Calculating Energy Savings and Projected Emissions Reduced

A Case Study of Industrial Energy Efficiency Improvement Options in Bangladesh

RESULTS AT A GLANCE: FIRST 8 EE OPTIONS

54,296 tCO_2e

mitigated from 2015 to 2030

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

3,268 tCO_2e

mitigated in 2015

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

$668,350

estimated cost savings in 2015

51,081 GJ

of energy saved annually

74 interventions

(EEIOs) completed or underway as of 2015

88 individuals

trained as certified energy auditors

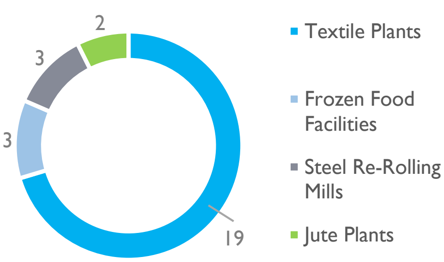
Access the Clean Energy Emission Reductions (CLEER) calculators at cleertool.org.

This case study is one of a series being developed by the USAID Resources to Advance LEDS Implementation (RALI) project 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 energy efficiency interventions, including potential greenhouse gas (GHG) emission 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. RALI seeks to develop cost-effective methodologies for assessing the impact of the full range of clean energy assistance provided by USAID.* [2]

COMBATING ELECTRICITY SHORTAGES WITH ENERGY EFFICIENCY IMPROVEMENT OPTIONS (EEIOs)

Bangladesh is a rapidly growing nation with a goal of diversifying its industries and becoming a middle-income economy by 2021. This economic growth is accompanied by increasing greenhouse gas (GHG) emissions and challenges of meeting growing electricity demand. While Bangladesh's GHG emissions accounted for only 0.38% of global emissions in 2013, emissions grew by 93% from 1990–2013.[3] Energy currently accounts for approximately one-third of GHG emissions in Bangladesh, but the country projects an increase of 264% in energy-sector emissions from 2011–2030.[4]

Industrial Facilities Implementing EEIOs



In response to anticipated growth in energy demand and associated GHG emissions, and to combat electricity shortages, USAID Bangladesh launched the $15 million Catalyzing Clean Energy in Bangladesh (CCEB) project in 2012. CCEB supports the identification and implementation of energy efficiency improvement options (EEIOs) in the textile, frozen food, jute, and steel re-rolling industries, where there is high potential to improve energy efficiency. To reach a goal of implementing EEIOs in at least 40 small- or medium-sized industrial facilities, CCEB networks extensively with industry stakeholders to catalyze interest in investing in energy efficiency. For potential partners that express interest, CCEB conducts initial walk-through audits to assess potential energy savings. In facilities with high potential, CCEB conducts investment-grade audits to provide detailed information on the financial viability and energy impacts of the EEIOs. Both audits are conducted by professional organizations staffed by certified energy auditors. After completing the analyses, partners are invited to apply for an incentive grant award to cover up to 30% of the energy efficiency investment costs.

As of mid-2015, CCEB had conducted 100 initial energy efficiency audits and 38 investment-grade audits, and 74 EEIOs at 27 small- or medium-sized industrial facilities were underway. The efficiency upgrades of the first eight EEIOs are poised to yield significant energy and GHG emissions savings that can be replicated at other facilities.

DEMONSTRATING FINANCIAL VIABILITY AND ENERGY EFFICIENCY IN SMALL- AND MEDIUM-SIZED FACILITIES

Facility owners from eight interventions reported energy savings of 51,081 gigajoules (GJ) in 2015. The energy-saving measures were implemented in textile plants, a steel mill, and a frozen food facility. Nearly 94% of the energy savings displaced natural gas consumption, while 6% displaced consumption of grid electricity.

Five additional EEIO interventions have been completed but have not yet reported their energy savings, and 61 more interventions are currently underway. Due to this growing pipeline, the CCEB project as a whole is expected to achieve energy savings and GHG benefits much greater than those estimated in this case study. Additionally, CCEB training has supported the certification of 88 Association of Energy Engineers-certified energy auditors and facilitated the establishment of an Association of Energy Engineers Chapter in Bangladesh.

This efficient thermo oil heating system and exhaust gas boiler are saving 30,620 GJ of energy annually at an apparel factory.

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 reduced) and EG.12-7 (projected future GHG emissions reduced). These activities can also report on EG.12-4 (investment mobilized).[5]

STEP 1 - RALI obtained project data from the CCEB team. RALI made calculations using eight EEIO interventions that have been completed and reported energy savings.

STEP 2 - RALI estimated the GHG emission reductions from natural gas and electricity savings. The following equation was used to estimate emission reductions from natural gas savings:

$$\text{Emissions Reduced } (\text{tCO}_2\text{e}) = \text{Natural Gas Savings (GJ)} \times \text{Emission Factor } \left(\frac{\text{tCO}_2\text{e}}{\text{GJ}}\right)$$

The natural gas emission factor is the amount of carbon dioxide (CO_2) emitted per unit of energy. The emission factor used for natural gas was 0.056 tCO_2e/GJ, obtained from the Intergovernmental Panel on Climate Change (IPCC).[6]

The following equation was used to estimate emission reductions from electricity savings:

$$\text{Emissions Reduced } (\text{tCO}_2\text{e}) = \text{Electricity Savings (MWh)} \times \text{Emission Factor } \left(\frac{\text{tCO}_2\text{e}}{\text{MWh}}\right) \times \frac{1}{(1 - \text{Line Loss Factor})} (\%)$$

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), which are based on the CDM methodology.[7] The line loss factor accounts for additional energy needed to be produced in order to deliver the required amount of electricity. The line loss factor was derived from International Energy Agency (IEA) data, and adjusted to remove non-technical line loss such as theft of electricity.[8]

In order to estimate projected cumulative GHG emissions avoided for each year through 2030 from these interventions, RALI assumed that the resulting energy impacts from the EEIOs would continue through 2030. RALI assumed a technology degradation rate of 0.5% per year (based on RALI expert judgement).

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.

COST SAVINGS METHODOLOGY AND ASSUMPTIONS

The USAID RALI project estimated cost savings associated with energy efficiency interventions. The following equation was used to estimate cost savings from electricity savings:

$$\text{Cost Savings } (\$) = \text{Electricity Savings (MWh)} \times \text{Electricity Price} \left(\frac{\text{Tk}}{\text{MWh}}\right) \times (1 + \text{VAT})(\%) \times \text{Exchange Rate} \left(\frac{\$}{\text{Tk}}\right)$$

Electricity savings (MWh) is the amount of electricity saved as a result of the energy efficiency intervention. The electricity price used was the per unit-price of electricity for small industries in Bangladesh for 2015, obtained from the Dhaka Power Distribution Company.[9] The value added tax (VAT), which is applied to all energy purchases, is obtained from the Dhaka Electric Supply Company.[10] The exchange rate of Bangladeshi Taka (Tk) to U.S. dollars was obtained from the United States Treasury, and reflects the 2015 market rate.[11]

The following equation was used to estimate cost savings from natural gas savings:

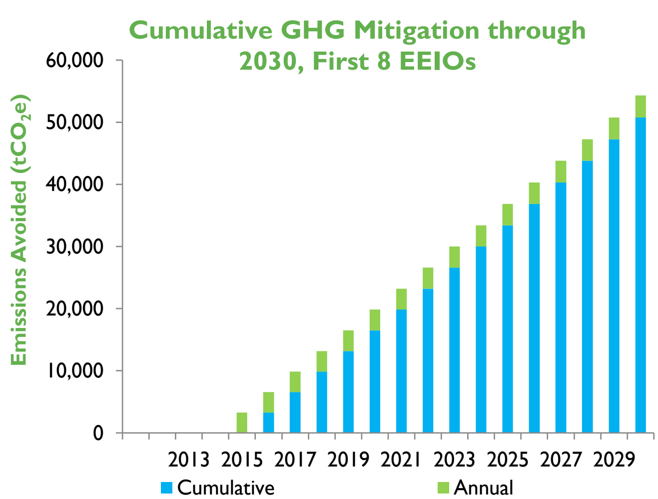
$$\text{Cost Savings } (\$) = \text{Natural Gas Savings (GJ)} \times \text{Natural Gas Price} \left(\frac{\text{Tk}}{\text{GJ}}\right) \times (1 + \text{VAT})(\%) \times \text{Exchange Rate} \left(\frac{\$}{\text{Tk}}\right)$$

The natural gas price used was the flat rate in 2015 obtained from the Bangladesh Energy Regulatory Commission via Roots BD.[12]

GHG CALCULATIONS AND RESULTS

The eight EEIOs that were reviewed consisted of technology installations at four industrial plants, including air compressor inverters, energy-efficient LED lights, an efficient thermo oil heater system, an efficient exhaust gas boiler, a recuperator with an efficient burner system, and freezer insulation.

Year	GHG Savings (tCO_2e)
2015-2020	19,855
2021-2025	17,006
2026-2030	17,435
Total	**54,296**



In total, these eight EEIOs are expected to reduce energy consumption by as much as 51,081 GJ annually. In 2015, these EEIOs reduced GHG emissions by 3,268 tCO_2e. In total, these interventions are expected to avoid 54,296 tCO_2e from 2015 through 2030.[13] If similar GHG impacts are attained by the other 66 planned EEIOs, total emission reductions through 2030 would approach 500,000 tCO_2e, roughly equivalent to taking over 105,000 U.S. passenger vehicles off the road for one year.[14]

COST SAVINGS

Energy efficiency investments that displaced electricity are estimated to have saved $82,920 in 2015. Additionally, energy efficiency investments that displaced natural gas consumption are estimated to have saved $585,430 in 2015. In total, these interventions are estimated to have saved $668,350 in 2015. Similar cost savings are expected to continue to occur each year over the lifetime of the equipment, subject to changes in the market price of electricity and natural gas.

FOOTNOTES AND 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] World Resources Institute (2017). CAIT Climate Data Explorer. <http://cait.wri.org/>

[4] Ministry of Environment and Forests, Government of the People's Republic of Bangladesh (2015). Intended Nationally Determined Contributions (INDC). Government of the People's Republic of Bangladesh. <http://www4.unfccc.int/ndcregistry/PublishedDocuments/Bangladesh%20First/INDC_2015_of_Bangladesh.pdf>

[5] Investment mobilized measures capital invested by the private company partners on EE equipment as a result of the project.

[6] IPCC (2006). IPCC Guidelines for National Greenhouse Gas Inventories. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf>

[7] 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>

[8] IEA (2013). World Electricity and Heat Supply and Consumption. <https://www.iea.org/statistics/relateddatabases/electricityinformation/>

[9] Dhaka Power Distribution Company (2015). Tariff Rates. <https://www.dpdc.org.bd/index.php/customer-service/tariff-rates>

[10] Dhaka Electric Supply Company (2015). Tariff Rate. <https://www.desco.org.bd/?page=tariff-rate>

[11] US Treasury (2017). Treasury Reporting Rates of Exchange. <https://www.fiscal.treasury.gov/fsreports/rpt/treasRptRateExch/itin-12-31-2015.pdf>

[12] RootsBD (2015). New Price of Gas & Electricity in Bangladesh. <http://rootsbd.com/bangladesh/new-price-gas-electricity-bangladesh-september-2015-www-berc-org-bd/>

[13] Note that GHG savings increase slightly in the latter years, due to equipment degradation. Equipment in the baseline scenario and the intervention scenario are both assumed to degrade at roughly the same rate (0.5% per year). As energy usage is higher in the baseline scenario, slightly more energy is lost to equipment degradation. Thus, the GHG benefits from the intervention scenario are slightly higher in the latter years.

[14] U.S. Environmental Protection Agency (2017). Greenhouse Gas Equivalencies Calculator. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>

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This case study is made possible by the support of the American people through the United States Agency for International Development (USAID). The contents are the sole responsibility of ICF and do not necessarily reflect the views of USAID or the United States Government.