Towards a zero-energy building

Clever passive design in the new Waiheke Community Library has removed the need for air conditioning, while rooftop PV panels provide energy for lighting, fans and equipment. Will it be a zero net energy building?

THE COMMUNITY LIBRARY on Waiheke Island was completed in mid-2014 with an intention from the outset to produce a very low-energy building.

The installation of a modest 128 m² of photovoltaic (PV) panels in mid-2015 means the building can now be benchmarked against a net zero energy building. It is currently generating more electricity than it uses, with an excess yield during the summer months. Further monitoring will reveal how close the library is to being a zero energy building with increased output from the PVs and additional energy savings.

Passive design, not air conditioning

In order to reduce energy consumption, an important environmental design principle was to avoid air conditioning by using passive cooling techniques (see Figure 1).

Temperatures and sunshine hours in Waiheke are marginally higher than in Auckland, and annual cooling degree-days exceed heating degree-days. If air conditioning had been installed, it would have resulted in higher energy use for cooling than for heating.

Passive design features were included throughout the building:

- Extended eaves to the north that were calculated to completely shadow the glazed elevation over the summer while allowing the sun to penetrate into the building in the winter.

- A polished concrete floor around the perimeter that gives a high thermal mass to reduce overheating.

- Automated windows, controlled by internal air temperature, on both sides of the main library that allow through-ventilation and airflow at both high and low level.

- Large 2.4 m diameter ceiling fans that can silently supplement air movement for use on summer days with low wind speed.

- Windows on all sides in the main library that, together with skylights in the centre, give an even distribution of daylight throughout. Artificial lighting is controlled by both daylight and occupancy sensors.

- Heating in the winter by a radiant under-floor water system heated by heat pumps.

Positive staff feedback

Feedback from library staff indicates that internal temperatures have remained comfortable throughout the year without overheating.
Meters were installed on the lighting, heating and power circuits, and the overall energy consumption in the first year was around 51 kWh/m². However, this was distorted by the many operational and commissioning issues that occurred while the systems were being tuned and the occupants learned to use the building. This also does not take account of the contribution from the PV system that supplies electricity closely to the demand profile of the building.

Learnings identified further savings

Early lessons from the building indicate that there are further possibilities for reducing electricity use.

External lighting that remains switched on throughout the night contributes to a higher than expected energy use – about 10 kWh/m²/yr. While this could be switched off, the building has become a civic centre for Waiheke, and the lighting illuminates the public areas that surround the building.

Anecdotal evidence indicates that recommended artificial lighting levels are too high where an even distribution of daylight is achieved. Similarly, the high thermal mass of the building and contribution of internal heat gains in a highly insulated building indicate that winter internal heating temperature settings could be reduced.

High yield from photovoltaics

The PV panels are predicted to produce about 27,500 kWh/yr, based on Auckland weather data that underestimates solar radiation on Waiheke.

SolarCity, the installers, are monitoring the output and estimate that the system will exceed the predicted output by about 10%. The measured yield this year has exceeded – for the equivalent PV area - similar systems installed not only in Auckland but also in Pacific Islands such as Rarotonga and Funafuti.

Tweaking improves performance

As the control systems are tweaked and full monitoring continues, the performance of the building will improve. It already generates more electricity than it uses, resulting in excess yield in all but the winter months.

Further monitoring will reveal how close the likely increased output from the PVs and further energy savings could be to get the library to a zero-energy building.

Award winning

The building was the winner of the 2015 New Zealand Timber Awards, taking out the top award in the Commercial Architectural Excellence Category as well as the Overall Supreme Award.