Challenges for Renewable Energy Integration in the Pacific Islands Grids

Herb Wade

Why are There Challenges?

- Actually there are no serious challenges integrating most renewable energy generators into a grid as they just represent a different type of ordinary generating plant
  - Hydro
  - Geothermal
  - Biomass
  - Biofuel
  - Biogas

The problem is the variability of some sources

- Variable inputs are provided by
  - Solar
  - Wind
  - Wave
  - Tidal

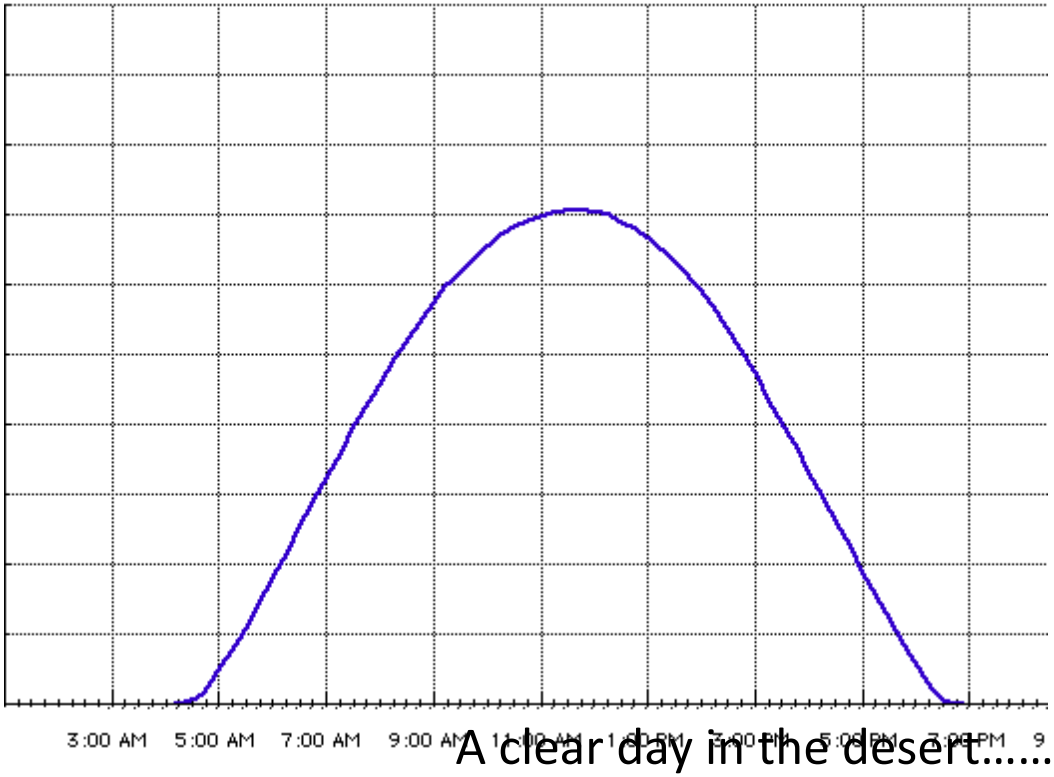
But the main problem is not just variability

- Problem with rates of change of power output
  - Engines have to keep up with the change
    - Fastest changes are with wind in stormy weather
    - Solar can change 80% in a few seconds
    - Wave more slowly
    - Tidal, very slow
      - And predictable

Integrating Solar

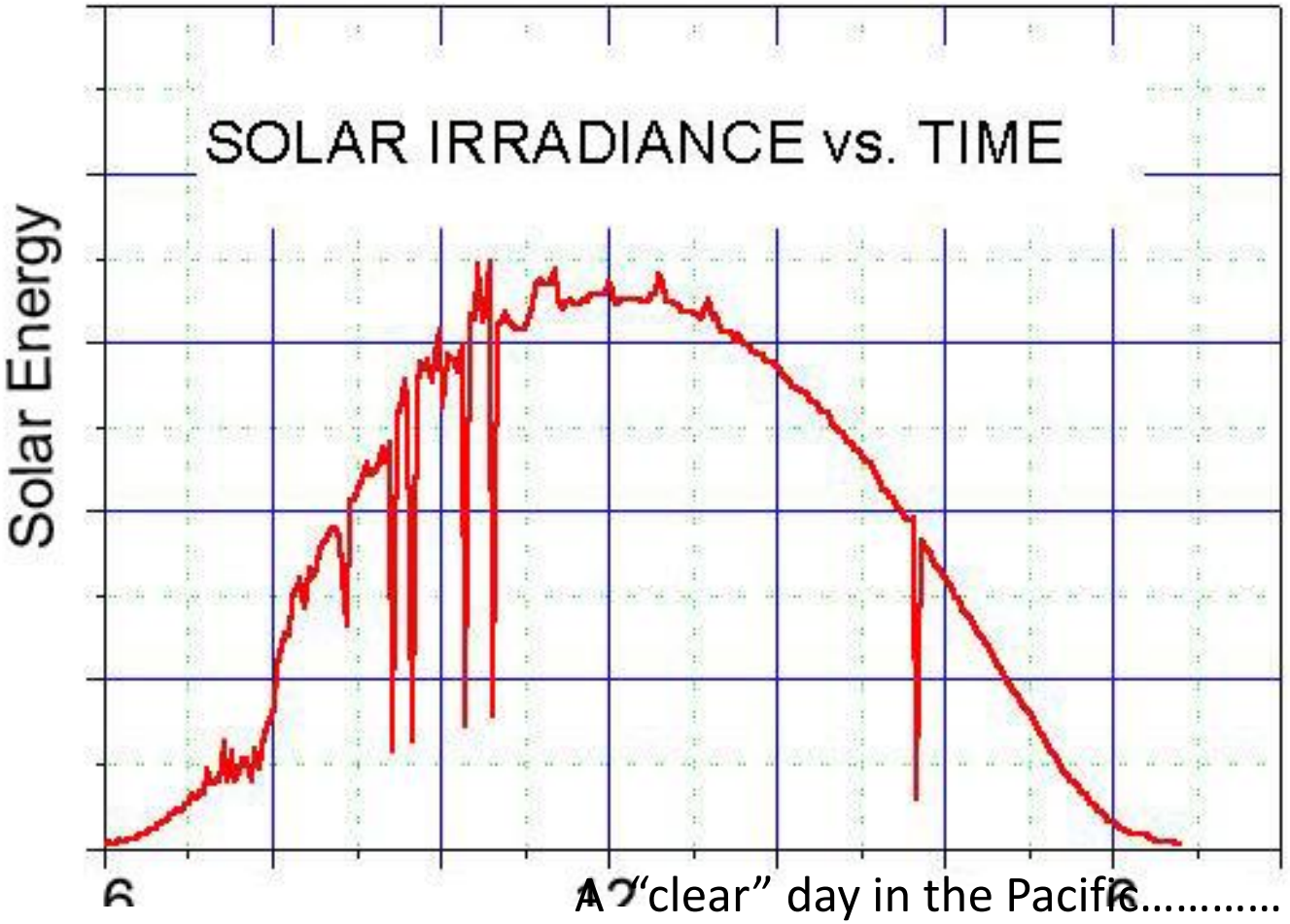
- Because solar only is available at high levels between about 0900 and 1500, the load at that time is the only one that is relevant with regards to solar design and integration unless there is substantial storage installed.
  - Generally, use the noon-time load as the guiding parameter because that is when the solar is the strongest and there is the greatest possible change of output if clouds come by.

What solar enthusiasts want you to think solar input is like



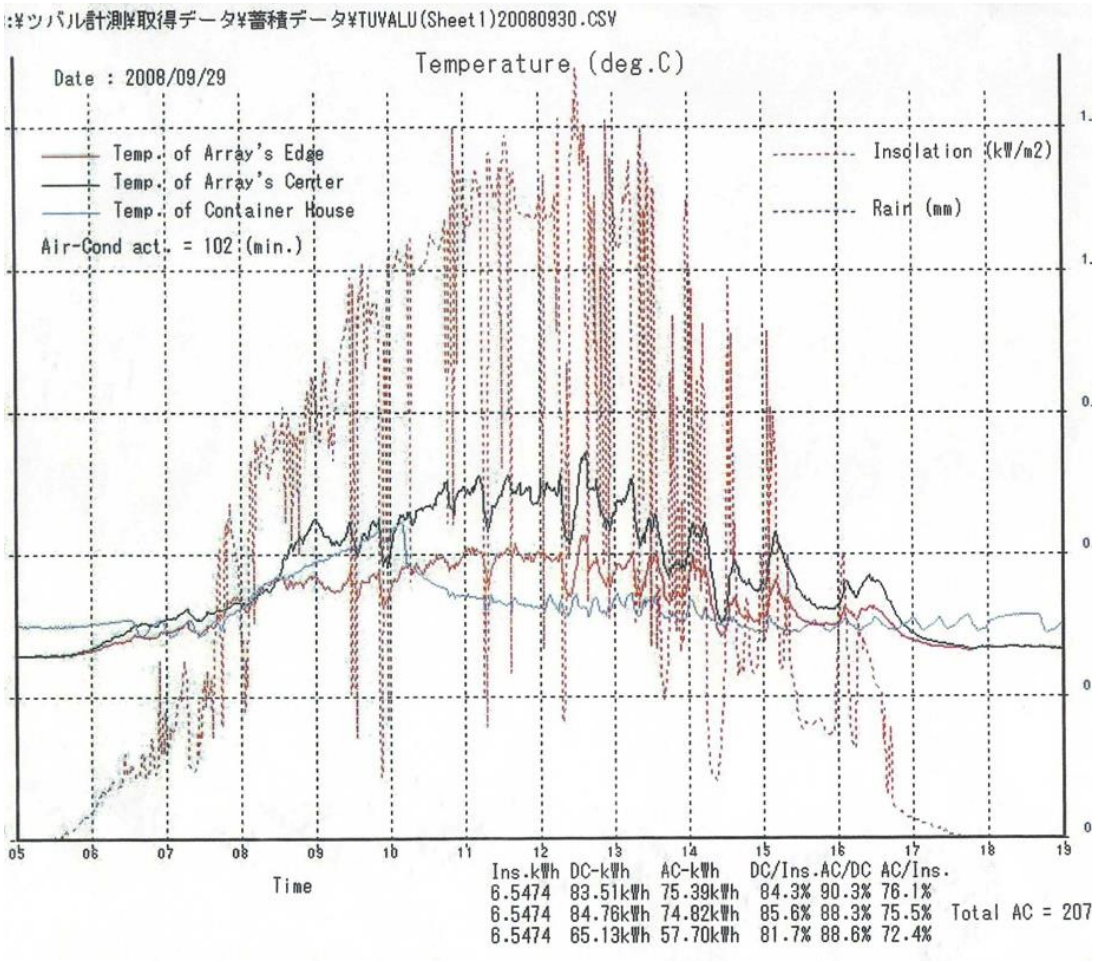
A clear day in the desert……

Solar generation in real life



A “clear” day in the Pacific……

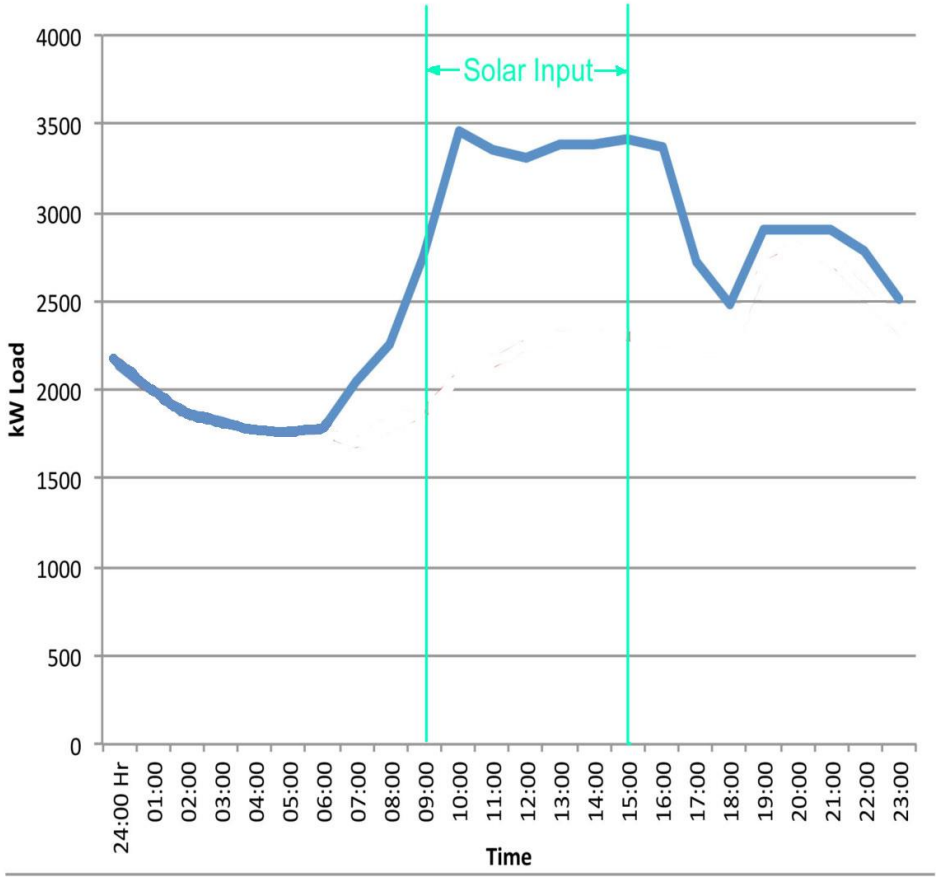
And a partly cloudy day in Tuvalu……



Also of concern is the pattern of the load…..

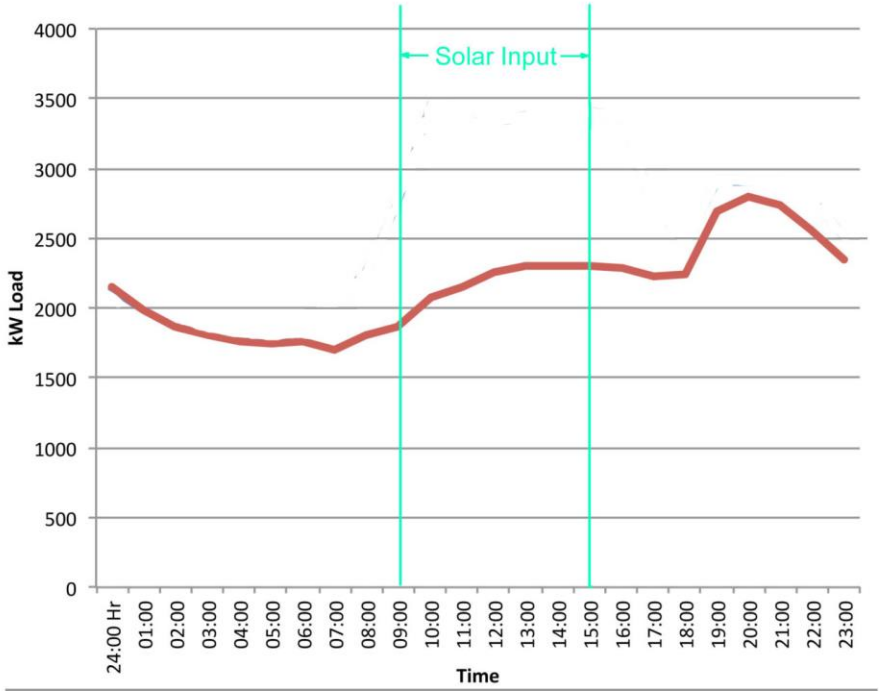
Noon time peak load – urban grid

- Good for grid-connected solar input
- Typical of larger urban utilities
  - Solar helps offset the peak
  - Often peak is air conditioning which is also dependent on solar input



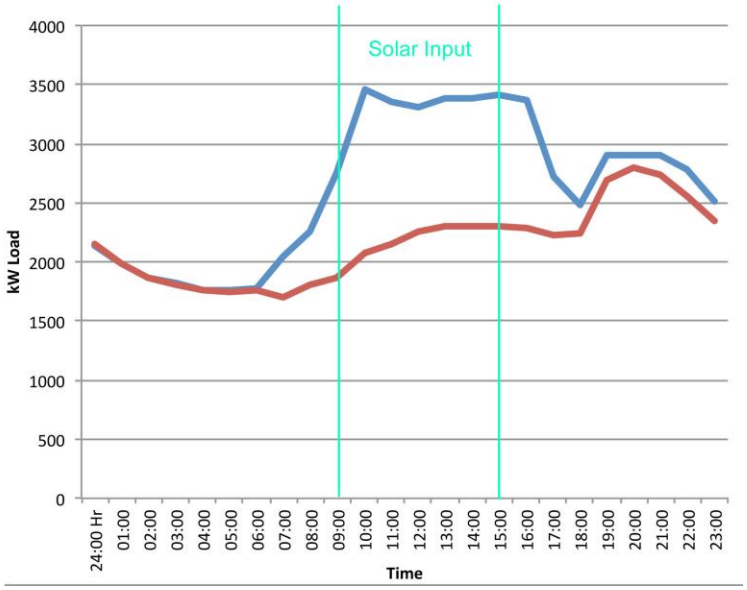
Evening Peak –
non-urban grid

- Not so good for grid connected solar
- Typical of small utilities with no major urban base
  - Can only provide a small benefit because the solar does not arrive when the load needs it



Rule of Thumb for Solar

- Once you see the noon-time peak for solar reaches 20% of the noon-time load, there need to be concerns though instability may not occur
until 50% or more if the solar is widely dispersed..
  - Don't forget noon time peaks are usually related to A/C use so Saturdays and Sundays may have a much lower noon-time load. Blue graph = weekday load and red graph = Sunday load which is
typical of non-urban loads because the government and many business offices are closed and their A/C is off

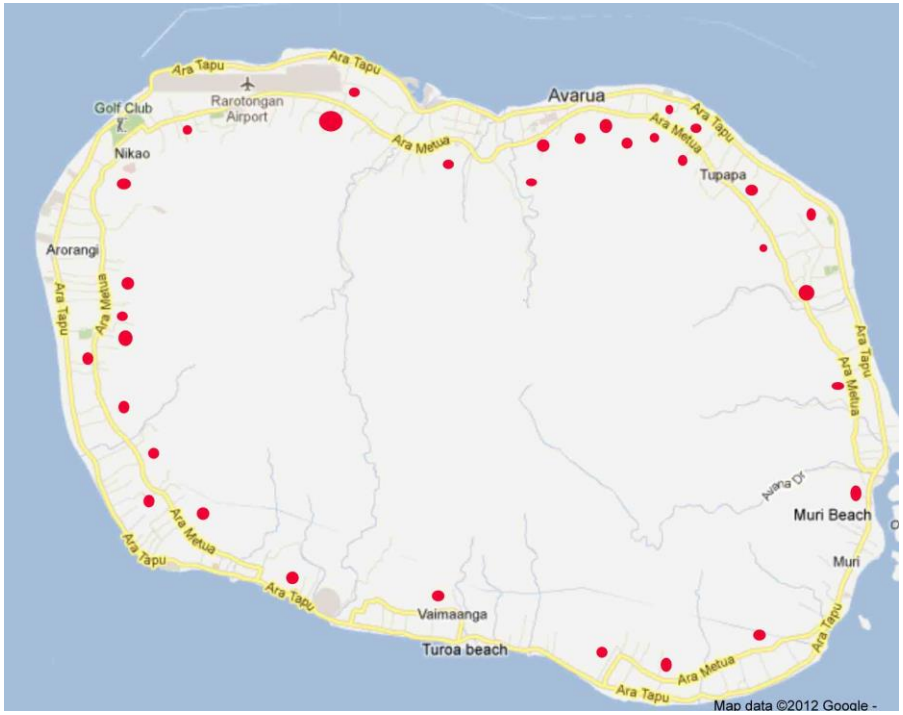


Increasing penetration

- What happens when you go over the limit?
  - It is much like a very large load going on and off when a cloud goes by
  - So to make it possible to go higher, split the solar generation into several parts and spread it around the island so it all does not change at the same time.

Single large solar installation for Rarotonga

Dispersed small arrays for Rarotonga



Then what

- 40% penetration of the noon load or even somewhat more can probably be achieved without significant problem with dispersed solar but to go much higher, energy storage and controls to help slow down and/or lower the extent of variations may be needed.

- Storage Options include
  - Pumped storage (existing hydro is interesting)
  - Batteries (the most common but rather expensive approach)
  - Flywheels (not a major contender)
  - Compressed air (requires special conditions not found in most of the Pacific)

How to predict what can reasonably be accepted?

- By using a dynamic model of the grid and trying different types of solar inputs in the model and different loading conditions to see the predicted results
  - Model must be validated for the type of grid in use (mostly diesel in the Pacific)