RESEARCH

Solar potential of schools

An energy audit at Remuera Intermediate School also investigated the potential of photovoltaics to give the school an independent energy supply and income from feeding surplus electricity into the grid.

By Zhi Jian (David) Wong and **Hugh Byrd**, School of Architecture and Planning, The University of Auckland

Schools are a focal point of a community. The efficient running of their buildings is important for both the school's economical operation and to ensure they can keep operating during power outages or other hazards.

Recently the School of Architecture and Planning at The University of Auckland carried out an audit of the energy used by Remuera Intermediate School and looked at the potential for photovoltaics (PVs). The first priority when installing a renewable energy system is to reduce demand to a practical minimum, so recommendations were also included for this.

Study at Remuera Intermediate School

Historically, energy efficiency was not a high priority in schools, as the Ministry of Education paid fuel bills. Concerned about future energy prices, Remuera Intermediate School has taken steps to reduce their energy consumption and, with the help of their architect, to look ahead to future energy supply and demand.

This study was carried out in several stages:

- An energy audit established how the school compared with other benchmarks and what could be done to improve the energy performance.
- A questionnaire asked staff members how they could be more involved in reducing the school's energy use.
- An analysis calculated the potential roof areas available for photovoltaics and how much energy this could supply at different times.

Audit identified areas for savings

The overall energy consumption of the school is about 53 kWh/m²/year, slightly above the recommended target of 40 kWh/m²/year. Lighting is the largest single user, with almost as much energy used lighting the exterior as the interior (see Figure 1). The outside of the school is flood lit from dusk until dawn due to graffiti problems at night. This is cheaper than paying to have graffiti removed.

Gas use for heating is carefully monitored and varied in relation to daily temperatures. There is a minimum amount of cooling, and electric heating is confined to 'relocs' and extensions.

Recommendations were made to reduce electricity consumption:

- Good management could save at least 10% of the lighting energy at little or no cost. Questionnaire responses indicated lights could be turned off when rooms are unoccupied or when daylight was adequate.
- Install a more responsive external lighting system with detection control.
- Improve efficiency of lighting systems and their controls.
- Improve controls for heating systems.
- Greater general awareness of energy through feedback to both staff and pupils.

The first two recommendations alone could bring the overall energy consumption down to about 40 kWh/m²/year. While improved insulation standards are desirable, they are most effective when part of an extension or other repairs.

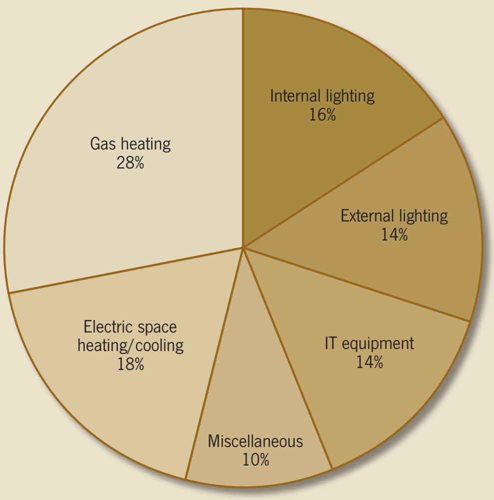

Figure 1: Annual energy consumption of Remuera Intermediate School by end use.

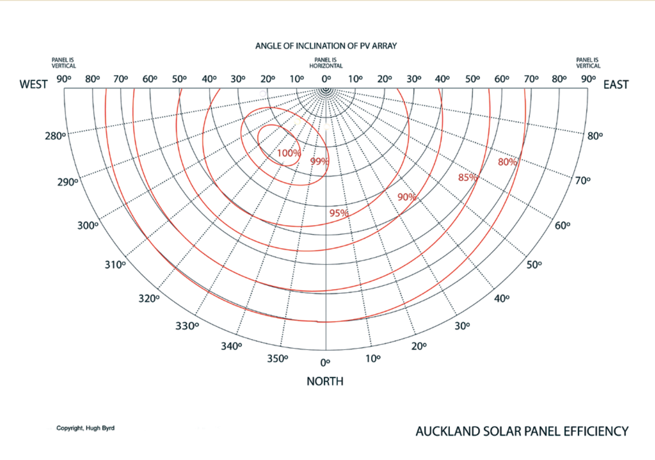

Figure 2: Protractor for calculating the efficiencies of photovoltaics in Auckland depending on orientation and tilt.

Photovoltaics potential

The roofs were then assessed for their photovoltaics potential. Figure 2 shows the varying efficiencies of a range of PV setups, derived from NIWA data for Auckland. Only roof slopes with a 95% efficiency or greater were considered, which excluded all south-facing roofs. Small and vulnerable roofs were also excluded. The total practical area for PVs was about 937 m^2 (see Figure 3).

Of the total annual energy available from the PVs, about 37% could be used directly by the school during its normal working hours from about 8.30 am to 3.30 pm. The remaining 63% would be available at weekends, holidays and towards the end of each day to be fed back into the grid. This would result in about a 30% saving on the electricity bill and a potential income from a feed-in tariff. The energy supply by PVs relative to electricity demand on typical winter and summer days is shown in Figure 4.

Increasing resilience

PVs offer the opportunity not only to reduce electricity costs but also to provide security to a community in the event of serious blackouts or other disasters.

Battery storage would be a costly option for a school. However, PVs with battery back-up offer schools subject to a high risk of load-sharing or disrupted electrical supply some resilience to maintain the operation of IT equipment, communications and basic lighting for teaching or community use.

Uneconomic until reasonable feed-in tariffs

To make PVs more cost-effective, the price for which they can sell electricity to the grid would need to be reviewed. If schools can reduce their electrical demand to a practical minimum, it may be appropriate to apply some form of preferential feed-in tariff.

Without reasonable feed-in tariffs, PVs can only meet about one-third of a school's annual electricity demand. This makes PVs uneconomic and the capital costs of installation prohibitive. Schools can only wait for the time that either feed-in tariffs become favourable or to lease their roofs to an electricity provider, now a common occurrence in some other countries.

Funding for this research was provided by The University of Auckland.

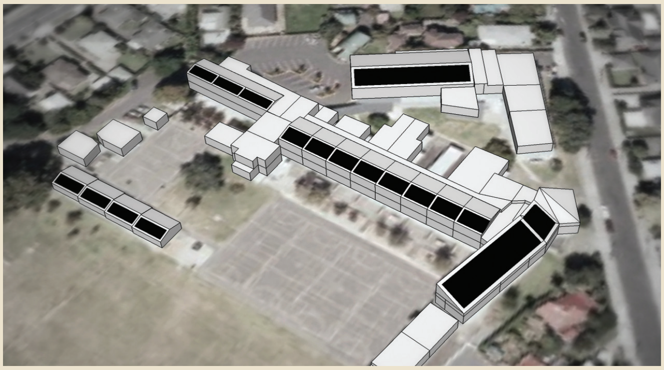

Figure 3: Possible PV layout on school roofs.

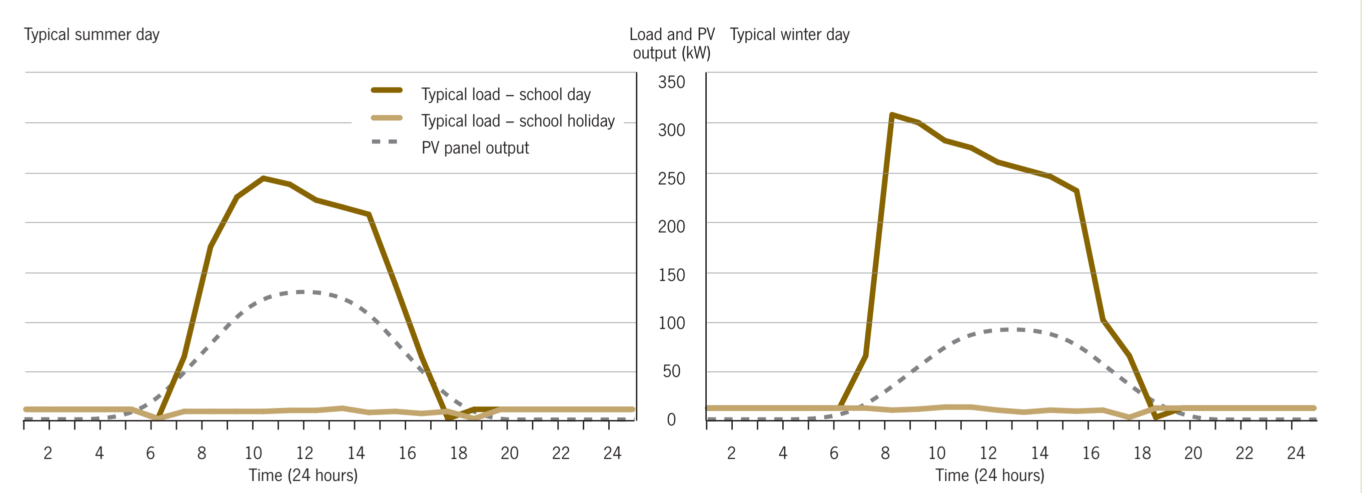

Figure 4: Comparison of the school electricity demand and supply by photovoltaics on typical days in summer (left) and winter (right).