Calculating and Projecting Energy and GHG Benefits

A Case Study of Solar, Wind, and Energy Efficiency Activities in El Salvador

RESULTS AT A GLANCE

4,863,778
tCO_2e
mitigated from 2018 to 2030

estimated using CLEER tool for reporting on EG. 12-7 Projected GHGs

360 MW
of renewable energy deployed

61%
reduction in energy consumed from public lighting in the Municipality of Zacatecoluca

$720 million
estimated investment facilitated for solar and wind projects

Access the Clean Energy Emission Reduction (CLEER) tool 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 solar, wind, and energy efficiency 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]

FACILITATING CLEAN ENERGY AND ENERGY EFFICIENCY INVESTMENTS IN CENTRAL AMERICA

While Central America is not a major contributor to the world's GHG emissions, opportunities for GHG mitigation—ranging from small, yet scalable activities to larger, more capital-intense measures—exist within the region. The region has high potential for clean energy development, but the lack of a strong legal framework and institutional capacity hinder progress.

The Regional Clean Energy Initiative (RCEI) is a five-year USAID project (2012–2017) that provides technical assistance to Central American institutions to facilitate renewable energy development and energy efficiency. Through this project, USAID implements activities to support two objectives:

1. **Improve the investment environment for renewable energy development.** USAID is strengthening the capacity of regional organizations to improve the Regional Electricity Market. Activities include formulating energy plans to include renewable energy, providing technical assistance to national and municipal governments, and defining initiatives that determine the region's energy strategy and roadmap.

2. **Reduce energy consumption throughout the region.** USAID is providing technical assistance to governments to develop and implement national energy efficiency programs.

OVERVIEW OF CLEAN ENERGY ACTIVITIES

In El Salvador, USAID has supported increasing renewable electric generation capacity and implementing an energy-efficient street lighting program. These activities will yield significant GHG emission impacts for El Salvador, and can also be replicated in other countries in the region.

Improving the Environment for Public and Private Investments in Renewable Energy Projects: USAID supported the government of El Salvador in its efforts to expand renewable energy production by assessing how solar and wind power can be integrated into the electricity grid and by providing technical assistance to regulators and policymakers. Between 2013 and 2014, USAID supported the General Electricity and Telecommunications Superintendence in two competitive bidding processes: a 15 MW distributed renewable generation reverse auction worth US$45 million and a 100 MW non-conventional renewable generation reverse auction with a total investment of US$200 million. In August 2015, El Salvador's National Energy Council announced plans to auction an additional 150 MW of renewable energy projects, which are expected to come online in 2018. This success followed a USAID-led study examining the impacts of additional renewable generation on the Salvadoran electric power system. USAID then provided support to regulators in transitioning to an energy market based more on contracted supplies. This support will facilitate US$720 million in private clean energy investments, resulting in approximately 320.7 MW of solar and 40 MW of wind power deployed. These additions would represent an approximate 20% increase in the overall generation capacity of El Salvador.[3]

Increasing Energy Efficiency and Public Safety with Street Lighting: In 2015, USAID supported the municipality of Zacatecoluca, El Salvador, in transitioning to energy-efficient street lighting by helping the municipal council estimate the costs and benefits of efficient lighting, which ultimately show significant energy and cost savings. USAID also supported the launch of the Zacatecoluca bidding process for the equipment, installation, operation, and maintenance of 1,668 efficient lamps. Technical and business model requirements for bidders were identified, which together made the project sustainable and provided safeguards for stakeholders. In addition, USAID donated 177 energy-efficient lamps to the municipality with a value of approximately US$200,000, resulting in 1,845 efficient lamps in total. Besides saving energy and offsetting the use of fossil fuels, the new lights provide better illumination, contributing to increased economic activity and reduced public security risks and crime.

GHG ESTIMATION METHODOLOGY AND ASSUMPTIONS

The USAID RALI project used the Clean Energy Emission Reduction (CLEER) tool to quantify GHG 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).

Solar and Wind Power

STEP 1 - RALI obtained project information from the RCEI Mission. RALI assumed that renewable energy projects that were under development at the time the project information was shared would be operational in 2018.

STEP 2 - RALI calculated the amount of energy that will be generated annually from solar 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 and solar technologies were provided by RCEI. The calculations were made using country average capacity factors. For wind technologies, a capacity factor of 24% was used, based on International Energy Agency (IEA) statistics.[6] For solar technologies, a capacity factor of 17% was used, based on NASA statistics.[7] 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, RALI assumed that the systems are fully operational throughout the year.

STEP 3 - RALI estimated the annual GHG emissions associated with the baseline scenario, the scenario in which no wind or solar technologies are installed, using the following equation:

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

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 solar technologies are connected to the grid, and thus the baseline fuel source is the consumption of grid electricity that is avoided as a result of the wind and solar technologies.

STEP 4 – RALI calculated the annual GHG emissions reduced:

$$\text{Emissions Reduced (tCO}_2\text{e)} = \text{Baseline Emissions (tCO}_2\text{e)} - \text{Activity Emissions (tCO}_2\text{e)}$$

RALI assumed that there are no emissions associated with the operation of wind and solar technologies, and thus the activity emissions are equal to zero. Therefore, the total emissions reduced are equal to the baseline emissions. In order to estimate projected cumulative GHG emissions avoided for each year through 2030 from these interventions, RALI assumed that the energy impacts would continue through 2030. RALI assumed an annual technology degradation rate of 0.5% for solar technologies and 1% for wind technologies (based on expert judgement).

Energy Efficient Street Lighting

STEP 1 - RALI obtained project information from the RCEI Mission. The implementer provided information on the number and type of lighting fixtures.

STEP 2 - RALI estimated the GHG emissions reductions from diesel savings using the following equation:

$$\text{Emissions Reduced } (tCO_2e) = \text{Electricity Savings (GJ)} \times \text{Emission Factor} \left(\frac{tCO_2e}{GJ}\right) \times \frac{1}{(1 - \text{Line Loss Factor})} (\%)$$

RALI calculated the amount of energy that will be consumed by new energy-efficient fixtures in Zacatecoluca (using details on the number of units by wattage level), as well as the energy that would have been consumed by the same number of traditional 175 watt high-pressure mercury vapor lamps, in order to estimate the electricity savings. Emission factors refer to the amount of carbon dioxide (CO_2) emitted per unit of energy. The grid electricity emission factor utilized is a national-level combined marginal emission factor. This factor is a national average of all combined marginal emission factors used by registered Clean Development Mechanism (CDM) projects (2004-2015) in El Salvador, based on the CDM methodology.[4] The line loss factor accounts for additional energy needed to be produced in order to deliver electricity. The line loss factor used was derived from IEA data, and adjusted to remove non-technical line loss such as theft of electricity.[5]

What is a combined marginal emission factor?

A *combined marginal emission factor* takes into account both operating margin and build margin. Operating margin reflects avoided emissions from existing power infrastructure (i.e., power plants or sources that already supply electricity to the country's electric grid). Build margin reflects avoided emissions from new infrastructure (i.e., new power plants or sources that would need to be built to meet additional electricity needs).

CLEER uses combined marginal emission factors to better reflect the emissions likely to be reduced or avoided as a result of clean energy interventions.

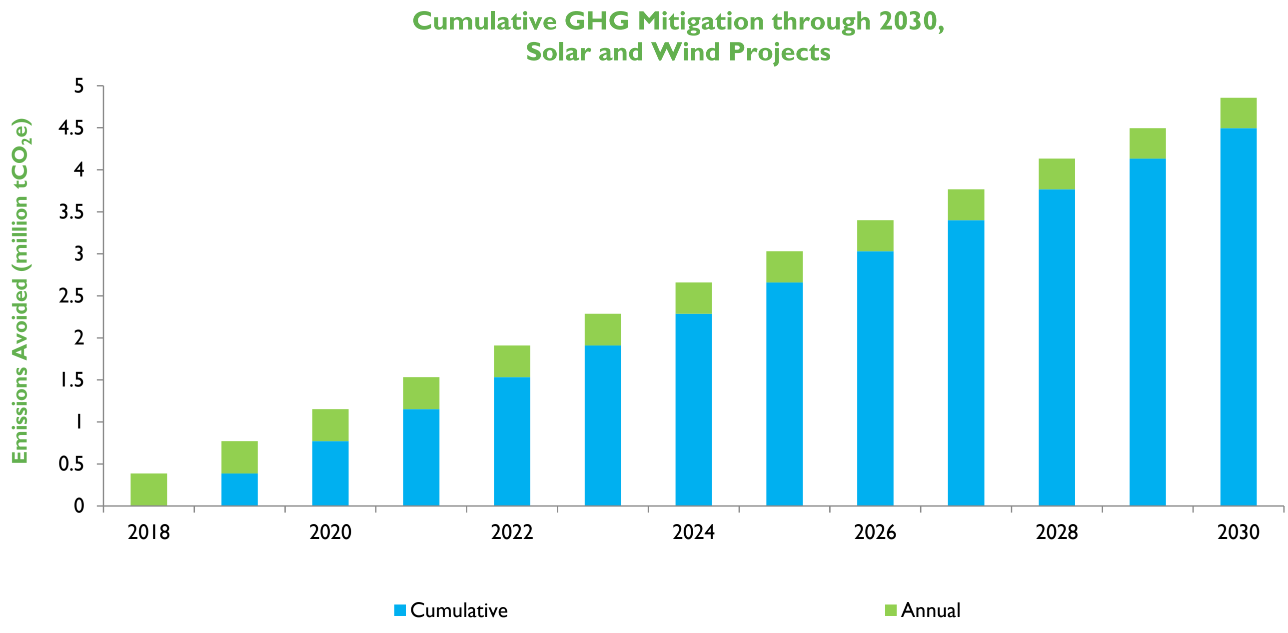
In order to estimate projected cumulative GHG emissions avoided for each year from these interventions, RALI assumed that the energy impacts would continue through 2026, based on RALI estimates of lightbulb lifetimes. RALI assumed a technology degradation rate of 0.5% per year (based on expert judgement).

GHG CALCULATIONS AND RESULTS

Renewable Energy Capacity: RALI estimates that in 2018, 330,437 metric tons of CO_2-equivalent (tCO_2e) will be avoided from the addition of 320.7 MW of solar capacity, and 56,128 tCO_2e will be avoided from the addition of 40 MW of wind capacity in El Salvador. From 2018-2030, these projects are expected to avoid over 4.8 million tCO_2e.

Energy-Efficient Public Lighting Program: The energy-efficient public lighting program in Zacatecoluca is projected to reduce energy consumption from public lighting by 61% and avoid 7,180 tCO_2e from 2016-2026. While small in size, this project is replicable for other municipalities in El Salvador and the region. RALI projects that 407,030 tCO_2e could be avoided over this timeframe if all public lighting in El Salvador were replaced with similar technologies.

Year	GHG Savings (tCO_2e)			
	Solar	Wind	Energy Efficiency	Total
2016-2020	986,363	166,706	3,215	1,156,284
2021-2025	1,611,332	266,914	3,296	1,881,542
2026-2030	1,571,450	253,832	669	1,825,951
Total (2016-2030)	**4,169,145**	**687,453**	**7,180**	**4,863,778**



REFERENCES

[1] USAID (2016). GCC Standard Indicator Handbook. <https://www.climatelinks.org/resources/gcc-standard-indicator-handbook>
[2] USAID (2016). GCC Clean Energy. < https://www.usaid.gov/climate/clean-energy>
[3] CIA (2017). The World Factbook 2016. <https://www.cia.gov/library/publications/the-world-factbook/geos/es.html>
[4] Institute for Global Environmental Strategies (2015). List of Grid Emission Factors – Version 2015/10. <http://pub.iges.or.jp/modules/envirolib/view.php?docid=2136>
[5] IEA (2013). World Electricity and Heat Supply and Consumption. <https://www.iea.org/statistics/relateddatabases/electricityinformation/>
[6] IEA (2011). World Statistics: Wind Power Generation Capacity and Total Energy Generated. <http://www.iea.org/statistics/>
[7] NASA (2012). Surface meteorology and Solar Energy (SSE) Release 6.0 Data Set (Jan 2008) 22-year Monthly & Annual Average (July 1983 - June 2005) Parameter: Insolation on a Tilted Surface.
[8] IGES (2015). List of Grid Emission Factors – Version 2015/10. <http://pub.iges.or.jp/modules/envirolib/view.php?docid=2136>

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