Joint IRENA-PPA Workshop:
Assessment of Grid Stability for Increased Renewable Energy Integration in the Pacific Region

15 July 2012, Vanuatu

Summary

Introduction

In their efforts to reduce the high dependency on fossil fuels and diversify the energy mix, the Pacific island countries plan to accelerate the deployment of renewable energy technologies. Most of the Pacific island countries have set ambitious renewable energy targets in an attempt to achieve this transition from a fossil fuel-based to a renewables-based power system. Most of the countries are considering solar and possibly wind as the main renewable energy sources, at least in the near term. Where higher shares of these renewables will be integrated into the existing grid systems, grid stability requires attention. It is particularly critical on islands where the grids are small and will be subject to high shares of variable power input from solar and wind energy sources.

The utilities and policymakers need to understand the thresholds at which their grid systems may begin to have problems sustaining the integration of such variable renewable energy sources without affecting the power quality.

In the Pacific Region, most of the island power systems use diesel generators with an average age of 20 years and with capacities ranging from 25 kW to 60 MW. With renewables increasingly being integrated, stability problems are being anticipated, or already being experienced, in some small island power systems, such as Niue and the Cook Islands.

The *IRENA Renewable Energy Islands Initiative* aims to assist islands in transitioning to an increased share of renewable energy and to learn from their unique experiences. As part of this initiative, IRENA together with the Pacific Power Association (PPA) is carrying out a study to identify the technical criteria for retaining grid stability in order to assist the Pacific utilities to identify appropriate technology solutions.

In this context, IRENA and the PPA jointly organised a workshop on strategies and technology solutions that can help retain grid stability with an increasing level of renewables. The workshop was held in Vanuatu in association with the 21st Annual PPA Conference. Over 35 experts and Pacific utilities gathered to discuss ways to introduce higher shares of variable renewables, such as solar and wind, into island grids while retaining grid stability. The workshop involved presentations, case studies and discussions on topics, such as renewable energy integration challenges in the Pacific islands, storage systems for integration, and grid assessments and modeling.

Key Discussion Points

- As the trend is to transition to more grid-connected renewables, risks associated with high levels of variable renewable energy (solar and wind) penetration must be better understood by the utilities in order to plan effectively to reduce grid instability. Variable power inputs from

renewables reduce diesel generating efficiency, and increase the wear and tear on the engines, thus reducing engine life span. This is especially critical for the older engines that have low inertia, such as are commonly used in the Pacific Region, that are used for spinning reserves when the renewables are delivering power to the grid.

- Different strategies and solutions can be used depending on the levels of renewable energy integration. The first priority is to tackle challenges without installing expensive additional electricity storage equipment, such as batteries and flywheels, while looking at the economic viability of the solutions.
- When the renewable penetration is less than 20% of the load, the direct connection of renewables to the grid is usually feasible without any problems. If the penetration level is between the ranges of 20% and 50% of the actual load, additional measures and control systems will be required to mitigate the variability. The possibilities include limiting renewable energy power output, installation of secondary diesel units (spinning reserves) and short-term energy storage, such as flywheels, and using smart inverters that slow the variations in order to allow generators to keep up with the changes in the renewable energy inputs.
- For higher penetration of renewable (i.e. more than 50% of the load), the effects of the variability become more pronounced. In this situation, more advanced and sophisticated measures and control systems are required. Solutions include power limiting using advanced inverters and long-term energy storage, such as batteries and pumped storage.
- Another way to mitigate the variability is to design a system in which the renewable generation is split into several parts, which are spread around the island so that all the output is not changed at the same time.
- Using a “smart grid” will be another important solution to consider. This looks into demand-side management using load shifting.
- A step-by-step approach was proposed to increase the levels of renewables. The retrofit of new technology control systems for old diesel generators allows much better control of variations caused by renewables.
- As the types of renewable energy resources and individual generation systems on the Pacific islands vary greatly in size, make and age, the strategies and solutions need to be tailor-made for each island.
- In order to better understand how much renewable energy the islands’ grids can absorb without affecting power quality, it is critical to be able to simulate the behaviour of frequency and voltage variability on the grid through computer modeling.
- There was a general understanding that dynamic modeling of the power systems is vital to better plan renewable energy integration. It helps to predict the effects on frequency and voltage under the varying load conditions caused by renewables on a seconds-to-minutes time scale. This can be used for design purposes, as opposed to static modeling, which examines power system performance at a single point in time, and is used for the assessments of grid losses but provides no information about the response of the grid to changing inputs over time. In island grids dynamic modeling is necessary, in particular because the influence of a single power system component has more effect on the whole system than would be the case in a larger on-grid system that has more grid components in the system.
- The participants also recognised that assessments using the existing combination of various controls and machines are required to predict the effects of renewable integration to island

grids, and that the whole energy system should be taken into consideration. The solutions therefore need to be packaged for the whole system and tailor-made for each island grid system. Dynamic modelling is the first critical step of the whole energy system planning, which includes long-term operational planning.

- It was pointed out that renewable energy integration should be considered in combination with energy efficiency.
- The transition to renewable energy has a long way to go, but there was general consensus that the dynamic modeling study by IRENA and PPA for island utility grid stability was an important first step in improving decision making of the Pacific utilities and policymakers. It was recommended that IRENA works closely with utilities and other stakeholders in the region, to continue progress on renewable energy integration, and to assist the Pacific island countries in their energy planning decisions so that they become more confident in the integration of increasing renewable energy in their island grids.

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