Sustainable Energy for Remote Indonesian Grids (SERIG)

The United States Department of Energy (DOE) is funding the US $1.2 million SERIG project to support Indonesia's efforts to develop clean energy and increase access to electricity in remote locations across the country. SERIG has two components: pilots and nationwide deployment.

- **Pilots:** SERIG conducted technical and economic analyses for high-penetration renewable energy technologies to replace high-cost diesel generation on selected islands and remote grids. The project now aims to facilitate hand-offs for private-sector development of the identified renewable electricity solutions at three chosen pilot locations: Lamandau District of Central Kalimantan, and Sabu and Sumba Islands of East Nusa Tenggara.
- **Nationwide deployment:** SERIG is also providing a set of strategies for accelerating deployment of renewable electricity in remote locations nationwide. The state-owned electric utility Perusahaan Listrik Negara (PLN) and the Ministry of Energy and Mineral Resources (ESDM) are vital partners for successful deployment at remote locations across Indonesia.

Supporting Indonesia's Policy Goals

SERIG directly supports the aggressive goals of Indonesia's National Energy Policy proposed in 2011 and enacted in January 2014. The primary policy goals are to:

- Reduce reliance on energy imports and oil consumption by further developing Indonesia's indigenous energy resources
- Increase the percentage of new and renewable energy in the country's energy mix to 23% – the Jokowi Administration raised the goal to 25% – by 2025 (renewable energy comprised 5% when the policy was proposed in 2011, rising to 6% as of 2015)
- Achieve 100% electrification by 2020 (76% of the population had access to electricity in 2011, rising to 86% as of 2015)

With the heavily-populated urban areas already connected to the grid, increases in the national electrification ratio will need to come from bringing electricity to remote communities across Indonesia's 6,000 inhabited islands. The Government of Indonesia has placed a priority on bringing electricity to districts with less than 60% electrification; SERIG pilot locations range from 25-36% electrification.

ESDM's Bright Indonesia Program aims to electrify – largely with renewable sources – over 12,600 villages lacking on-demand access to electricity or relying on diesel generation, including over 2,500 with no electricity access. The projected investment required to achieve this is 100 trillion rupiah (Rp), or US $7.5 billion.

Presenters at the SERIG stakeholder workshop in Jakarta in October 2014 included officials from the U.S. Department of Energy, Indonesian electric utility PLN, Indonesia's Ministry of Energy and Mineral Resources, the U.S. National Renewable Energy Laboratory, Winrock International, and the U.S. Agency for International Development.

To attract private investment for renewable energy, the Government of Indonesia has set feed-in tariff (FIT) policies, establishing the prices that PLN will pay to purchase renewable electricity from independent power producers (IPPs). The FIT varies by the type of renewable resource and by location, with a higher FIT reflecting a higher generation cost or a more remote location.

Nationwide Deployment

The remote regions and islands of Indonesia are nearly 100% dependent on high-cost and carbon-intensive fossil fuels, particularly diesel, for electricity. Development of strategies for accelerating deployment of the renewable energy solutions identified for SERIG pilot sites will provide the Government of Indonesia with a path for implementation in remote locations nationwide. In turn, Indonesia can serve as a leader in clean energy for the rest of the world and especially for island nations most vulnerable to increases in imported diesel prices and the impacts of climate change.

The magnitude of potential cost savings from nationwide deployment is evident from the following simplified numeric estimates. On average, replacing diesel generation with renewable electricity purchased from an IPP can save PLN an estimated Rp 2,000 per kilowatt-hour (kWh), or US $0.15/kWh.[1] For each megawatt (MW) of diesel generation capacity replaced by 1 MW of renewable generation capacity, PLN would see estimated savings of Rp 17.5 billion (US $1.3 million) annually. PLN currently operates 2.8 gigawatts (GW) of diesel generation capacity.

[1] Assumptions: Average diesel generation cost of Rp 4,000/kWh (US $0.30/kWh), average FIT of Rp 2,000/kWh (US $0.15/kWh), and exchange rate of Rp 13,300 to US $1.

SERIG Project Accomplishments

- Identified renewable electricity solutions for three pilot locations
- Completed five technical reports, including a feasibility study for grid integration of variable renewable generation at the pilot locations
- Conducted a stakeholder workshop in Jakarta in October 2014, which brought together PLN, ESDM, U.S. government agencies, technology providers, and development banks[2]
- Published a report with recommendations for accelerating development of the renewable solutions at the pilot locations[3]

Renewable Electricity Solutions

DOE's National Renewable Energy Laboratory (NREL) and Winrock International's Jakarta-based office (contractor to NREL) conducted technical and economic analyses for the following renewable electricity solutions at the SERIG pilot locations. The fact that three pilot locations have three different renewable solutions is a testament to Indonesia's diverse and rich renewable energy resources.

- **Lamandau District solution:** 3.5 MW of generation with biogas from palm oil mill effluent (POME). The two palm oil mills studied in Lamandau emit biogas from their effluent ponds directly into the atmosphere. Instead, systems can be installed to capture and refine the biogas for combustion to generate renewable electricity for the mills and nearby communities. This solution could be replicated at the more than 600 palm oil mills across Indonesia.
- **Sabu Island solution:** 1 MW of solar photovoltaic (PV) generation with 461 kWh of lead-acid battery storage, or 350 kW of PV without storage. Due to the intermittent nature of PV electricity generation, integration of the larger PV capacity requires storage for grid stability, while the smaller PV capacity does not need storage.
- **Sumba Island solution:** 850 kW wind turbine with flywheel or other storage. SERIG's grid integration study for this wind and storage system is contributing to the Sumba Iconic Island initiative – which aims by 2025 to achieve 95% electrification and 100% renewable generation to meet the entire island's load – by preparing Sumba for increasingly higher penetration of variable renewable power.

Next Steps

- Use the completed technical and economic analyses to attract private-sector financing and development of the identified renewable electricity solutions at the pilot locations
- Publish a set of strategies for nationwide deployment, with potential endorsement by PLN and ESDM
- Conduct workshops with PLN and ESDM regional offices on how to implement key aspects of the strategies

[2] Presentations from the workshop are available on the Clean Energy Solutions Center at https://cleanenergysolutions.org/news/serig.
[3] The full report is available at http://www.nrel.gov/docs/fy15osti/64018.pdf.

Palm oil mill effluent (POME) ponds at the PT Nirmala Agro Lestari mill in Lamandau District. DOE's SERIG project developed technical and economic analysis for generating renewable electricity from the biogas emitted from the effluent ponds at this and another nearby mill. This would provide power for the mills and nearby communities.

A 60-meter meteorological (met) tower was installed on Sumba Island by Winrock International (contractor to DOE's National Renewable Energy Laboratory on the SERIG project) to collect data on the quality of the site's wind resource in preparation for development of a wind project (funded by the Asian Development Bank).