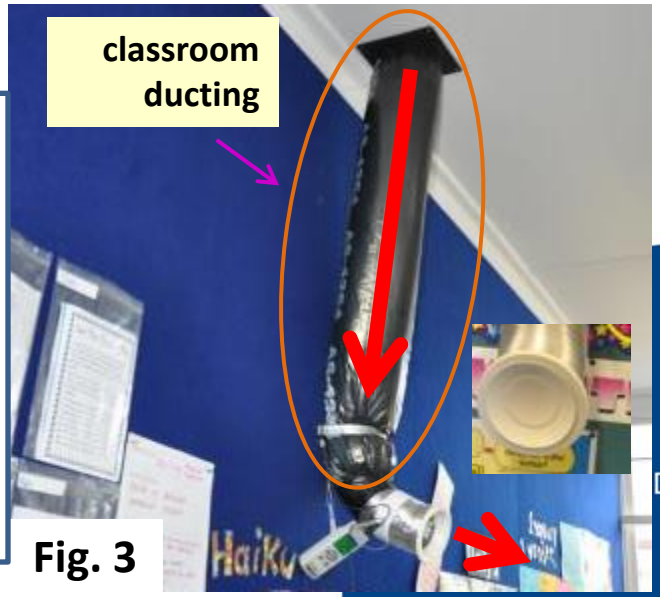


Fig. 3

Fig.1: Front of the solar panel.

Fig.2: Back of the solar panel.

Fig.3: Classroom ducting.

Results

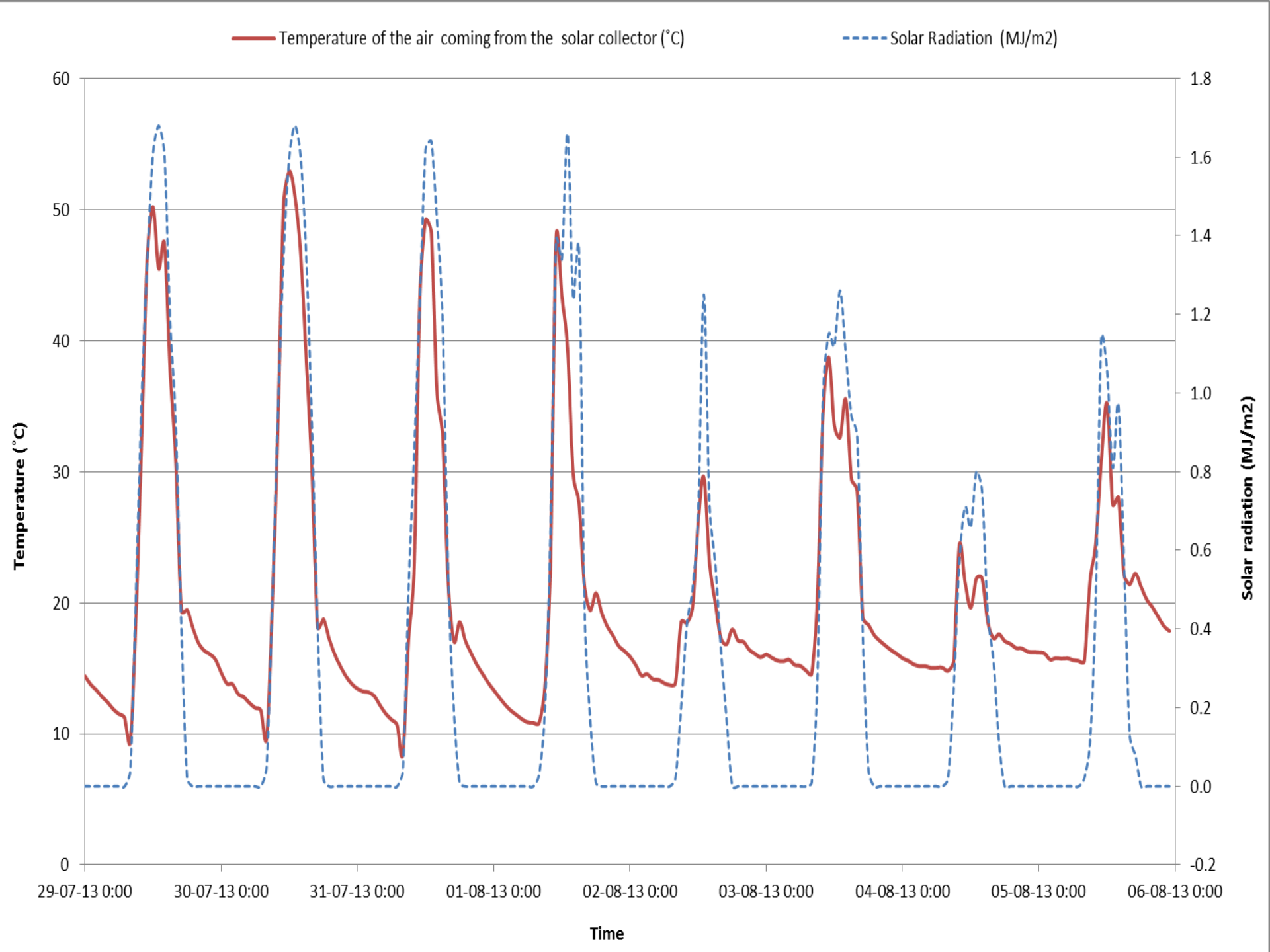
Treatment classrooms were warmer, yet used their heaters 2.5 times less than control classrooms

Lower carbon dioxide levels

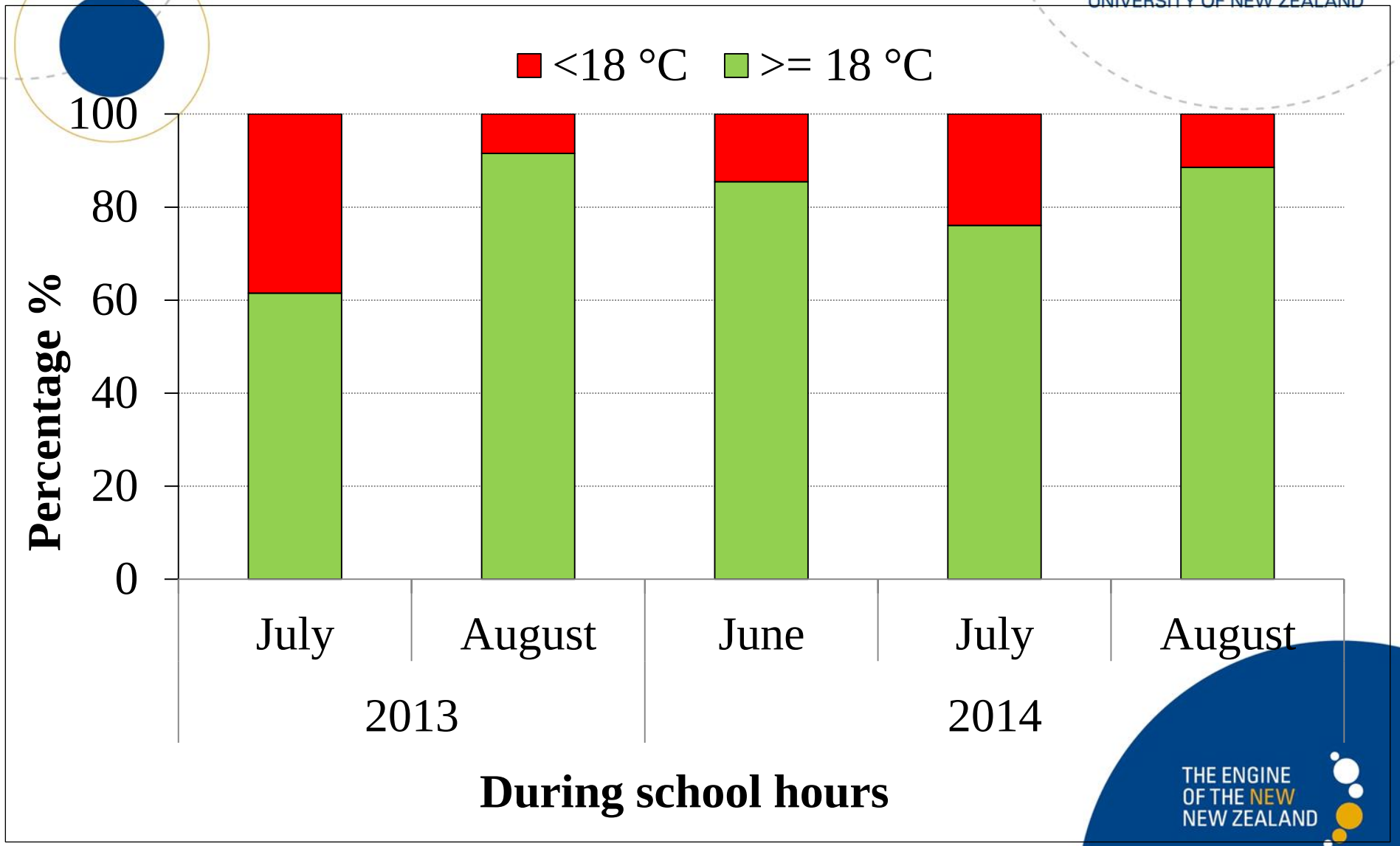
Lower relative humidity

Lower levels of respirable particulates

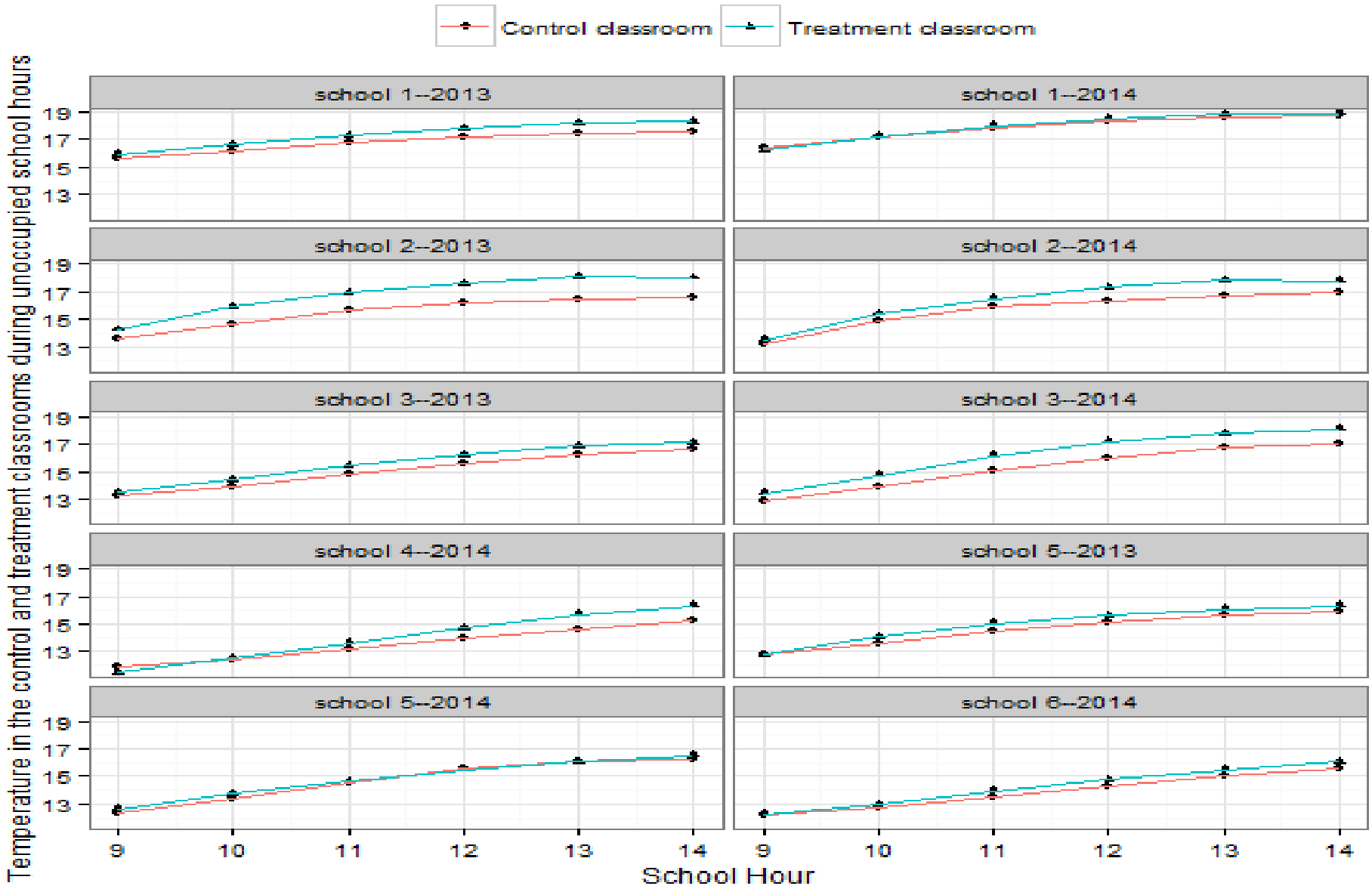
Health data still being analysed


Temperature of the air coming from the solar collector (˚C)
Solar Radiation (MJ/m2)
Temperature (˚C)
Solar radiation (MJ/m2)
Time
60
50
40
30
20
10
0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
29-07-13 0:00
30-07-13 0:00
31-07-13 0:00
01-08-13 0:00
02-08-13 0:00
03-08-13 0:00
04-08-13 0:00
05-08-13 0:00
06-08-13 0:00

Incoming air temperature



Classroom temperature unoccupied



Incoming flow rate

Max Flow rate = **163m³/h** at **21.1 ºC**.

(1.2 hours to change the air volume of a 200 m^3 classroom).

Average flow rate = **65 m³/h** (over both winters).

(**13 times lower than the 850 m³/h** than recommended value from NZ Standard).

Increase the collector area

Conclusions

- bb
  - For 80 % of the time, incoming air temperature > WHO 18.0 ºC.
  - Classroom temperature up to 1.3 ºC higher in the treatment classroom.
  - A need to increase the flow rate.

MidCentral District Health Board
Te Pae Hauora o Ruahine o Tararua

hrc Health Research Council of New Zealand

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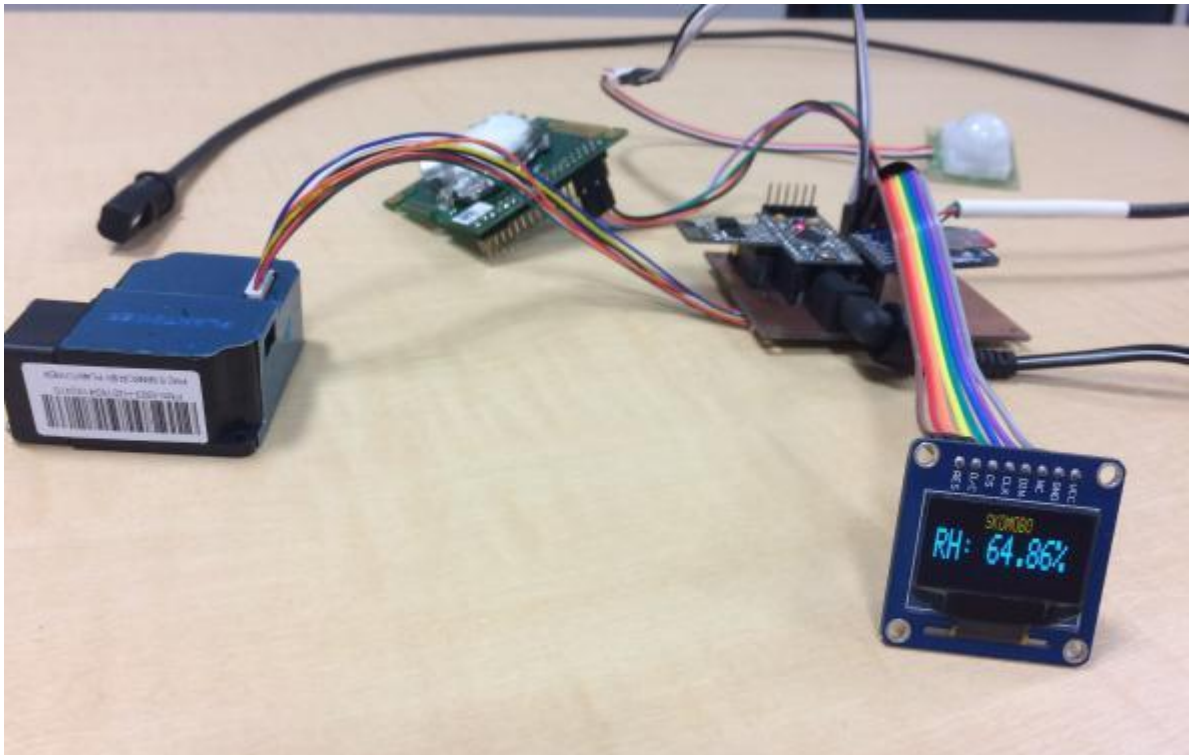
Next step 1 - SKOMOBO

- Cheaper monitoring, CO2, temperature, RH, particulates, noise, window use. Winter 2017 - SKOMOBO's in 100 classrooms throughout NZ.



Next step 2 Demo classrooms

- Demo classrooms matched control and treatment conditions,
- Differences will be thermal insulation, noise absorption, solar air heating,
- Wellington and Auckland