- The Water Energy Nexus -

Energy Footprint for Water Supplies in Pacific Islands

PECC Seminar, Auckland, 8-11 December 2009
“Toward energy autonomous public utilities"

SOPAC

Marc Overmars, Water Adviser

Introduction SOPAC
Access to Water and Sanitation
Energy Use in Reticulated Water Supplies
Water Demand Management

Some examples from the region:

Surface Water Intakes
Solar Pumping
Wind Energy
Groundwater Pumping
Desalination

Organisational Overview

- Intergovernmental Organisation
- Established 1972
- 21 members
  - 14 Island States
  - 5 Territories
  - Australia and New Zealand
- Member of Council of Regional Organisations in the Pacific (CROP)
- Regional centre
  - Applied science
  - Technical expertise and support

Mandate

Contribute to **sustainable development**, reduce **poverty** and enhance **resilience** by supporting

- Development of natural resources
- Investigating natural systems
- Managing vulnerabilities

Responsibilities to Coordinate

- Disaster Risk Management
- Energy
- Water and Sanitation
- Applied Geosciences

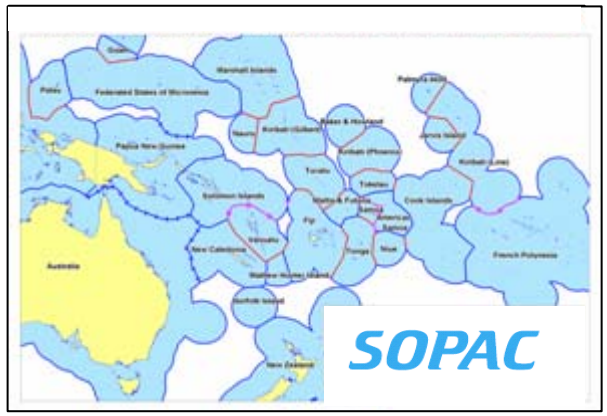
Established Coordination Mechanisms

- Pacific Disaster Risk Management Partnership Network
- Pacific Water Partnership

Member Countries

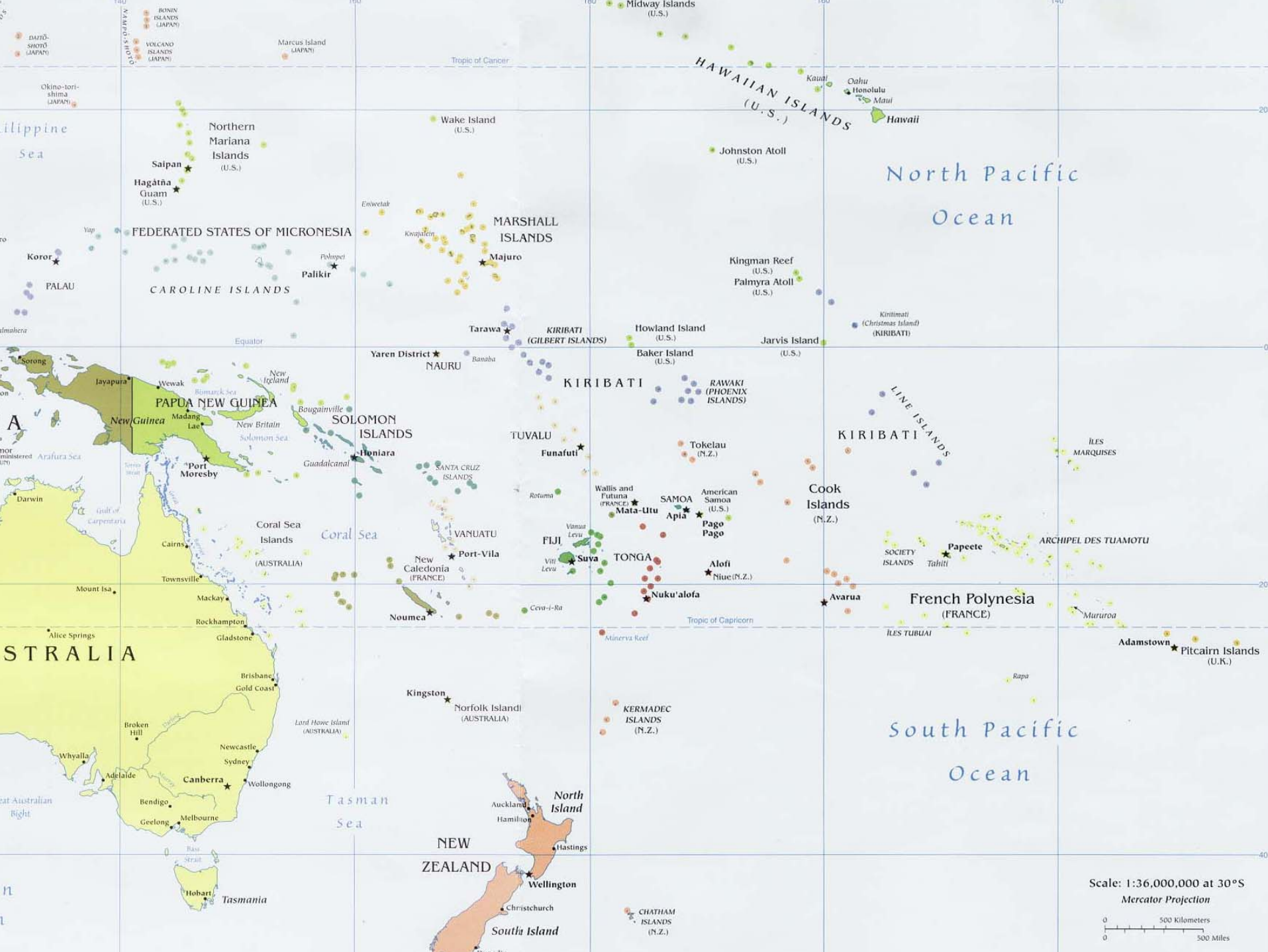
MEMBER COUNTRIES

- Australia
- Cook Islands
- Federated States of Micronesia
- Fiji Islands
- Guam
- Kiribati
- Marshall Islands
- Nauru
- New Zealand
- Niue
- Palau
- Papua New Guinea
- Samoa
- Solomon Islands
- Tonga
- Tuvalu
- Vanuatu



ASSOCIATE MEMBERS

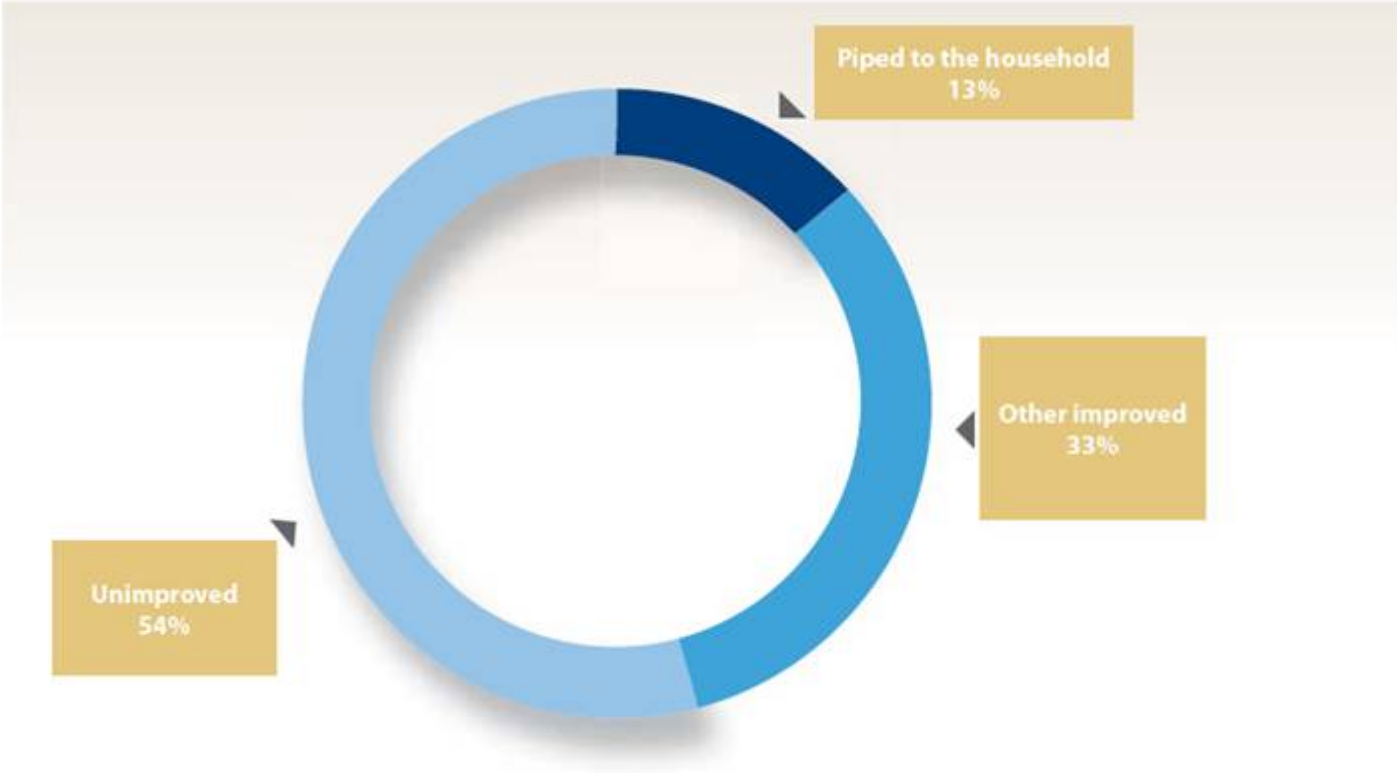
- American Samoa
- French Polynesia
- New Caledonia
- Tokelau


Midway Islands (U.S.)
HAWAIIAN ISLANDS (U.S.)
Kauai
Oahu
Honolulu
Maui
Hawaii
Tropic of Cancer
Wake Island (U.S.)
Johnston Atoll (U.S.)
North Pacific Ocean
Northern Mariana Islands (U.S.)
Saipan
Hagåtña
Guam (U.S.)
Eniwetak
MARSHALL ISLANDS
Majuro
Kwajalein
FEDERATED STATES OF MICRONESIA
Yap
Koror
PALAU
Pohnpei
Palikir
CAROLINE ISLANDS
Kingman Reef (U.S.)
Palmyra Atoll (U.S.)
Kiritimati (Christmas Island) (KIRIBATI)
Tarawa
KIRIBATI (GILBERT ISLANDS)
Howland Island (U.S.)
Baker Island (U.S.)
Jarvis Island (U.S.)
Equator
Yaren District
NAURU
Banaba
KIRIBATI
RAWAKI (PHOENIX ISLANDS)
LINE ISLANDS
KIRIBATI
Sorong
Jayapura
Wewak
New Ireland
Bismarck Sea
PAPUA NEW GUINEA
New Guinea
Madang
Lae
New Britain
Bougainville
SOLOMON ISLANDS
Solomon Sea
Honiara
Guadalcanal
Arafura Sea
Torres Strait
Port Moresby
SANTA CRUZ ISLANDS
TUVALU
Funafuti
Tokelau (N.Z.)
ÎLES MARQUISES
Rotuma
Wallis and Futuna (FRANCE)
Mata-Utu
SAMOA
Apia
American Samoa (U.S.)
Pago Pago
Cook Islands (N.Z.)
Darwin
Gulf of Carpentaria
Coral Sea Islands (AUSTRALIA)
Coral Sea
Cairns
VANUATU
Port-Vila
Vanua Levu
FIJI
Suva
Vitu Levu
TONGA
Alofi
Niue (N.Z.)
SOCIETY ISLANDS
Papeete
Tahiti
ARCHIPEL DES TUAMOTU
Townsville
Mount Isa
Mackay
New Caledonia (FRANCE)
Nuku'alofa
Avarua
French Polynesia (FRANCE)
Noumea
Ceva-i-Ra
Tropic of Capricorn
Minerva Reef
Rockhampton
Gladstone
Alice Springs
Mururoa
ÎLES TUBUAI
Adamstown
Pitcairn Islands (U.K.)
Brisbane
Gold Coast
Rapa
Kingston
Norfolk Island (AUSTRALIA)
KERMADEC ISLANDS (N.Z.)
Broken Hill
Lord Howe Island (AUSTRALIA)
Newcastle
Sydney
Whyalla
Adelaide
Canberra
Wollongong
South Pacific Ocean
Great Australian Bight
Bendigo
Melbourne
Geelong
Tasman Sea
Auckland
North Island
Hamilton
Hastings
NEW ZEALAND
Bass Strait
Wellington
Hobart
Tasmania
Christchurch
South Island
CHATHAM ISLANDS (N.Z.)
Scale: 1:36,000,000 at 30°S
Mercator Projection
0 500 Kilometers
0 500 Miles

Access to Water

For every eight people in the Pacific island countries, only one had access to piped water into their dwelling, plot or yard in 2006.

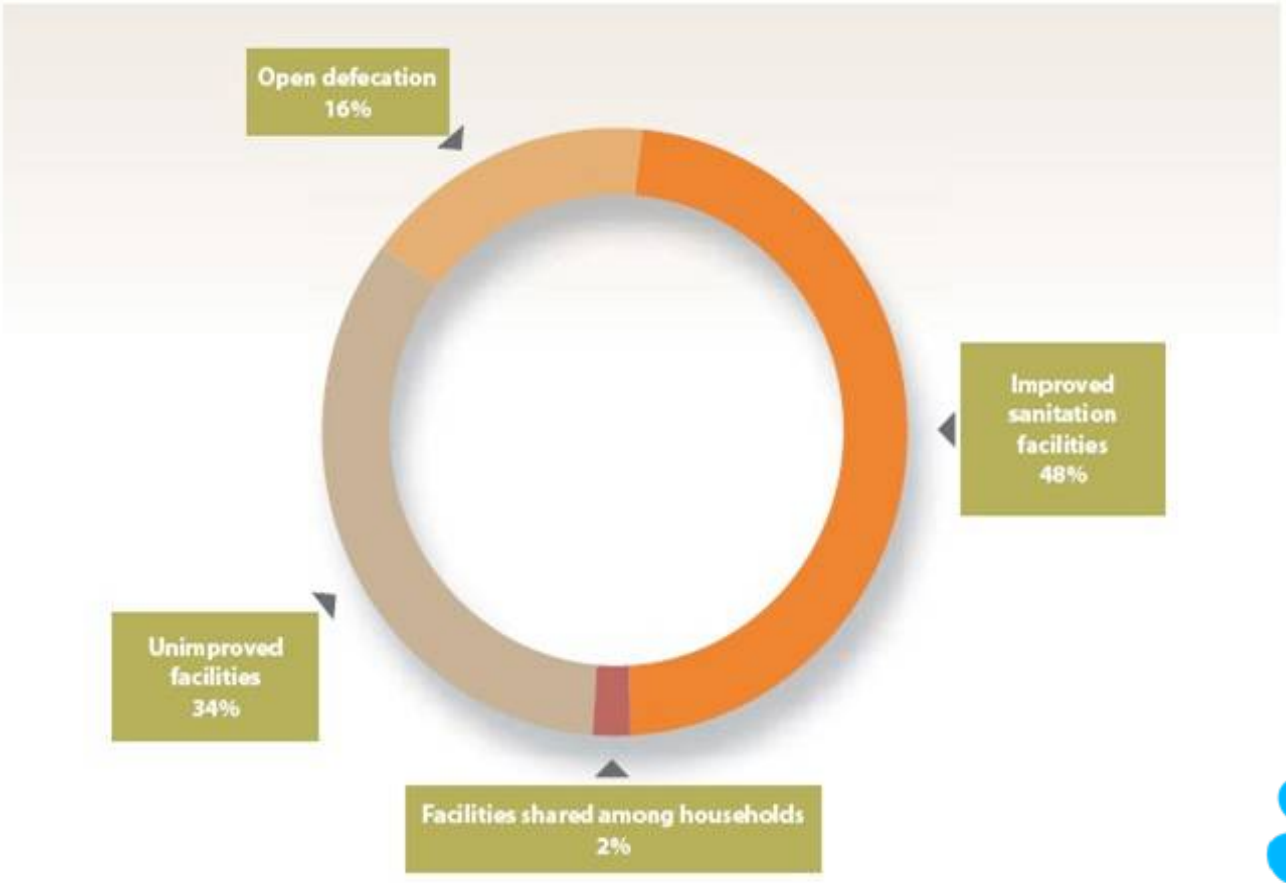
Proportion of people using different types of drinking-water sources in the Pacific island countries, 2006



Access to Sanitation

Less than 10 % of the Pacific population is connected to a reticulated wastewater system.

Proportion of people using different types of sanitation practices in the Pacific island countries, 2006



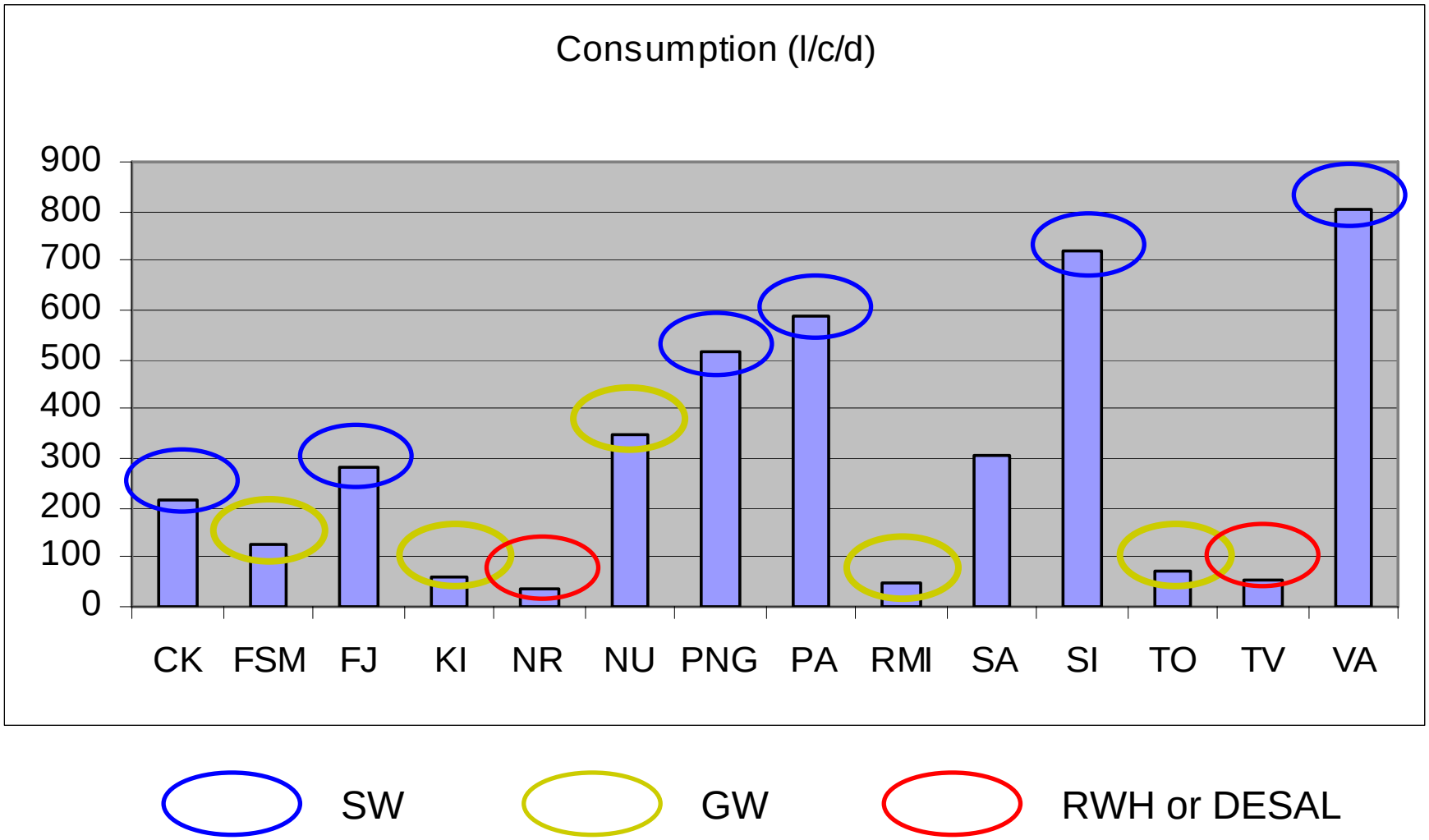
Source: primary country coverage data from WHO, UNICEF (2008)

Pacific Urban Water and Sanitation Services

Domestic Water Consumption

Countries	Population	Land Area (km2)	Population Density (pers/km2)	Annual Rainfall (mm)	Estimated Consumption (l/c/d)	Reported Consumption (l/c/d)
Cooks	15,000	235	64	2100	215	1200
FSM	108,000	700	154	3000	128	
Fiji	850,000	18,333	46	2000	283	200
Kiribati	92,000	811	114	1000	58	
Nauru	8,500	22	386	2090	35	40
Niue	1,600	259	6	2180	2278	350
PNG	5,800,000	462,840	13	2000	514	
Palau	20,000	847	41	3700	591	700
RMI	51,000	181	281	2000	47	100
Samoa	180,000	2,944	64	3000	308	500
Solomons	409,000	30,000	14	1500	721	150
Tonga	115,000	747	153	1689	72	170
Tuvalu	11,000	26	423	3569	55	
Vanuatu	200,000	12,281	16	2000	805	

Domestic Water Consumption



Fiji Islands
Water Processing and Distribution

ADB Case Study 2008

- Suva Water Treatment Plants (Waila and Tamavua), both conventional chemically assisted sedimentation plants
- Average daily production 150 ML/D (90+60) servicing 320,000 people
- Raw water abstracted from surface sources and pumped to WTPs
- Electricity supplied from FEA grid. No on-site generation capacity
- Approximately 60% of treated water pumped to high level service reservoirs

Fiji Islands
Energy Requirements

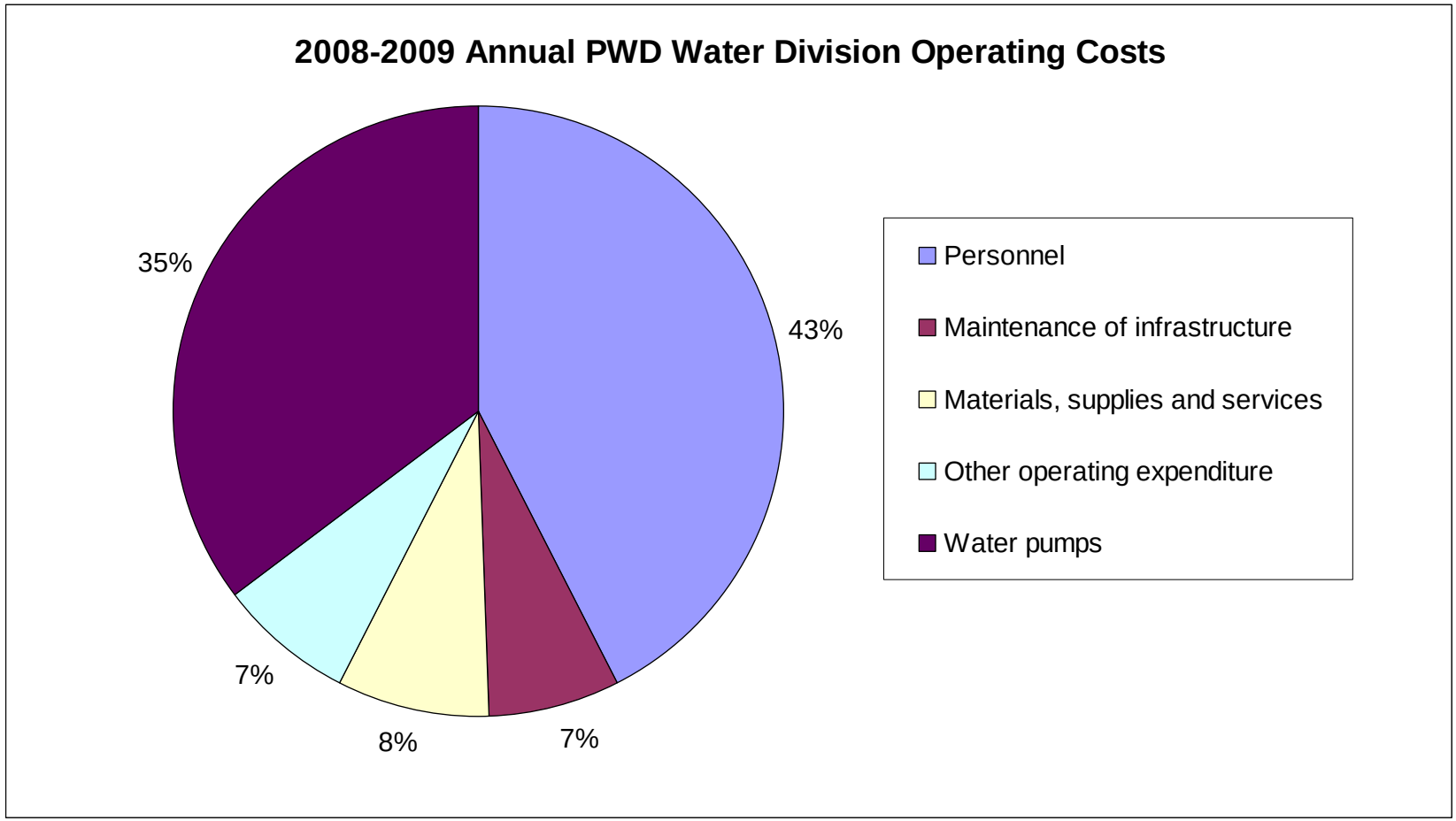
- Waila & Tamavua WTP, Suva, Fiji
  - Waila WTP: electricity = $2.1 M/year
  - Tamavua WTP: electricity = $1.5 M/year

- Average electricity cost = $0.066/kL, compared with base rate tariff = $0.067/kL

- A major water and energy efficiency problem of pipe networks is leakage

- System losses = 55% of production!

Niue
Water Division Operation Costs



Electricity for pumping groundwater accounts for 35 % of the operating costs

Pumping groundwater is the largest share of national electricity consumption

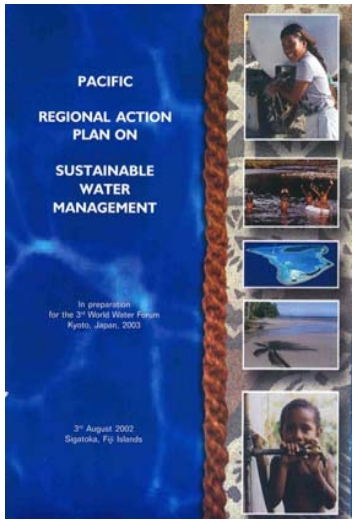
Vanuatu
Luganville Water Supply Espiritu Santo

Luganville Pumping Station Power Bill (2008)	
Monthly average	2,247,310 Vatu
Pumping cost per ML	17,897 Vatu
Annual total	26,967,726 Vatu
Annual total	NZ $387,232

- Electricity to pump water from bore to two reservoirs is by far largest variable cost in budget.

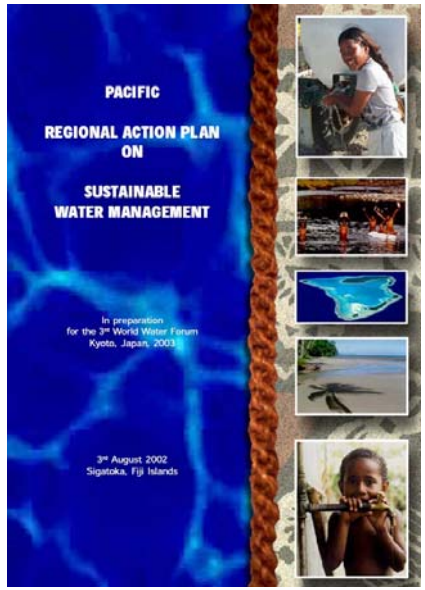
Water Use = Energy Consumption

- Conservation
  - Reduce the use
  - Awareness
  - Education
  - Tariff Setting
- Efficiency
  - Water Demand Management
  - Leak Detection
- Use renewable energy
  - Solar
  - Wind
- Desalination???



Pacific RAP Theme IV: Technology

Key Message 2: Utility collaboration and regional partnership to reduce unaccounted for water will significantly improve the sustainability of utilities and reduce the need for developing new water resources.



Supporting statement:

Reducing the amount of unaccounted for water is the highest priority action item for the utilities throughout the Pacific Island Countries

Water Division

Public Works Department

Niue

...every drop counts...

Pacific
Water Demand Management Program

Metering

- The water supply systems are sectorized in District Metered Areas. Bulk flow meters are installed on reservoir outlets and boreholes

Water Conservation

- Awareness and Education programmes conducted in schools and communities

System Loss Management Plan

- System Loss Management Plans have been developed and adopted

Leakage Reduction

- Intensive Active Leakage Control programs are underway using advanced leak detection technology which could reduce real losses in Niue by **50%*** over a 12 month period

Pressure Reduction

- Reducing average system pressure in Luganville Vanuatu will result in an estimated annual financial saving of **17 – 35 %** through reducing electricity consumption for pumping.

Financial Savings Niue From Reduced Electricity Use (NZD)	
Annual Water Supply (ML)	274
Annual Electricity Budget	$104,000
Annual Electricity Cost per ML Supplied	$379.56
Potential Annual Savings From Active Leakage Control (ML)*	52
Potential Annual Financial Savings	**$19,737**

= ¼

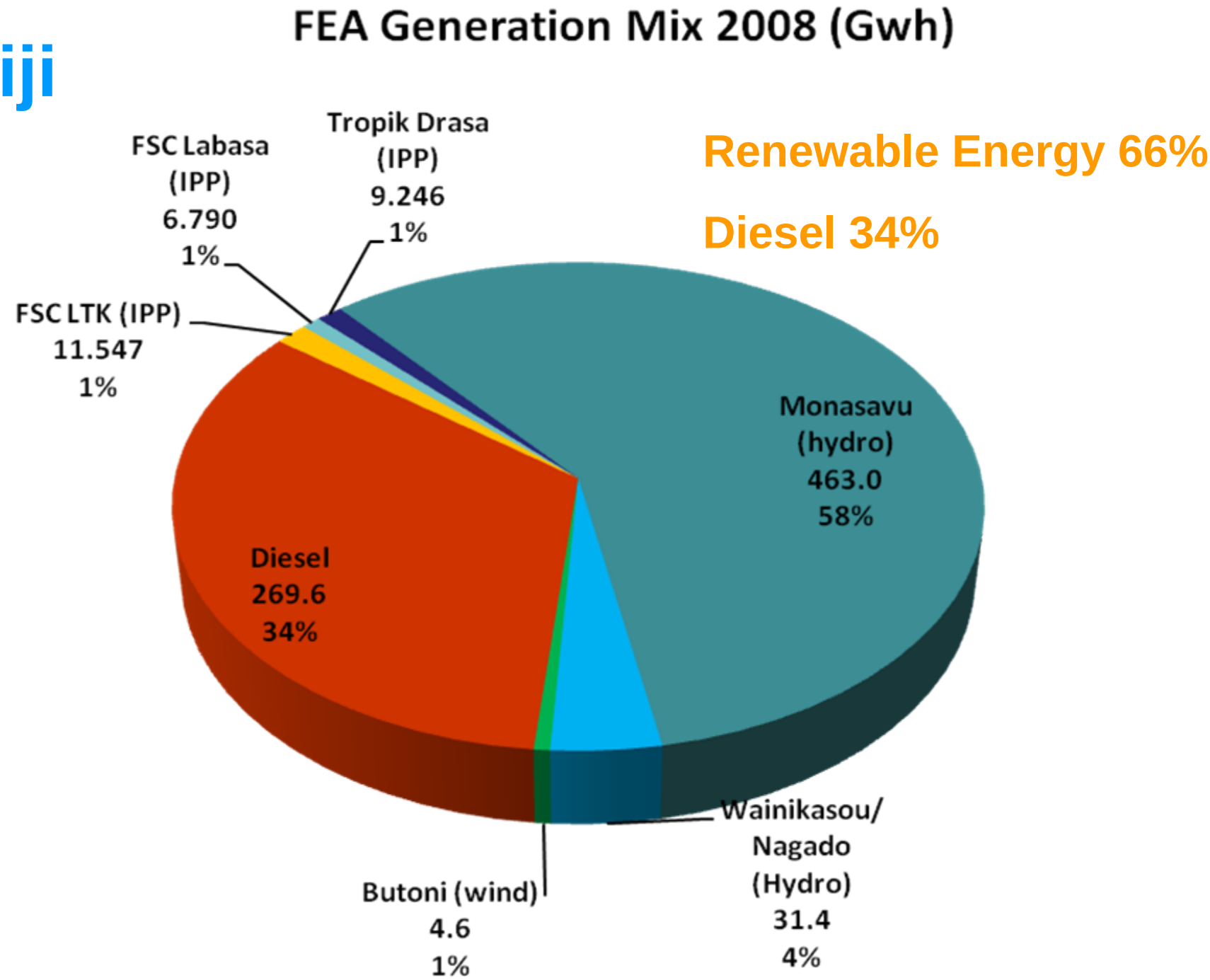
* Based on detecting and preventing 50% of current real losses.

Niue Electricity

- Prime power source of 3 GWatts being generated by Niue Power Company using fossil fuel
- Reduce transmission losses of +/- 7% by placing power source near to the load and allow distributed cogeneration by renewable power source-solar energy
- Niue's electrically powered water pumps are the single highest consumer of electricity and are situated far from the main electrical grid
- Storage and nightflows need to be taken into account as well as adjust peak demands for water and energy
- Water will have to be pumped for future use but the sustainable development plan aims for alternative supply to be provided through RWH for 20 % by 2015

Niue Solar Powered Groundwater Pumping System

Fiji

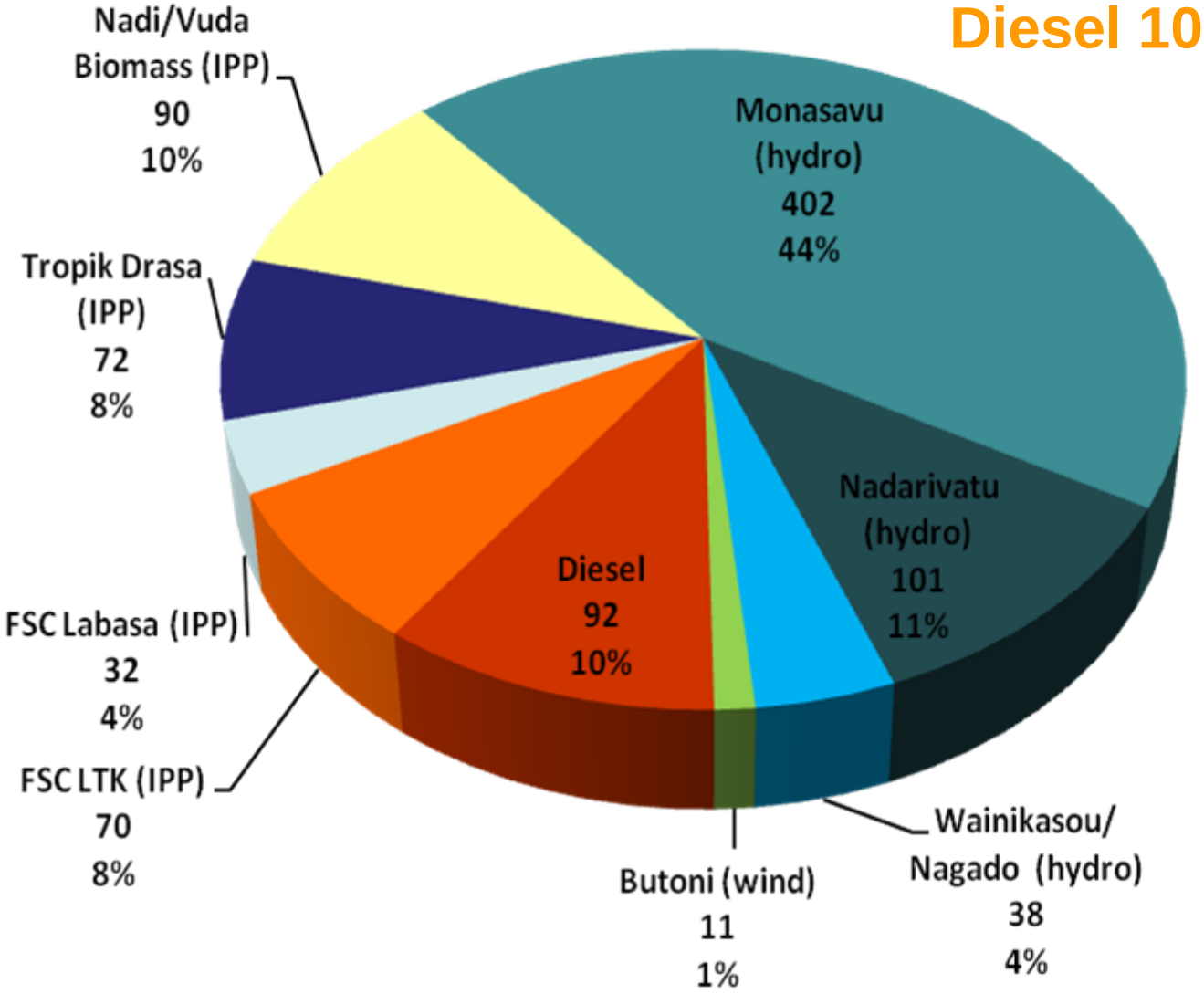

FEA Generation Mix 2008 (Gwh)
Renewable Energy 66%
Diesel 34%
FSC Labasa (IPP) 6.790 1%
Tropik Drasa (IPP) 9.246 1%
FSC LTK (IPP) 11.547 1%
Monasavu (hydro) 463.0 58%
Diesel 269.6 34%
Wainikasou/ Nagado (Hydro) 31.4 4%
Butoni (wind) 4.6 1%

Fiji

FEA Projected Generation Mix 2015

Renewable Energy 90%

Diesel 10%



FEA investment was F$35m with very low return

Penetration rate is less then 5% overall

Desalination

**“Water, water, every where,
Nor any drop to drink.”**

The Rime of the Ancient Mariner

Samuel Taylor Coleridge (1798)

Desalination: Advantages

- Unlimited feed water for coastal Pacific
- Delivers in principle safe drinking water
- Independent of weather and climate
- May use renewable energy technologies where available
- Higher cost may promote conservation practices, lowering energy demand, and increasing sustainability

Desalination: Disadvantages

- High cost of desalination technologies, especially for developing countries
  - High capital cost of infrastructure
  - Energy cost ranging from high to very high
  - Cost passes on to consumer
  - Requires sustainable technological infrastructure and trained operators
- Concentrated brine disposal – sinks and causes harm to aquatic life
- Open ocean water intakes harm sea life
- Distribution may require additional costs.

Desalination in the Pacific

- Very little data available
- General and anecdotal information available suggests many small Pacific countries introducing desalination have soon encountered problems with:
  - capital and operating costs
  - maintenance, sustainability
  - training and retention of staff

Tuvalu

Funafuti

- Cost estimated at AUD 10 / m^3
  - includes electricity, salaries, and delivery to houses, plant depreciation, and maintenance.
- Electricity alone estimated at about AUD 5.68 / m^3.
- No cost recovery mechanism
- Sustainability in question
- Rainwater Harvesting preferred option

Nauru

Nauru

- Electricity costs very high
- Original MSF plant replaced by RO
- Energy use typically 42 kWh/m3, “which is rather high”
- Estimated cost +/- 17 AUD/m^3
- No cost recovery mechanism
- Sustainability in question?

Multi Stage Flash Unit

Reverse Osmosis

SOPAC

Maldives

SOPAC

Maldives

- Malé
- Very expensive (no figures given)
- The average household spends between US$40 and $60, or 6-9% of their income, per month
- Tariff covers the cost of operation and routine maintenance, but does not provide any additional funds for infrastructure replacement.

Kiribati

SOPAC

Energy Requirements
Desalination vs Groundwater

- The unit cost of supplying desalinated water from a reverse osmosis system installed on the island of Betio, Tarawa is A$5.40/m3, compared with A$2.40/m3 for groundwater

- In terms of energy (electricity) costs, desalinated water is about 16 times more expensive than groundwater (A$2.81 compared with A$0.17).


12. 8. 2000


12. 8. 2000


110m³/D SEAWATER DESALINATION UNIT
Water Boy
type 400

SOPAC

Another failed system

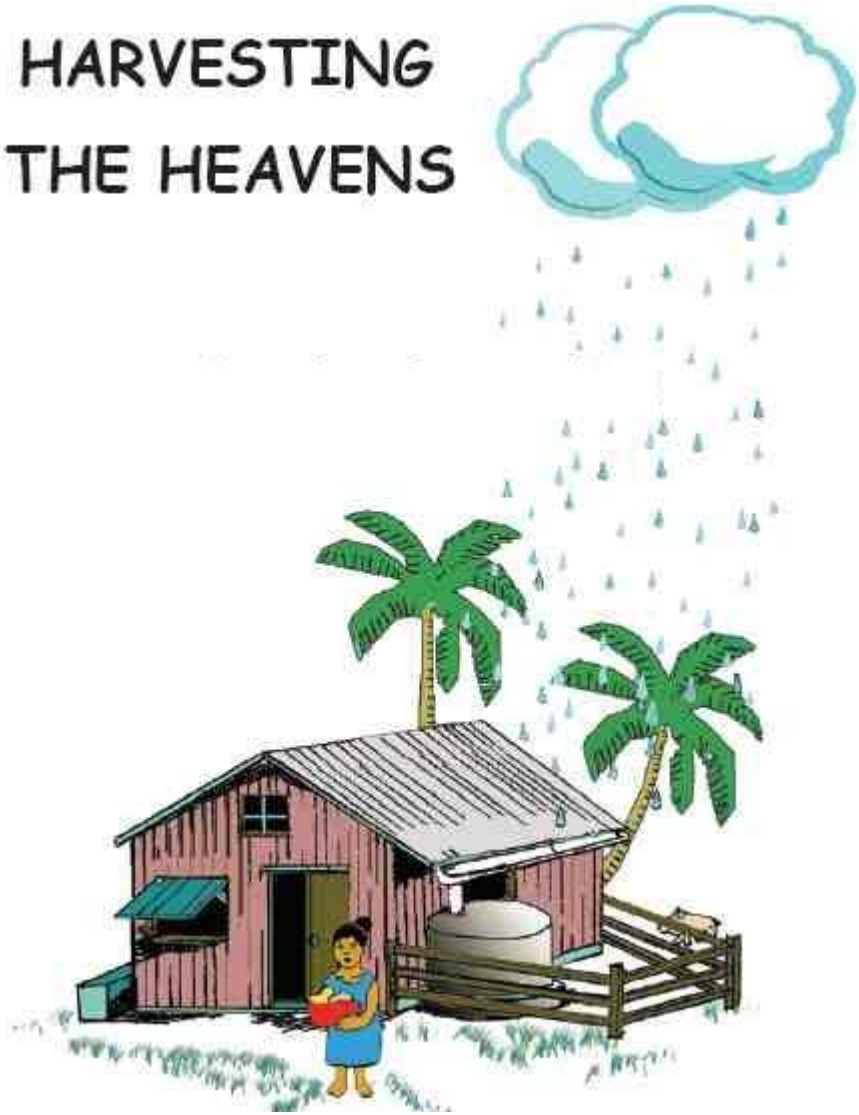
Alternatives

- Desalination should only be used as a last resort
- Use of Surface Water, Groundwater and Rainwater Harvesting should be maximised
- Water Demand Management and Water Conservation are first priorities
- Recycling water or desalination of brackish groundwater requires up to 50% less energy due to lower salt content of source water and produces fresh water at lower cost to the consumer

Increase Water Use Efficiency

Wastewater Reuse

HARVESTING
THE HEAVENS



Promote Rainwater Harvesting

Conclusion

"Perhaps the greatest barrier to desalination remains its high economic cost compared to alternatives, including other sources of supply, improved wastewater reuse, and especially more efficient use and demand management".

DESALINATION, WITH A GRAIN OF SALT,
A CALIFORNIA PERSPECTIVE

Heather Cooley, Peter H. Gleick, and Gary Wolff
JUNE 2006

Integrated Water Resources Management

“Island Style”