Energy Resources

Solar energy

Ben Liley, Andrew Tait, and Greg Bodeker discuss what we know of New Zealand’s solar energy resource.

Solar radiation is the basis of most of our renewable energy. The sun’s heat evaporates water to condense as rain and snow for hydroelectric supply, and it creates the weather systems that give rise to wind and wave energy. Sunlight drives photosynthesis, directly or indirectly feeding almost all life on the planet, and so creating both modern biofuels and the fossil fuels from earth’s past. Solar heat and light can also be used directly, or converted to electricity using photovoltaic cells.

Incoming solar radiation

On average, 1,600 watts of visible, infrared, and ultraviolet radiation from the sun passes through each square metre at the top of earth’s atmosphere. Only about half of this radiation reaches the ground; the rest is absorbed or reflected by gases, clouds, and dust in the air. Cloud is the most variable of these factors, changing with both time and location. On average, cloud reflects about 20% and absorbs about 4% of all incoming radiation, but this understates the immediate local effects. Available solar energy under cloud can be less than a tenth of clear-sky values.

NIWA measures solar radiation at over 90 sites around New Zealand, and hourly totals are recorded in the NIWA climate database. Most instruments measure global irradiance: the rate of energy flow per unit area on a horizontal surface. Using these observations, we can estimate available solar energy, as in the map on page 9.

More detailed measurements are made at several key sites. At NIWA’s atmospheric research station at Lauder in Central Otago, the premier site in New Zealand for solar radiation study, the measurements include: separate direct sun and diffuse sky radiance; ultraviolet, infrared, and visible spectra; all-sky images analysed for cloud cover; and a wide range of atmospheric-gas concentrations. These detailed measurements are used to support and interpret the national climate data series of solar radiation.

Effects of cloud

To better understand the patterns of cloudiness that determine the availability of solar energy, we use satellite images of New Zealand to make maps of average cloud cover and type. The map below shows the average percentage of clear skies as the satellite passed overhead.

Combining this pattern of cloudiness with the effect of latitude (the sun angle, discussed below) explains much of the pattern in measured irradiance. The higher proportion of clear-sky days around Nelson and Blenheim, and over the Manawatu, Bay of Plenty, and Hawke’s Bay, explains the higher solar irradiance there, and Northland benefits from its higher sun angles. The relationship is more complex for Canterbury through to Central Otago, as cloud type and thickness make more difference here. NIWA research is developing a better understanding of these effects, leading to better maps of surface radiation and better prediction of available energy.

Harnessing solar energy

Two-thirds of energy use in New Zealand homes is for heating – one-third for space heating and another third for water heating. The solar energy arriving at the roofs of New Zealand homes over the course of a year is twice

A 360-degree, all-sky image taken at NIWA in Lauder.
Ben Liley and Dr Greg Bodeker study atmospheric processes and radiation at NIWA in Lauder. Dr Andrew Tait studies climate variability at NIWA in Wellington.