



**Renewable Energy Consulting**

# **Renewable Energy for Off Grid and Developing Communities**

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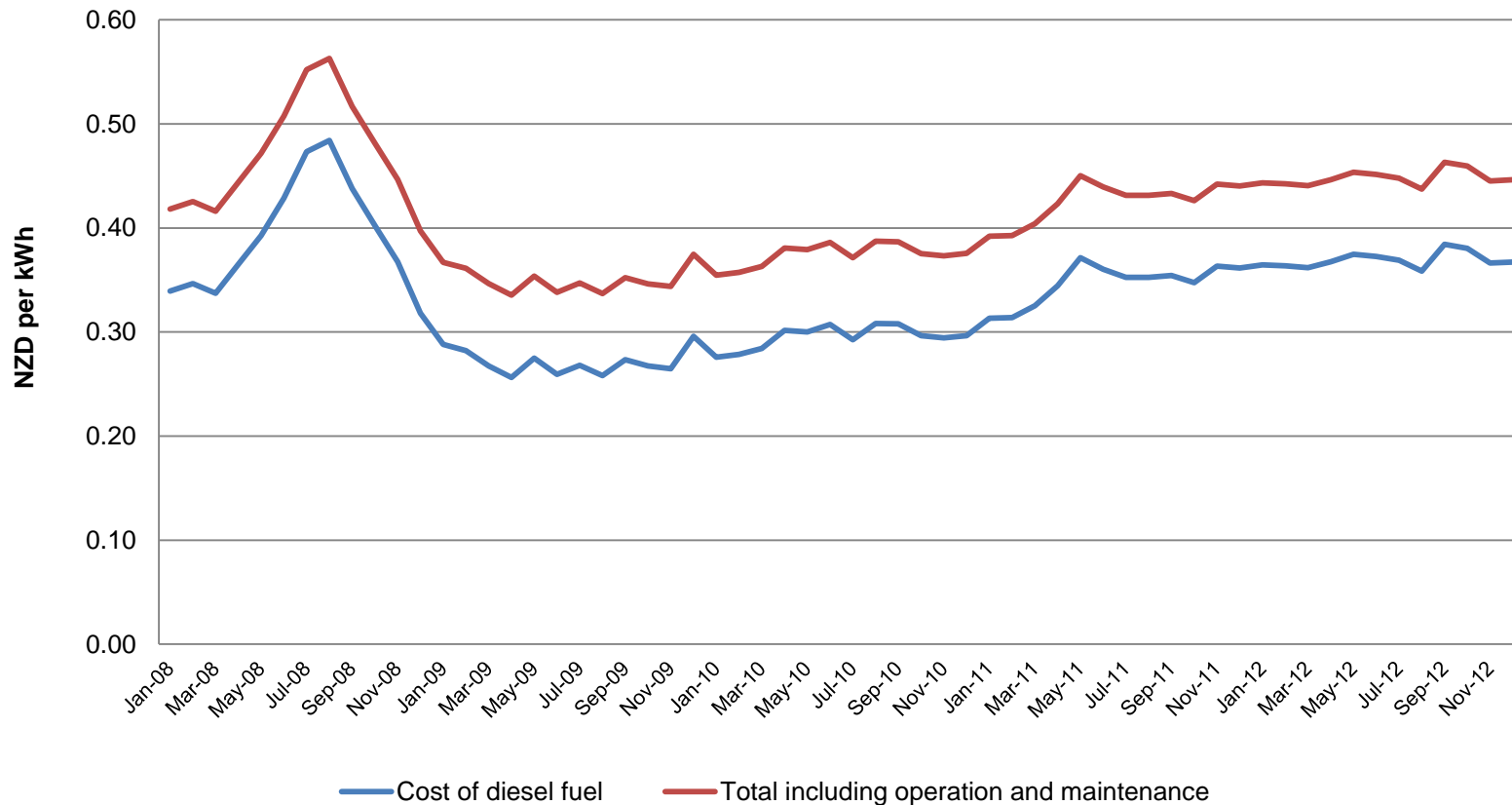


## Diesel based generation – Economic Issues

- Cost of diesel is market dependant = difficult to budget
- Samoa paid \$1.20/l
- Outback Aus paying up to \$2.00/l
- Large consumers \$0.80/l



# Fluctuation of diesel cost (=tariff) in Samoa





# Palau Utility uses this formula to calculate Tariff

- The description of the Automatic Fuel Price Adjustment Clause (AFPAC) in Schedule E of the Electric Service Rates, (June 2008) is complex.
- 
- Schedule E states that:
- 
- The Fuel Rate for the next month = Fuel rate for current month + Fa
- 
- Where:
- $$Fa = \frac{(PD * VD) + (FU - FO)}{Sk} \quad (-) \text{ Current Fuel Rate}$$
- 
- Fa = Automatic fuel cost adjustment
- PD = Next month projected diesel price
- VD = Next month projected volume of diesel consumption
- FU = Excess actual fuel cost of prior month over estimated
- FO = Excess estimated fuel cost of prior month over actual
- Sk = Estimated kWh sales for next month
- 
- An easier to understand literal interpretation of this Fuel Rate formula is:
- 
- Fuel Rate (\$/kWh) =
- 
- $$\frac{(\text{Forecast NM \$ / gallon} * \text{Forecast NM gallons}) + (\text{Excess PM fuel \$ over forecast} - \text{Excess PM forecast fuel \$ over actual})}{\text{Forecast NM electricity kWh sales}}$$
- 
- Where:
- NM = Next month
- PM = Prior month



## Diesel based generation – Environmental Issues

- CO<sub>2</sub>e per kWh:
  - Diesel 0.58 to 1kg
  - Coal ~1.16kg
  - PV ?
- Tokelau – discard drums in the ocean
- Antarctica – major concern – 17 papers published
- Africa – drums used as water tanks













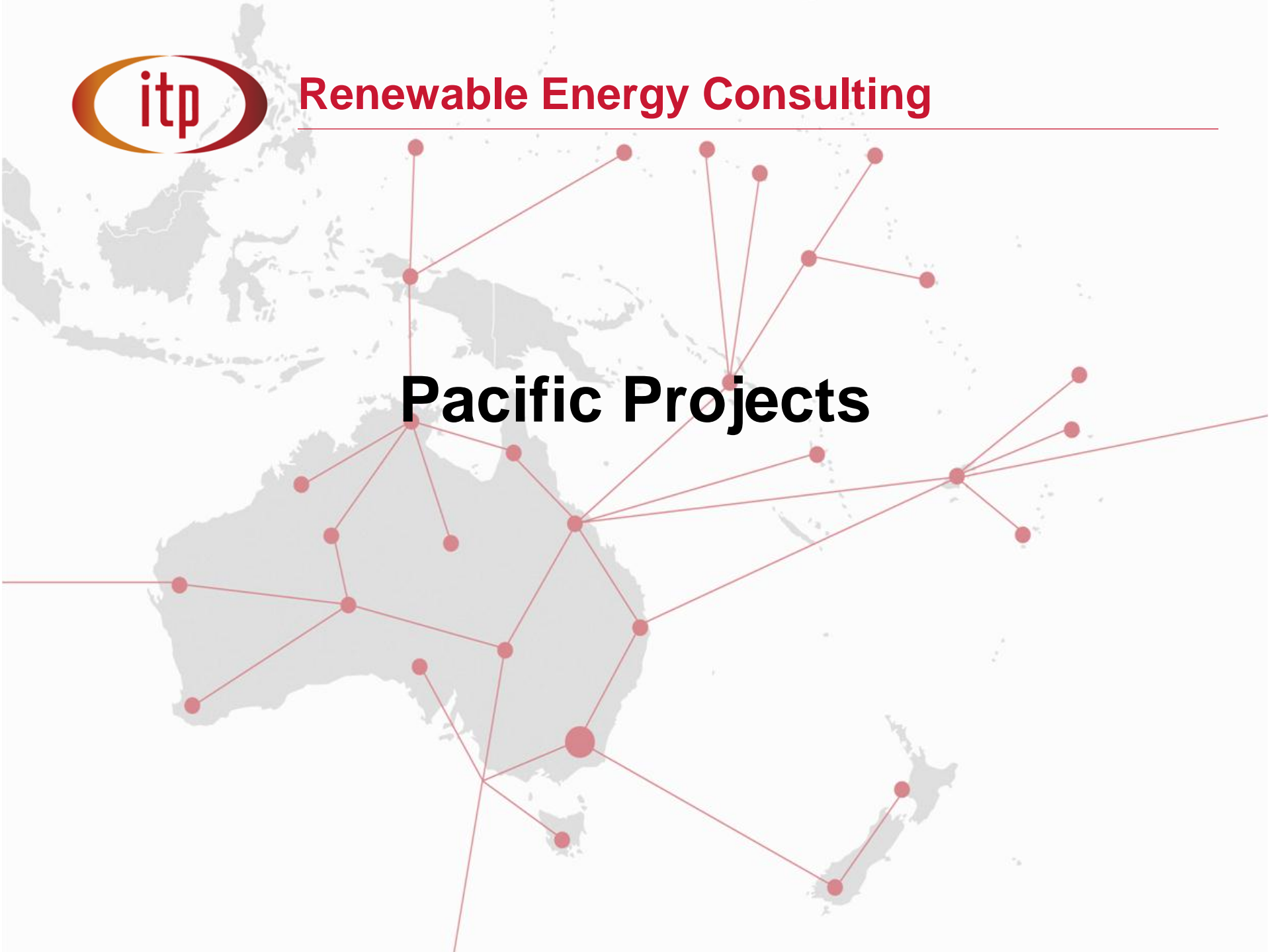




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# **Pacific Projects**











# INTRODUCTION

- Pacific Island Nations face particular challenges in the energy sector
- Previously mainly small-scale, off grid renewables
- Recent shift to larger scale grid-connected renewables







## Samoa

- ~194,000 people
- ~USD 5,670 per person/yr
- two main islands, Savai'i and Upolu
- 60% elec from diesel, 40% hydro

## Tokelau

- ~1,500 people
- ~USD1,000 per person/yr
- three atolls
- no significant land > 2m above sea level
- most food and drink is shipped to the islands

## PV System details



### Samoa

- 400kW grid-connected
- Rooftop mounted
- 600kW possible on both Upolu and Savai'i

### Tokelau

- 1MW PV over 3 x stand alone
- Batteries
- 150% of electricity needs
- First two arrays complete



# Social benefits

- Reliable power supply with predictable costs = ability to plan micro-business
- Students have the ability to study at night time
- Reduced noise in residential areas
- Local employment, construction and operation
- Utility staff learn skills necessary for long-term management, operation and maintenance of the PV system





# Economic benefits

- Reduced exposure to fluctuating and rising diesel prices
- Improved balance of payments
- Fuel cost saving:
  - Samoa ~236,000l/yr,
  - Tokelau ~73,000l/yr
- Tokelau - 24hrs electricity/day (currently only 15-18)
- Improved power quality
- Reliable and inexpensive electricity boosts economic growth
- Local employment and capacity building





# Environmental benefits

- Avoid 195 tonnes CO<sub>2</sub>-e GHG emissions per year
- Avoid diesel spills
  - both on land and in water
- Zero noise



















# Tokelau - Fakaofa system

- 365kW
- 1,584 panels
- 33 Battery inverters
- 44 DC/DC chargers
- 77 String inverters
- 528 Batteries
- 14,000 Bolts
- Concrete foundations drilled with bolts and leveling nuts
- Leveling by laser
- All framework cut, drilled and then assembled in NZ, BEFORE being sent for anodising

































# ITP Island Projects

- Tokelau – 1MW off grid
- Samoa – 400kW plus grid connect
- Norfolk Island – strategy for high penetration PV on diesel grid
- Cape Barren Island – Owner's engineer on wind / diesel / solar hybrid
- Palau – 100kW grid connect
- Nuie – Owner's engineers for 100kW grid connect
- Palau – Develop PPA framework for ~ 1MW grid connect
- Nauru – Development of electricity (and water) standards
- And REP5 – Strategy for deployment of RE in five pacific Nations



# ITP Current Activity

- Cooks
- Tuvalu
- Tokelau
- Samoa
- Vanuatu
- Fiji
- Afghanistan
- South Africa
- And not forgetting, Australia

# Questions?

