Calculating Energy Access, Finance Mobilization, and Projected Emissions Reductions

A Case Study of Small-Scale Solar and Hydroelectric Clean Energy Activities in Indonesia

HYDROELECTRIC AND WIND RESULTS AT A GLANCE

13,526,156 tCO_2e

mitigated from 2016 to 2030

estimated using CLEER GHG projections calculator for reporting on EG. 12-7 Projected GHGs

59,178 tCO_2e

mitigated in 2016

estimated using CLEER GHG calculator for reporting on EG. 12-6 Emissions Reduced

474 MW

hydro and wind capacity installed by 2018

prospective results based on EG. 12-5 clean energy capacity

3.95 million

people with improved energy access from 2016-2018

prospective results based on EG.7.1-1 clean energy beneficiaries

$1.4 billion

funding leveraged for hydro and wind between 2011 and 2020

prospective results based on EG.12-4 investment mobilized

Access the Clean Energy Emissions Reductions (CLEER) calculators at cleertool.org.

This case study is one of a series being developed by the USAID Resources to Advance LEDS Implementation (RALI) activity to demonstrate how to calculate USAID Global Climate Change (GCC) standard indicators for different types of clean energy activities. This case study calculates results achievable from hydroelectric and wind projects, including potential greenhouse gas (GHG) emissions reductions through 2030, which can be reported under USAID GCC clean energy standard indicators. [1] *Note: USAID does substantial work supporting clean energy reforms that are not easily quantified but may have a greater impact than the activities described here. The RALI project seeks to develop cost-effective methodologies for assessing the impact of the full range of clean energy assistance provided by USAID.* [2]

INCREASING ENERGY ACCESS WHILE REDUCING GHG EMISSIONS

With a population of almost 255 million and as a member of the G20, Indonesia is among the world's top emitters of GHGs.[3] Approximately one-fifth of the population lacks access to electricity, despite Indonesia having high renewable energy and energy efficiency potential with traditionally low electricity rates.[4]

USAID Indonesia launched the five year, $15 million Indonesia Clean Energy Development (ICED) Project in March 2011 to increase access to energy services, stimulate economic growth, slow the growth of energy sector GHG emissions, and develop clean energy and transportation initiatives. ICED set a goal of avoiding 4 million metric tons of CO_2-equivalent (tCO_2e) annually from energy and transportation, installing 120 megawatts (MW) of clean energy generating capacity, and completing at least 20 small- to medium-sized renewable energy and energy efficiency projects. ICED was also an important contributor to the U.S.-Indonesia Comprehensive Partnership signed by President Barack Obama and President Susilo Bambang Yudhoyono in 2010.

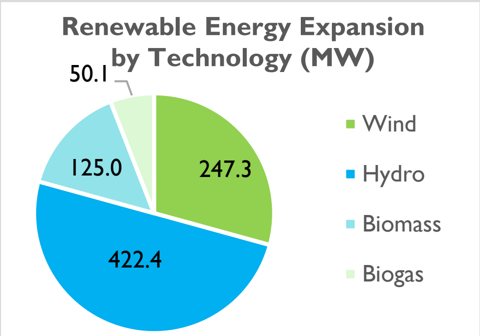
6MW Hydropower Plant in North Sumatra Province

ICED provided critical assistance to help develop Indonesia's first four wind farms, through feasibility studies and power grid enhancements to improve integration. ICED also helped implement a small-scale hydro project along the Sei Bingei River, increasing the local population's access to energy. ICED facilitated cooperation between Indonesia and Thailand to exchange experience on biogas development. This resulted in the mapping of potential biogas resources in Kampar, facilitating the development of the domestic biogas industry.

ICED partners include 12 Indonesian banking and financial institutions, the Indonesia National Power Company, Ministry of Energy and Mineral Resources, the Central Bank, and Ministry of National Development Planning. The project concluded in February 2015.

ICED LEVERAGED $1.4 BILLION TO EXPAND HYDROELECTRIC AND WIND CAPACITY

ICED assistance to renewable energy projects resulted in a significant expansion of Indonesia's clean energy sector. Many renewable energy project developers took advantage of the GoI's feed-in tariff policy and power purchase agreements, and collectively leveraged over $1.7 billion, of which $1.4 billion supported hydroelectric and wind energy. Small hydroelectric generation capacity comprised nearly half of all renewable generation projects supported by ICED, with ICED helping to develop over 422 MW of small hydro projects across Indonesia. ICED supported the development of 247 MW of wind energy generation (expected to be commissioned within the next several years), 125 MW of biomass, and 50 MW of biogas generation capacity. In total, ICED contributed to the development of 845 MW of renewable energy capacity, an increase of 14% in installed renewable capacity relative to Indonesia's 2012 levels.



The USAID RALI activity estimated the current and anticipated GHG emissions avoided by hydroelectric and wind power projects developed by ICED. GHG mitigation potential from biomass, biogas, and energy efficiency actions were not included, as detailed data for these projects are not available; thus, the ICED program as a whole is expected to achieve even greater GHG benefits than profiled for this case study.

GHG ESTIMATION METHODOLOGY AND ASSUMPTIONS

The USAID RALI activity used the Clean Energy Emission Reduction (CLEER) tool to quantify GHG mitigation benefits through 2030. The calculations, detailed below, align with USAID indicators EG.12-6 (annual GHG emissions reductions) and EG.12-7 (projected future GHG emission reductions). These activities can also report on EG.12-4 (investment mobilized), EG.12-5 (MWs clean energy capacity), and EG.7.1-1 (clean energy beneficiaries).

STEP 1 - RALI obtained project information from the ICED Mission and organized data based on the most recent project status. RALI assumed projects would be operational in 2016 or 2018, depending on their status at the conclusion of the ICED program.

- Operational projects were assumed to be online as of 2016.
- Projects that were under construction or financially closed were assumed to come online in 2018.

NEW INSTALLED CAPACITY (MW)			
Technology	Online in:		
	2016	2018	TBD
Hydro	33	194	196
Wind	0	247	0

An additional 196 MW of hydro projects were in the proposal or development stage at the conclusion of ICED; GHG benefits from these projects have not been included in these calculations.

STEP 2 - RALI calculated the amount of energy that will be generated annually from hydroelectric and wind energy technologies using the following equation:

$$\text{Electricity Generated}\left(\frac{\text{kWh}}{\text{year}}\right) = \text{Generation Capacity (kW)} \times \text{Capacity Factor (\%)} \times \text{Operating Hours}\left(\frac{\text{h}}{\text{year}}\right)$$

The generation capacity of the wind technologies and hydroelectric turbines were provided by ICED. The calculations were made using country average capacity factors. For wind technologies, a capacity factor of 41% was used, based on International Energy Agency (IEA) statistics.[5] For hydroelectric technologies, a capacity factor of 27% was used, based on INTPOW statistics.[6] These capacity factors represent average annual conditions, and thus account for conditions such as variable winds. The operating hours represent the total amount of time that the system is producing energy in a year. For these calculations, the systems are assumed to be fully operational throughout the year.

STEP 3 - RALI estimated the GHG emissions associated with the baseline scenario, the scenario in which no wind or hydroelectric technologies are installed:

$$\text{Baseline Emissions}\left(\frac{\text{tCO}_2\text{e}}{\text{year}}\right) = \text{Electricity Consumption}\left(\frac{\text{kWh}}{\text{year}}\right) \times \text{Emission Factor}\left(\frac{\text{tCO}_2\text{e}}{\text{kWh}}\right)$$

RALI assumed that the renewable energy installations will not change consumption habits, and thus the electricity consumption will be equal to the energy generation calculated in Step 2. The wind and hydroelectric technologies are used to service locations that are off of the electric grid in order to expand energy access. RALI assumes that these locations will be connected to the grid in the future, and thus the baseline fuel source is the consumption of grid electricity that is avoided as a result of the wind and hydro technologies. Emission factors refer to the amount of CO_2 emitted per unit of electricity generation. The grid electricity emission factor utilized is a national-level combined marginal emission factor. This factor is a combination of an operating margin emission factor, which represents the emissions from the specific power generation sources that are immediately displaced by the project, and a build margin emission factor, which represents the displacement of potential power generation sources that are not constructed due to the energy generated by the project. The emission factor used is a national average of all combined marginal emission factors used by registered Clean Development Mechanism (CDM) projects (2004-2015), which are based on the CDM methodology.[7]

STEP 4 – RALI calculated the total GHG emissions reduced:

$$\text{Emissions Reduced } (tCO_2e) = \text{Baseline Emissions } (tCO_2e) - \text{Activity Emissions } (tCO_2e)$$

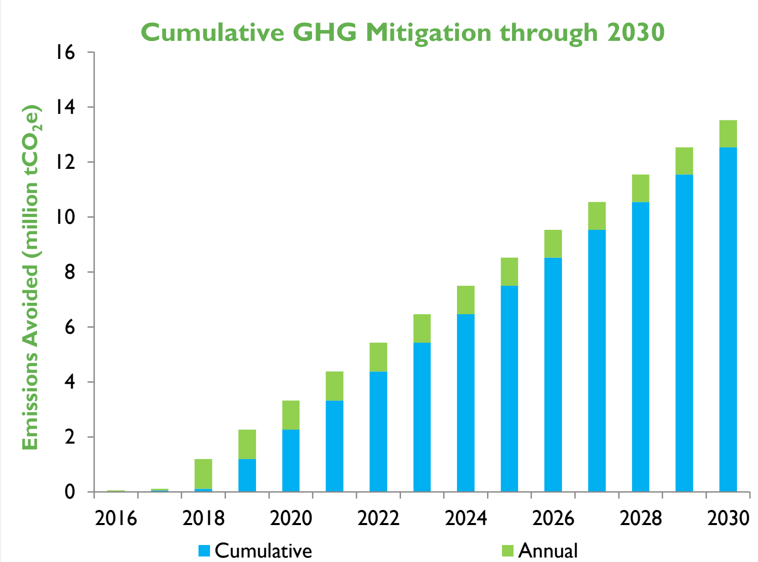
RALI assumed that there are no emissions associated with the operation of wind and hydroelectric technologies, and thus the activity emissions are equal to zero. Therefore, the total emissions reduced are equal to the baseline emissions. To project cumulative GHG emissions avoided for each year through 2030, RALI multiplied the estimated emissions reduced by an annual technology degradation rate of 0.3% for hydroelectric technologies and 1% for wind technologies. These degradation rates were based on RALI consultations with industry experts. Finally, it was assumed that the renewable energy systems and resulting energy impacts would continue through 2030.

GHG CALCULATIONS AND RESULTS

Hydroelectric capacity: ICED supported the development of 226 MW of small hydro capacity, which is expected to generate 538,604 megawatt hours (MWh) of electricity annually by 2018. ICED also supported the initial development of an additional 196 MW of hydro capacity. RALI estimates that in 2018, ICED's operational hydro projects will reduce GHG emissions by 408,121 tCO_2e. In total, ICED's hydroelectric projects are expected to avoid 5.3 million tCO_2e from 2016 through 2030.

Wind capacity: ICED supported the development of 247 MW of wind capacity, which is expected to generate as much as 880,000 MWh annually by 2018. RALI estimates that in 2018, ICED wind projects will reduce GHG emissions by 669,246 tCO_2e. In total, these projects are expected to avoid 8.2 million tCO_2e from 2018 through 2030.

Total: In total, ICED projects are expected to reduce GHG emissions by 13.5 million tCO_2e from 2016 through 2030. During this timeframe, the annual GHG savings are expected to reach 1.06 million tCO_2e by the year 2020, which is equivalent to taking nearly 225,000 passenger vehicles off the road for one year.[8]



Year	GHG Savings (tCO_2e)		
	Hydro	Wind	Total
2016-2020	1,338,873	1,987,728	3,326,602
2021-2025	2,010,198	3,182,554	5,192,752
2026-2030	1,980,225	3,026,577	5,006,802
Total 2016-2030	**5,329,296**	**8,196,859**	**13,526,156**

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Published November 2016
Prepared by ICF under the USAID Resources to Advance LEDS Implementation activity. Visit: climatelinks.org/projects/rali