Floating solar PV in the PIC-11

TA-6680 REG Preparing Floating Solar Plus Projects under the Pacific Renewable Energy Investment Facility

TA 6680 is funded under the Clean Energy Financing Partnership Facility, through the Asian Clean Energy Fund established by government of Japan, and the Clean Energy Fund with financing partners: the governments of Australia, Norway, Spain, Sweden, and the United Kingdom, and administered by the Asian Development Bank.

First priority: Kiribati, Tonga and Tuvalu

Second priority: Federated States of Micronesia (FSM), Republic of the Marshall Islands (RMI)

Third priority: Cook, Nauru, Vanuatu, Palau, Samoa and the Solomon Islands.

• 15% of the globe’s surface
• 2,000 islands
• Total landmass of 46,000 km²
• Population of 1.5 million

Floating PV and Productive Uses of Energy
Transformational technologies that yield energy and use it for climate resilience, financial benefits and economic growth opportunities
Under the ADB TA-6680 REG (49450-028) Preparing Floating Solar Plus Projects under the Pacific Renewable Energy Investment Facility, a roadmap for FPV development in each of the PIC-11 is to be developed. The roadmap for floating PV development requires several stages.

1st
An analysis was undertaken based on a GIS methodology and identifications of relevant GIS layers.

2nd
Identify grid connection points and eventually grid upgrades or strengthening required.

3rd
Determine the electrical load as well as productive uses of electricity and decarbonization targets.

4th
Policy environment and how it supports the integration of further variable RE

Under the ADB TA-6680 REG (49450-028) a total of 33 Floating PV projects across the 11 PIC is to be delivered, including full feasibility studies for 3 sites, pre-feasibility studies for another 3 sites and concepts for the remaining 27.
Near shore FPV and coastal protection

Beach regeneration & shore and floating PV protection

Concept of Biorock sunken structure for wave attenuation and reef growth
Integrating FPV with Kiribati Roadmap

Based on the Kiribati Integrated Energy Roadmap (KIER) 2017-2025, many renewable energy targets have been adopted by Kiribati as official policy goals.

<table>
<thead>
<tr>
<th>FPV implementation pipeline</th>
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</thead>
<tbody>
<tr>
<td><strong>Main goals</strong></td>
<td>2025 horizon – 45% reduction in fossil fuels</td>
</tr>
<tr>
<td><strong>FPV capacity needed</strong></td>
<td>4 MW</td>
</tr>
<tr>
<td><strong>RE % generation goal</strong></td>
<td>In Tarawa, 45% reduction in fossil fuel use by 2025 (23% of this goal will be achieved through deployment of RE) In Kirimiti, 60% reduction in fossil fuels by 2025 (40% is to be achieved through deployment of RE) In the outer islands, 60% reduction in fossil fuel use in all rural public infrastructure (40% through deployment of RE)</td>
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</table>

The goal for rural public and private institutions (e.g. Boarding schools, the Island Council, private amenities and households) is to meet of 100% electricity demand with renewable energy by 2025.
Kiribati – Betio Marine Training
Scheduled for implementation in 2023

Solar PV and grid upgrade
• Near shore floating PV 4MWac east of Betio port, next to MTC
• Ground mounted PV 3 MWac in the Bonriki water reserve, with BESS of 10MWh
• 33 kV transmission ring upgrade in the South Tarawa grid from Bonriki to Bikinibeu and Betio

Productive uses of Energy
• Reef regeneration and coastal protection near to the near shore floating PV array
• Electrical mobility: EV charging stations plus electrical vehicles
Kiribati – Betio Marine Training FPV plant
Scheduled for implementation in 2023

- Smaller islands
- Geometrical shapes
- Reduced drag and lift
- Protection by wave breaker
- Partially filled floaters
Integrating FPV with Tuvalu Roadmap

In 2013, Tuvalu launched the "Enetise Tutumau" - the Master Plan for Renewable Electricity and Energy Efficiency. The goal of the plan has been to generate 100% renewable energy by 2020 and to increase energy efficiency by 30%. However, the goal has been extended to 2025.

### FPV implementation pipeline and Energy Roadmap

<table>
<thead>
<tr>
<th>Main goals</th>
<th>2021 horizon</th>
<th>2023 horizon</th>
<th>2025 horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE % generation goal</td>
<td>49 %</td>
<td>60 %</td>
<td>~100 %</td>
</tr>
<tr>
<td>FPV capacity needed</td>
<td>3 MW</td>
<td>1 MW</td>
<td>3 MW</td>
</tr>
</tbody>
</table>

**EE measures:**
- Residential sector
- Transport sector
- Industry sector

- Increase energy efficiency by 30%.

The World Bank since 2014 has been implementing a system of prepaid meters in Tuvalu. According to Adb, the introduction of prepaid meters has the potential to reduce domestic demand by 10%, and with domestic customers making up around 40% of TEC electricity demand, this will account for 4% reduction of the total demand.¹³
Tuvalu – Funafuti: Fongafale FPV plant
Scheduled for implementation in 2023

Solar PV
• Near shore floating PV 1MWac north of the Princess Margaret hospital

Productive uses of Energy
• Reef regeneration and coastal protection near to the near shore floating PV array
• Electrical mobility: electrical boats and charging stations
Tuvalu – Funafuti: Fongafale
Scheduled for implementation in 2023

- Smaller islands
- Geometrical shapes
- Reduced drag and lift
- Protection by wave breaker
- Partially filled floaters
The Tonga roadmap developed to address the described issues is TERM “Tonga Energy Road Map” for a period of 10 years (2010-2020). One of the main goals has been to reach 50% RE generation by 2020. Due to the COVID-19 pandemic, this amount of RE integration has not been achieved.

An updated roadmap has been implemented TERMPlus for a period of 14 years (2021-2035) which is meant to meet the previous goal of 50% RE in the electricity mix and to increase it to 70% and up to 100% until 2035.

**FPV implementation pipeline and Energy Roadmap**

<table>
<thead>
<tr>
<th>Main goals</th>
<th>2025 horizon</th>
<th>2030 horizon</th>
<th>2035 horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPV capacity needed</td>
<td>10~20 MW</td>
<td>10 MW</td>
<td>10~15 MW</td>
</tr>
<tr>
<td>RE % electricity goal</td>
<td>50 %</td>
<td>70 %</td>
<td>100 %</td>
</tr>
<tr>
<td>EE measures:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential sector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport sector</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Industry sector</td>
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<tr>
<td>- Establishes a goal of 80% of retail stores selling reliable compact fluorescent lightbulbs at the “same cost” as incandescent;</td>
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<tr>
<td>- Banning import of inefficient electrical appliances;</td>
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<tr>
<td>- Banning all inefficient electrical appliance at border control.</td>
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<tr>
<td>Reducing energy use in transport and buildings by more than 50% in 2030</td>
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</table>
FPV sites in Tonga

Site 1: Popua

Site 2: Vaini

Site 3: Nukualofa South (Havelu)
In April 2018, the Energy Master Plan (EMP) has been developed, with the aim of providing electricity access to more than 80% of FSM households by 2020, and to nearly 100% by 2023.

For RE integration, the EMP for FSM has set the goal of reaching:

1. 44% RE penetration by 2020;
2. 63% RE penetration by 2027;
3. 84% RE penetration by 2037

### FPV implementation pipeline and Energy Roadmap

<table>
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<th>Main goals</th>
<th>2023 horizon</th>
<th>2027 horizon</th>
<th>2037 horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE % generation goal</td>
<td>44% of RE for 2020 which hasn’t been reached.</td>
<td>63% of RE</td>
<td>84% of RE</td>
</tr>
<tr>
<td>FPV capacity needed</td>
<td>16 MW</td>
<td>5-9 MW</td>
<td>5-9 MW</td>
</tr>
</tbody>
</table>

**EE measures:**

- Residential sector
- Transport sector
- Industry sector

In terms of energy efficiency measures, for 2030, the aim has been to double the national rate of improvement in energy efficiency.

Current existing policy and regulatory framework has been restrictions on incandescent bulbs and green public procurement. Proposed have been energy efficiency standards, EE public demonstrations and building codes. Until 2020, net metering has been proposed.
Chuuk State

This site is located near the Nantaku town, inside the southern part of Pou Bay, up north of the Weno municipality, being the largest town in the FSM, having a population of 13,856.

Site: In Pou Bay

It’s near the main transport infrastructures, such as the Chuuk international airport (2.2 km away) and Chuuk Shipping Harbour (2.6 km away) and close to the villages of Tunnuk and Mechitiw. Comprising 5 ha, the site is relatively protected from severe weather events given the fact that is located inside the atoll.
Kosrae State

Two locations have been identified for this site which is located north of Tofol, the capital of Kosrae, where the main power station is placed. It is sheltered from the ocean by Lelu Island, being also in the proximities of existing mangrove plantations in the closest coastline.

Prio Site 1:
North of Main station

The small harbour in Yen Yen can be used as an assembly point. The site has an estimated area of 2 hectares and there are few dwellings close to the site.
Pohnpei State

Prio Site 1 : Near Main Airport and port

The site is located north of Kolonia, being adjacent to the main road, Dekehtik Causeway, connecting the Pohnpei International Airport to the city. Existing mangroves and a dumpsite owned by the PUC, Pohnpei Utilities Corporation separate the airport from the area of the proposed floating PV site.

The floating PV site has an estimated area of 6 ha and is also near an old power barge where the plant can be connected to the grid. In the opposite side of a medium-size harbour and of the Pohnpei Shipping harbour, where the imported floating PV parts will likely be shipped to.
In order to achieve the RE targets, a whole-grid approach has been defined in the RMI electricity Roadmap as follows.
FPV in RMI

Prio Site 1: North of Majuro

This site is located near the RMI High School, in the island district of Darrit, north of Majuro Atoll. Darrit is largely residential. A road connects Darrit with Laura at the western end of the atoll. It passes through the Marshall Islands International Airport. The site is also near the main transport infrastructures. The Uliga Pier is almost 1 km far from the FPV site, and the Majuro fishing port is 2.7 km far from the site.

Comprising 13 ha, the proposed FPV site area is relatively protected from the outer sea, being sheltered with land stretches from all sides except from the west.
Integrating FPV with Cook Islands Roadmap

According to CIREC, one of the main proposed technologies to increase the RE intake is through solar PV with diesel backup, but the implementation of FPV can have an important role in countering several challenges such as land issues (for example land/rooftop availability and land rights).

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<tr>
<td><strong>Main goals</strong></td>
<td>2025 horizon</td>
</tr>
<tr>
<td><strong>RE % generation goal</strong></td>
<td>Achieve 100%. The policy target has been to reach this goal in 2020.</td>
</tr>
<tr>
<td><strong>FPV capacity needed</strong></td>
<td>13 MW</td>
</tr>
<tr>
<td><strong>EE measures:</strong></td>
<td></td>
</tr>
<tr>
<td>- Residential sector</td>
<td></td>
</tr>
<tr>
<td>- Transport sector</td>
<td></td>
</tr>
<tr>
<td>- Industry sector</td>
<td>The preparation of network study by CIREC included opportunities for demand side management such as EE.</td>
</tr>
</tbody>
</table>
Cook Islands

Priority 1 site: Rarotonga Island - Near Avarua

This site is located in the northern part of Rarotonga Island, the largest and most populous island of the Cook Islands. The location of the site is between Puapuauti Tapere and Avarua. The site is in front of the Rarotonga International Airport.

The area is largely residential and is the home to several touristic areas as well as governmental facilities such as the parliament, and other ministries. Additionally, the major port, Cook Islands Port is only 1 km far from the FPV site.

Comprising 17 ha, the proposed FPV site area is located in a secure area. The site is also close to a substation and a vacant land.
The productive uses of energy (PUE) are inevitably linked to nexus. Each nexus binds energy and each area to allow for a broader understanding of what is intended to impact.

- Aquaculture, Fish | Shellfish farming
- Aquafarming: Direct water-based systems - Aquaponics - Vertical farming - Reef growth - Ice making

- Desalination, water supply, storage
- Pumped storage for hydropower

- Reduce: import of raw materials
- Recycle to create a circular economy at the PIC 11
- Reutilize resources rather than buying new.

- Decarbonize transport
- Biofuels
- Green hydrogen production

- E-mobility | EVs, e-scooters, e-bikes
- Charging stations
- Solar e-boats and inter islands

Productive uses of energy and nexus

The productive uses of energy (PUE) are inevitably linked to nexus. Each nexus binds energy and each area to allow for a broader understanding of what is intended to impact.
Productive uses of Energy and floating PV
Thank you!

Agostinho Miguel Garcia
Deputy team leader TA 6680