
Photo by IT Power

View of the south roof of Nauru College

Grid-connected PV in the Pacific

As part of the European Union's Support to the Energy Sector in Five ACP Pacific Island Countries Programme (REP-5), administered by the Pacific Islands Forum Secretariat and managed by a consortium led by IT Power, the Government of Nauru requested that a grid-connected PV system be installed on the roof of one of the secondary schools in Nauru.

BY PHILIPPE MCCRACKEN


Photo by IT Power


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Inverter room (top) and PV array on north roof (bottom)

A Country in Need

Located 50 km south of the Equator in the Pacific Ocean, Nauru is one of the smallest, most remote countries in the world. At 21 km^2, it is less than half the size of Manhattan Island, and with a population of only 10,000 is one of the least populous independent countries. In the second half of the 20th century, Nauru enjoyed one of the highest per-capita incomes in the world thanks to its phosphate deposits. However, over the past 20 years these deposits have been depleted and in the early 2000s the country's economy collapsed. It now is one of the poorest countries in the world, and it struggles to afford the goods and services to which it had grown accustomed. Electricity generation has suffered due to a lack of maintenance of equipment at the power station and on the transmission and distribution network. As there is no longer sufficient generating capacity at the power plant, power is currently available for only 16 hours per day on a rotating load-shedding schedule. Some buildings, such as the airport, the hospital, and main government buildings, receive power 24 hours per day. All of Nauru's electricity comes from diesel generators, meaning that it is highly vulnerable to sudden increases in the price of oil.

In its national energy policy, the Government of Nauru recognizes that its dependence on fossil fuels makes its economy vulnerable to the price of oil, which it cannot control. It, therefore, commits itself to producing 10% of its electricity through renewable resources by 2020. As the island of Nauru is very small, there is no hydrological potential. The wind resource has not been properly assessed, the strip-mining of phosphate over the past century has left only a limited amount of arable land so biofuels are not practical, and ocean technologies are not at a point where they can be reliably installed and maintained in a country that is remote, has a very steep drop in its sea floor past its fringing reef, and has major cash-flow problems. The only practical renewable energy technology for power generation at this point is solar photovoltaics.

The Solution

The European Union's Support to the Energy Sector in Five ACP Pacific Island Countries Programme (REP-5) is administered by the Pacific Islands Forum Secretariat and managed by a consortium led by IT Power and including Transenergie and ADEME. Its objective is to increase electricity access to outer-island populations through the use of renewable energy, and implement energy efficiency and renewable energy projects on islands that already have an electricity grid. The program is being implemented in Niue, Nauru, Palau, the Federated State of Micronesia and the Marshall Islands.

REP-5 has provided Nauru with 1.5 million euros for renewable energy and energy efficiency projects. As part of its REP-5 allocation, the Government of Nauru requested that a grid-connected PV system be installed on the roof of Nauru College, one of the secondary schools. The site was chosen because the building was only a few years old and its roofs were in good condition as well as being oriented east-west and being inaccessible to thieves and vandals. The college had the additional benefit of being close to the power station so instabilities in the electricity supply could be minimized, and it could also be put on the 24-hour power circuit, so that the PV system could feed into the grid dur-

ing sunlight hours. The Nauru Utilities Authority agreed to maintain the system. The PV system has a maximum capacity of 46 kWp and is composed of:

- 7 SMA SMC5000A inverters (5,000 W)
- 196 Solarnova SOL 206 GT modules (206 Wp polycrystalline)
- 28 Solarnova SOL 200 GT modules (200 Wp polycrystalline)

The system was installed on the north and south roofs of Nauru College in early October 2008, at an installed cost of 6.37 euros/Wp. As Nauru is only 50 km south of the equator, placing the panels on both roofs is not expected to result in a dramatic decrease in yield versus putting all the modules on the north roof. The modules were connected to the inverters in arrays of 2 strings of 14 modules each (28 modules total per inverter). All 28 of the 200 Wp modules were placed on the north roof and connected to a single inverter.

Results So Far

A data logger was installed on the system for monitoring its performance. As no internet connection is available on-site the only way of retrieving data from the data logger is to download it directly onto a laptop. The data were downloaded on April 23rd, 2009 and analyzed to identify trends and potential problems.

As the data were recorded between October and April—summer in the southern hemisphere—the sun is in the southern sky at noon (Nauru is very close to the Equator) so the arrays on the south roof produced more energy than those on the north roof. In the winter, the sun will be in the northern sky at noon and the arrays on the north roof are expected to produce more. The data for the end of April show that north roof arrays are beginning to produce more energy than the south roof arrays, as the sun moves from the southern to the northern sky. Between October and April, arrays on the south roof produced 14.1% more electricity than those on the north roof, with the maximum difference being over 28%. Over the course of a year, however, the difference in production between arrays on the south roof and the north roof is expected to be negligible. No difference in production was noticed between the array made of the 200 Wp modules and the other arrays (206 Wp modules) on the north roof. The reliability of the inverter had a more significant effect on production.

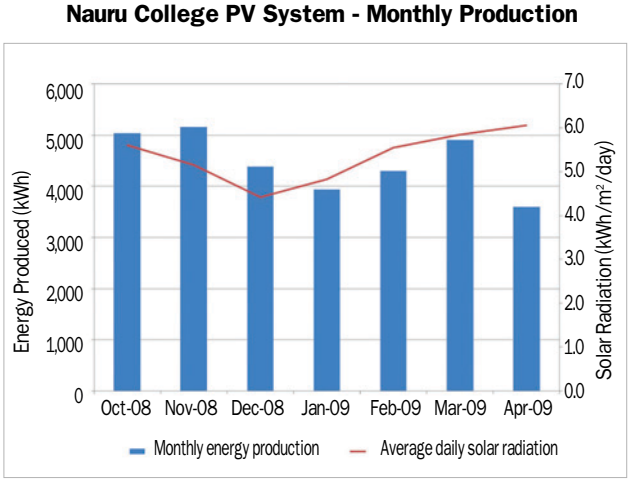

Figure1. Monthly electricity generation, October 4th, 2008 to April 23rd, 2009 (Source: IT Power)

The average plant production was 4,600 kWh/month. This is slightly less than the 5,000 kWh/month production that was expected, due to the following factors:

The Grid's Poor Quality Is Adversely Affecting the PV System

This issue was not expected to be as severe as it is. When the system was installed and commissioned, the inverter settings were changed so that the inverters would accept a wider range of voltages and frequencies. However, of the 7 inverters only 2 show a significant resistance to riding through faults, with one in particular almost never being perturbed by voltage or frequency faults. Most faults appear to be caused by the grid frequency going out of range. The settings on the inverters will have to be checked again to ensure that they have been properly kept since their installation.

The Availability of the Grid Is A Problem

Nauru College was put on the 24-hour grid in order to provide it with power during daylight hours, so that the PV system could feed in to the grid. However, every month there are roughly 3-4 entire days when the grid is not available. When the grid does become available, it can frequently go down for several minutes or even hours at a time. This greatly impacts the performance of the PV system (see Figure 1, January to April production). Most of the grid outages were very brief, however.

A Bright Future

Another inspection of the PV system will take place in early August 2009, and more data downloaded and analyzed. The inverter settings will also be checked to make sure that they are set to ride through the frequency faults that have been hampering them for the past several months. The Nauru Utilities Authority is currently working to increase its generating capacity in order to be able to provide 24-hour power. It is hoped that by then the interruptions that have caused the PV system to shut down for hours or days at a time will be dramatically reduced or even eliminated altogether. PV

Philippe McCracken is Project Engineer of IT Power (www.itpower.co.uk).

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In its national energy policy, the Government of Nauru recognizes that its dependence on fossil fuels makes its economy vulnerable to the price of oil, which it cannot control. It, therefore, commits itself to producing 10% of its electricity through renewable resources by 2020. And the only practical renewable energy technology for power generation in Naura is solar photovoltaics.