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RENEWABLE TECHNOLOGIES AND RISK MITIGATION IN SMALL ISLAND DEVELOPING STATES: FIJI'S ELECTRICITY SECTOR

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Overview

Renewable technologies have been advocated in Small Island Developing States (SIDS) as a risk mitigation measure against oil price volatility. Despite this, there have been no rigorous attempts to measure the impact of renewable technologies on financial risk in these countries. This paper applies empirical data in a custom-built stochastic simulation model, based on portfolio theory, in order to assess the economic impacts of using renewable technologies in expanding Fiji's electricity grid. Investments in low-cost, low-risk technologies such as geothermal, biomass and bagasse technologies, as well as improvements in energy efficiency, are found to lower both generation costs and financial risk in the grid. This suggests the Government of Fiji should be encouraging further investment in these technologies, commensurate with increases in total electricity supply. Such investment should also be prioritised over planned investment in hydro-power capacity. Renewable technology investments in other SIDS are likely to involve similar risk mitigation benefits.

Methods

Portfolio theory has been applied to the electricity sector in order to assess the economic impact of a generation technology on a portfolio of electricity generation technologies. However, standard portfolio theory does not consider the ability of various technologies to meet demand for power. Because electricity cannot be stored at low cost, an electricity utility needs to ensure that there is sufficient generation capacity that can be "switched on" to meet demand when needed (IEA, 2007, Ölz et al., 2007, Gotham et al., 2009). This is especially important in an isolated power grid that cannot draw power from other grids, such as those that exist in Fiji and other SIDS (Mayer, 2000, Marconnet, 2007). Power generation from some renewable technologies is variable and requires back-up generation capacity that provides electricity if the renewable technology stops producing electricity. In Fiji's case, this back-up capacity consists of oil-based generators.

We address this issue through a custom-built stochastic numerical simulation model future scenarios of electricity generation in Fiji in 2025. The model includes:

1. Capacity of each renewable technology, representing different scenarios of electricity supply investment.
2. Output from renewable technology capacity, computed from random realisations of output by technology, calibrated to historical output data.
3. Output from oil-based generation capacity, computed as the residual to meet fixed total electricity demand given stochastic output from renewable technology capacity.
4. Required minimum capacity of oil-based generation technology to meet electricity demand to achieve a given level of system reliability based on random realisations of renewables output.
5. Empirical cost data on each technology.

The model is implemented for numerical simulations using a Monte Carlo sampling approach.

Results

The results support investment in some, although not all, renewable technologies. Renewable technology investments forecast by the Fiji Electricity Authority (FEA) are shown to reduce expected average generation costs in the Fiji grid. The impact on financial risk, defined as the likelihood that actual portfolio costs will differ from expected portfolio costs in the future, is strong. Financial risk can decline by more than half as a result of renewable technology investments. Investment in renewable technologies

therefore involves considerable risk mitigation benefits for Fiji's electricity grid.

Additional investment in a portfolio of low-cost, low-risk renewable technologies, such as geothermal, energy efficiency, biomass, and bagasse technologies, would further reduce expected average generation costs and also reduce financial risk in the electricity grid, by supplanting oil use with higher renewables supply capacity. Investment in high-cost renewable technologies such as wind and solar-power would reduce financial risk but increase expected average generation costs. Investment in hydro-power would also decrease financial risk for the portfolio but would have a minimal impact on costs. These findings are confirmed in sensitivity analysis when varying discount rates and aggregate electricity production.

Conclusions

The results point to several policy implications in Fiji. First, they suggest that the government should be encouraging further investment in low-cost, low-risk renewable technologies on energy security grounds, and with the goal of lowering expected generation costs in the electricity grid. Renewable technology investments should be commensurate with growth in total grid-based electricity generation in Fiji. Second, the results suggest that investment in low-cost, low-risk technologies should be prioritised over investment in hydro-power generation capacity. This finding is significant, as it suggests the FEA's focus on run-of-the-river hydro-power projects, which is supported by the Government of Fiji, is mistaken when considered from a system-wide perspective. The Fiji Government should instead be encouraging investment in energy efficiency, geothermal, biomass and bagasse technologies, which lower portfolio generation costs to a greater extent than hydro-power technology, and have a similar impact on financial risk.

More broadly, the results highlight the importance of considering financial risk as well as generation cost when planning investments in electricity generation capacity. Least-cost (or cost-benefit) analysis provides only a partial view of the benefits of renewable technology investment, as it fails to consider financial risk. Portfolio theory provides a more balanced method for assessing and prioritising investments in different power generation technologies.

The broad findings are also relevant for other SIDS. The electricity sector in the majority of SIDS is dominated by oil-based power generation. As a result, this sector is vulnerable to oil price increases and oil price volatility. This paper has shown that renewable technologies can reduce financial risk inherent in oil-based generation, and can also lead to savings in expected costs. . The finding is likely to hold in the majority of SIDS, depending on the potential for and cost of renewable energy technologies.

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