Climate MRV for Africa – Phase 2
MRV of Mitigation Actions
Grid-Connected Renewable Electricity in Nigeria: Case Study

Lead partner

Project of the European Commission DG Clima Action

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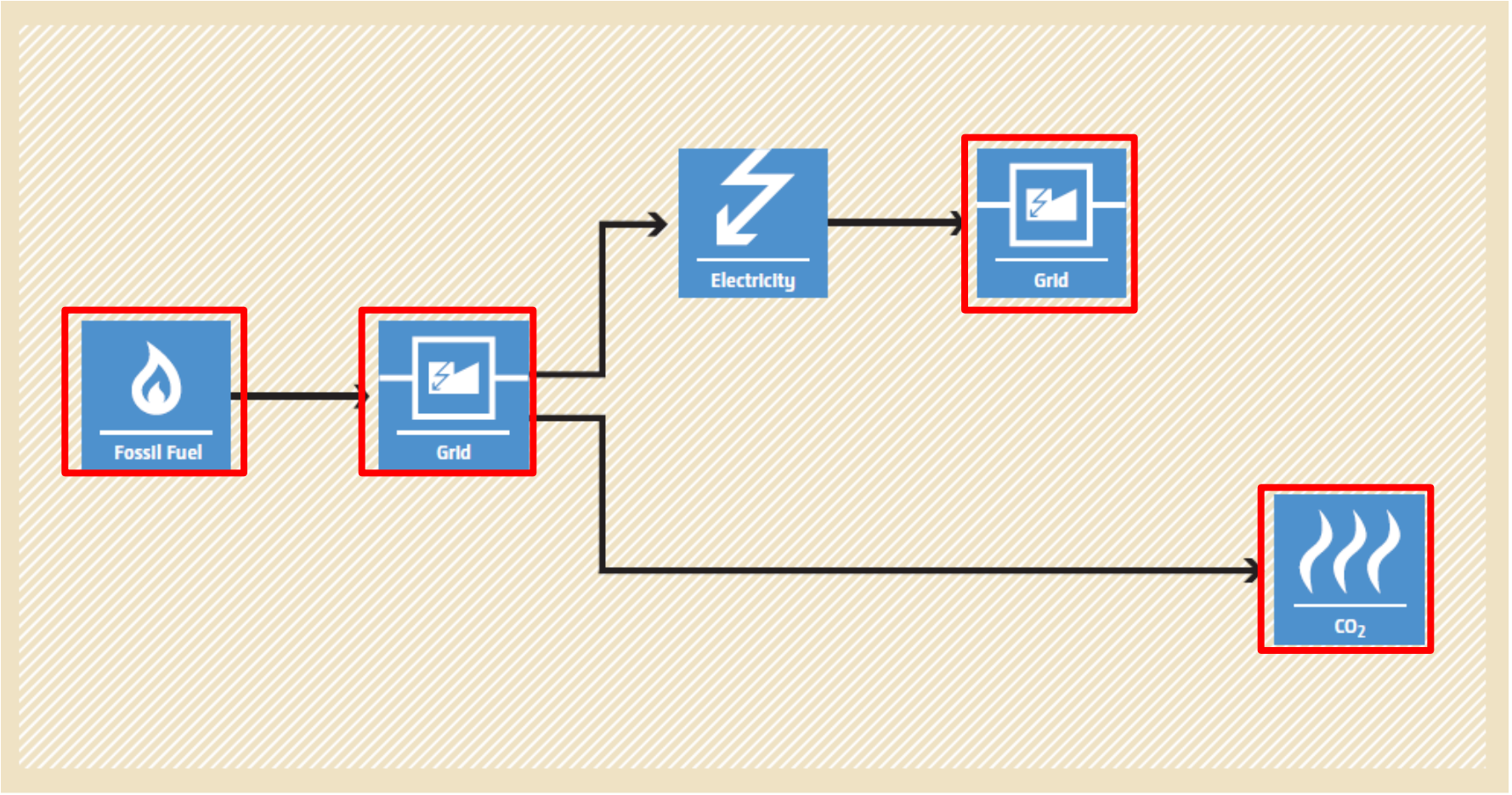
Agenda

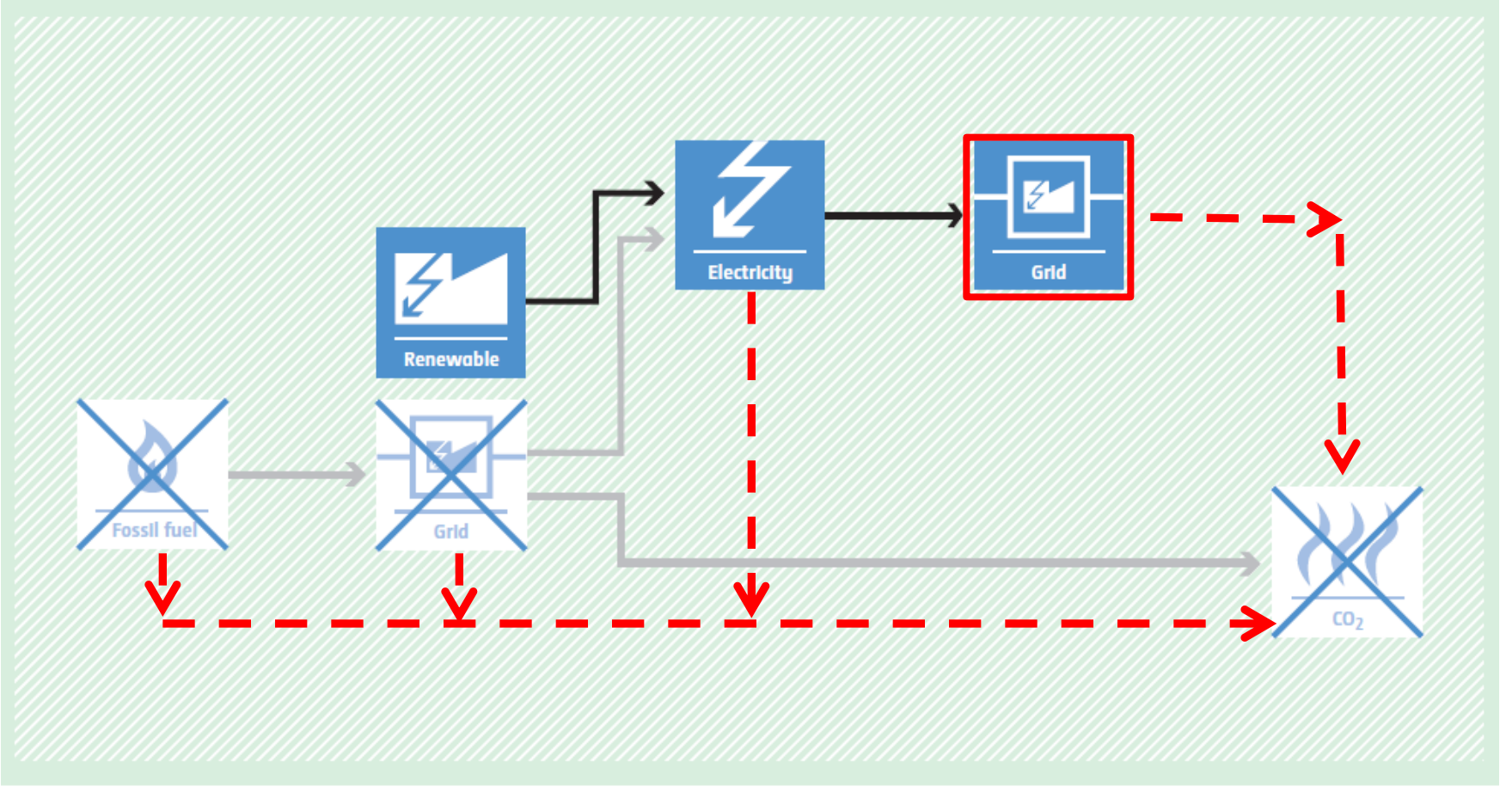
- Define Mitigation Action
- Co-Benefits of Mitigation Action
- Define the GHG Assessment Boundary
- Baseline Emissions
- Mitigation Action Emissions
- Monitoring & Reporting Performance over Time

1a. Define Mitigation Actions - Nigeria's Current Grid-Connected Electricity Generation



"Ex-ante" - Current Situation: Grid 75% Fossil Fuels ~ 25% Large Hydropower => *High Grid Emissions*

1b. Define Mitigation Action – Nigeria's Grid-Connected Renewable Electricity - After



"Ex-post": Increased Grid-Connected Renewable Electricity => *Reduced Grid Emissions*

1c. Define Policy/Action

Information	Example
The title of the policy/action	**Increased incentives for, reduced barriers to, grid-connected renewable electricity generation**
Type of policy or action	1. National Renewable Energy and Energy Efficiency Policy 2. Increased incentives for renewable electricity on-grid including Feed-in-Tariffs (FiTs) for renewables (NERC) 3. Easier licensing for renewable electricity generators 4. Easier access for small & medium scale renewables to grid
Geographical coverage	Nationwide coverage within the borders of the Federal Republic of Nigeria
The status of the policy or action	In place (MoPWH, NERC, ECN, FME, etc.)
Targeted GHG	CO_2
Key performance indicators	• Increased renewable energy-generated electricity on grid (GWh) • Reduction in CO_2 per unit of electricity consumed.

1d. Mitigation Activities for Electric Grid-Based Renewable Electricity

- **Install a number of Solar Photovoltaic (PV) arrays ("solar farms") Connected to the Grid:** Invest in & install high-efficiency, low-cost (per kWp installed) solar PV on the grid.

- **Install a number of High Efficiency, Run-of-River Small-Medium Hydropower (SMH) Plants Connected to the Grid:** Invest in & install new high-efficiency small-to-medium-scale hydro-electricity plants on the grid.

- **Prepare for further grid-connected Renewable Electricity (RE) Projects using Other High-Efficiency Technologies:** Prepare for new grid-connected RE technologies including Wind, LFG, etc..

1e. Grid-Connected RE Technologies for Mitigating GHG Emissions

- Solar PV Electricity Systems
- Hydropower Systems
- Wind Electricity Systems
- LFG & Other Biomass Electricity Systems
- Other Technologies
- New & state-of-art control & dispatch systems for grid connected RE
- New state-of-art grid storage systems
- Innovative grid dispatch programmes to reduce GHGs

2a. Define GHG Assessment Boundary

- Primary boundary is Nigeria's national inter-connected grid system (ICS)
- RE generators (initially solar PV & small hydro) connected to Nigeria's inter-connected grid system

2b. Define GHG Assessment Boundary

Assess the significance of potential GHG effects

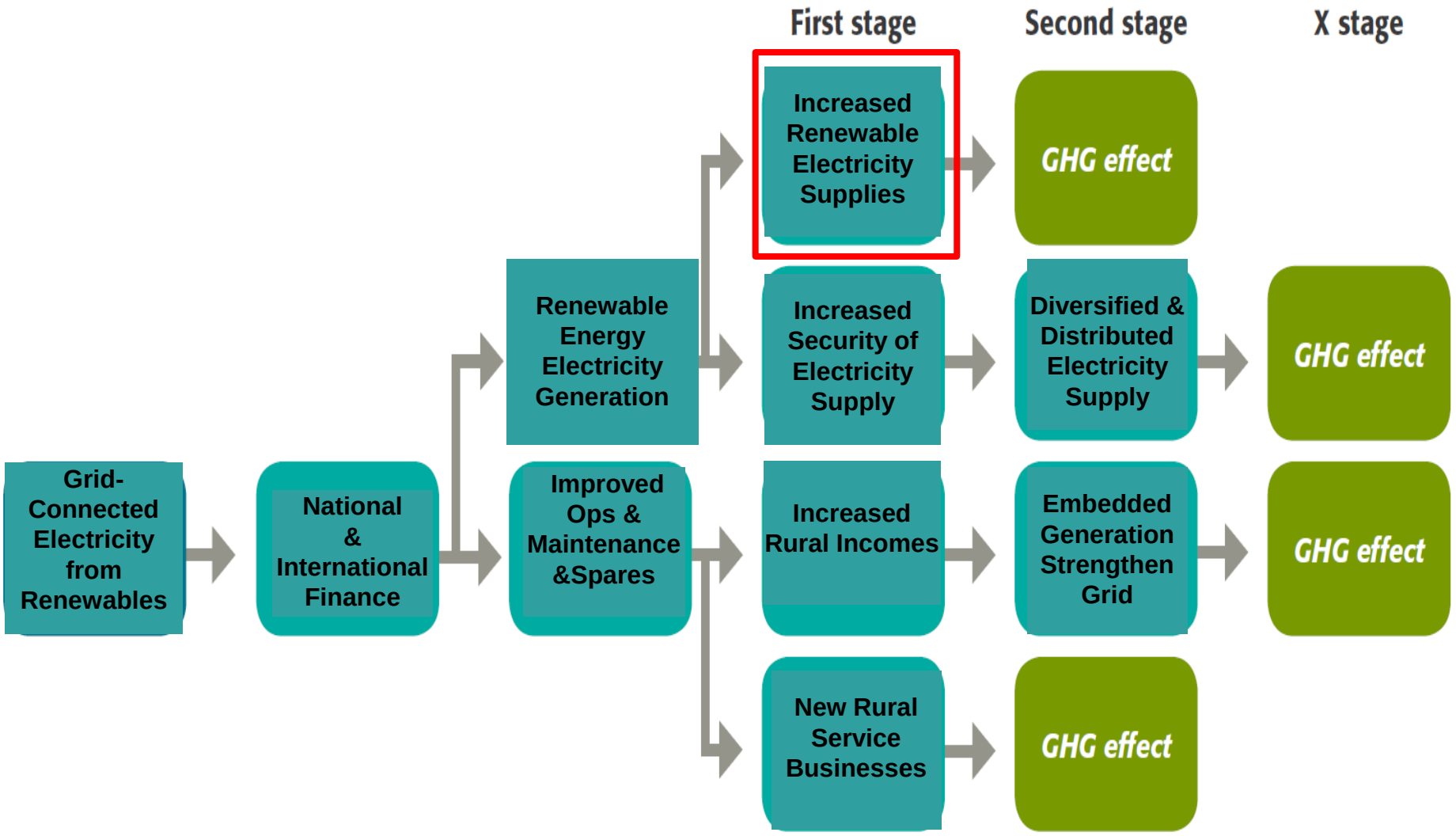
GHG effect	Likelihood	Relative magnitude	Included?
Reduced emissions from grid electricity generated from renewable resources			
CO_2	**Very likely**	**Major**	**Included**
CH_4	**Very likely**	**Minor**	**not included**
N_2O	**Very likely**	**Minor**	**not included**

List GHG to be included in Assessment Boundary

GHG effect	GHG Sources	GHG sinks	Greenhouse gas(es)
1 Reduced emissions on national grid from grid-connected electricity generated from renewable resources.	Electric power stations; electricity grid.	N/A	CO_2

List GHG sinks: None

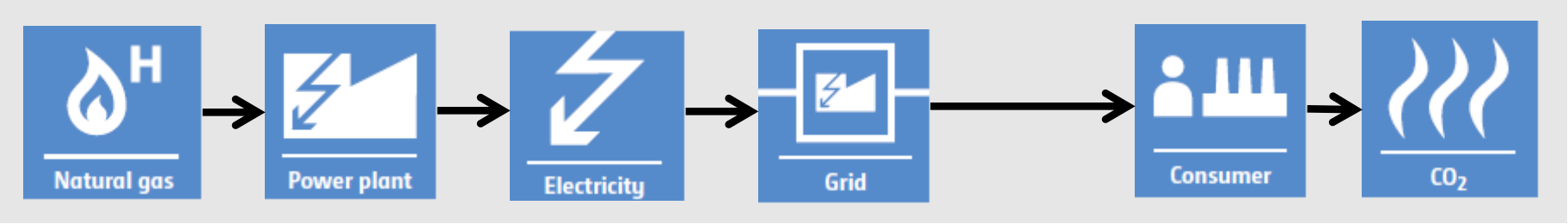
2c. Simplified GHG Causal Chain



3a. Baseline Emissions

Baseline Scenario

Increasing amounts of CO_2 are released into the atmosphere from fossil-fueled power stations supplying the grid.



Use CDM Methodology AMS-I.D. – Small-scale Methodology, Grid-connected renewable electricity generation, Version 18.0

Source: CDM Methodology Booklet , Eighth Edition, November 2016

3b. CDM Methodology: AMS – I.D

AMS-I.D: Small-scale Methodology, Grid-connected renewable electricity generation, Version 18.0

Typical project(s)	Construction and operation of a power plant that uses renewable energy sources and supplies electricity to the grid (greenfield power plant) or retrofit, replacement or capacity addition of an existing power plant that uses renewable energy sources and supplies electricity to the grid.
Type of GHG emissions mitigation action	Renewable energy. Displacement of electricity that would be provided to the grid by more-GHG-intensive means.
Important conditions under which the methodology is applicable	• Combined heat and power generation is not eligible (AMS-I.C. can be used here); • Special conditions apply for reservoir-based hydro plants.

Source: CDM Methodology Booklet , Eighth Edition, November 2016

3b. Baseline Emissions for Grid-Connected Electricity from Renewables - Key equation

$$BE_y = EG_{PJ,y} \times EFgrid_{,y}$$

Parameter	Definition
BE_y	Baseline emissions in year y (t CO_2)
$EG_{PJ,y}$	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the renewable electricity project activity in year y (MWh)
$EF_{grid,y}$	Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (t CO_2/MWh)

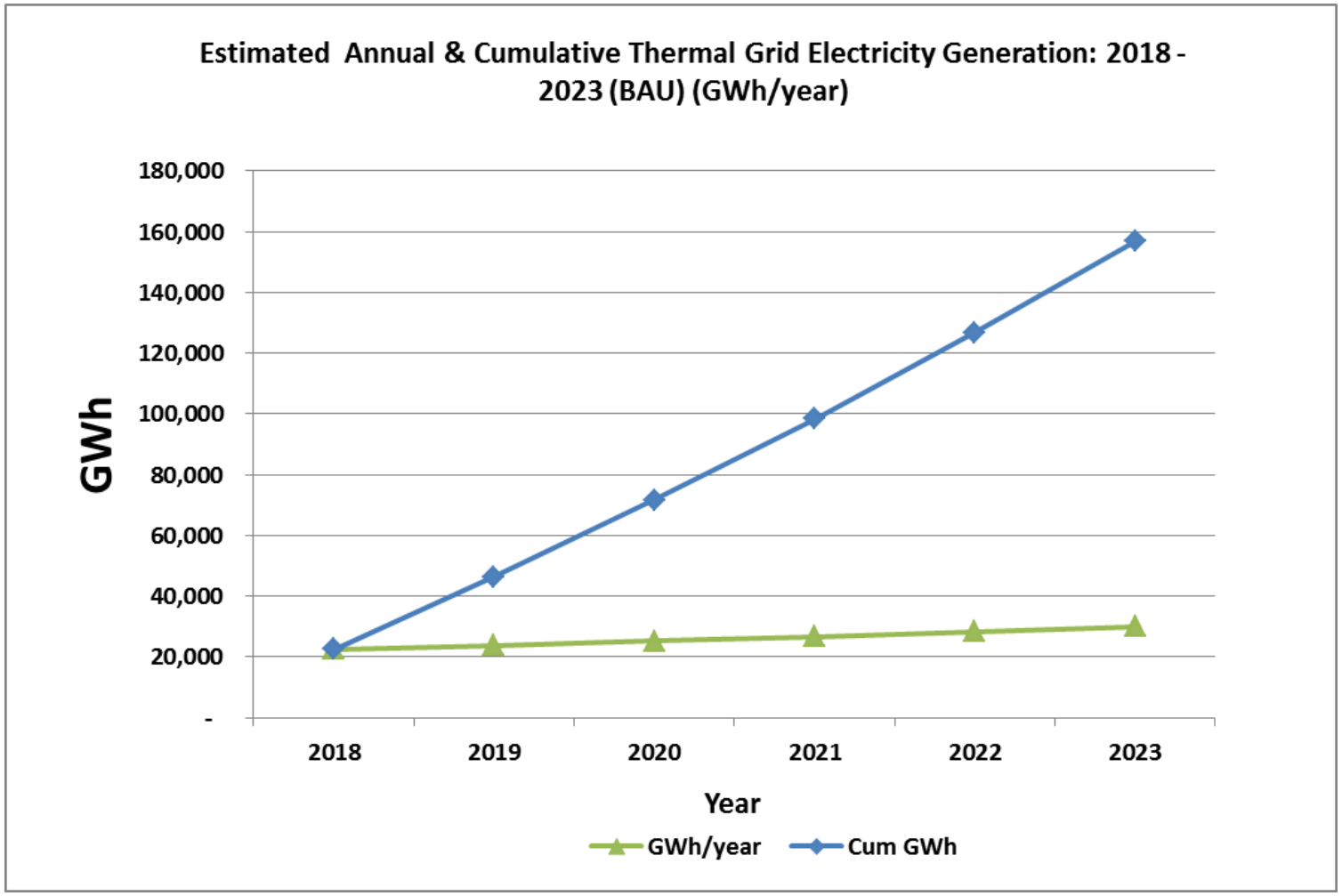
3c. Estimate emissions: Baseline

- **Fundamental equation for emission reductions (ERs)**

A		B		= A x B
Electricity generation (MWh)	**x**	**Grid Emissions Factor - EF (tCO_2/MWh)**	**=**	**CO_2 emissions (tCO_2)**

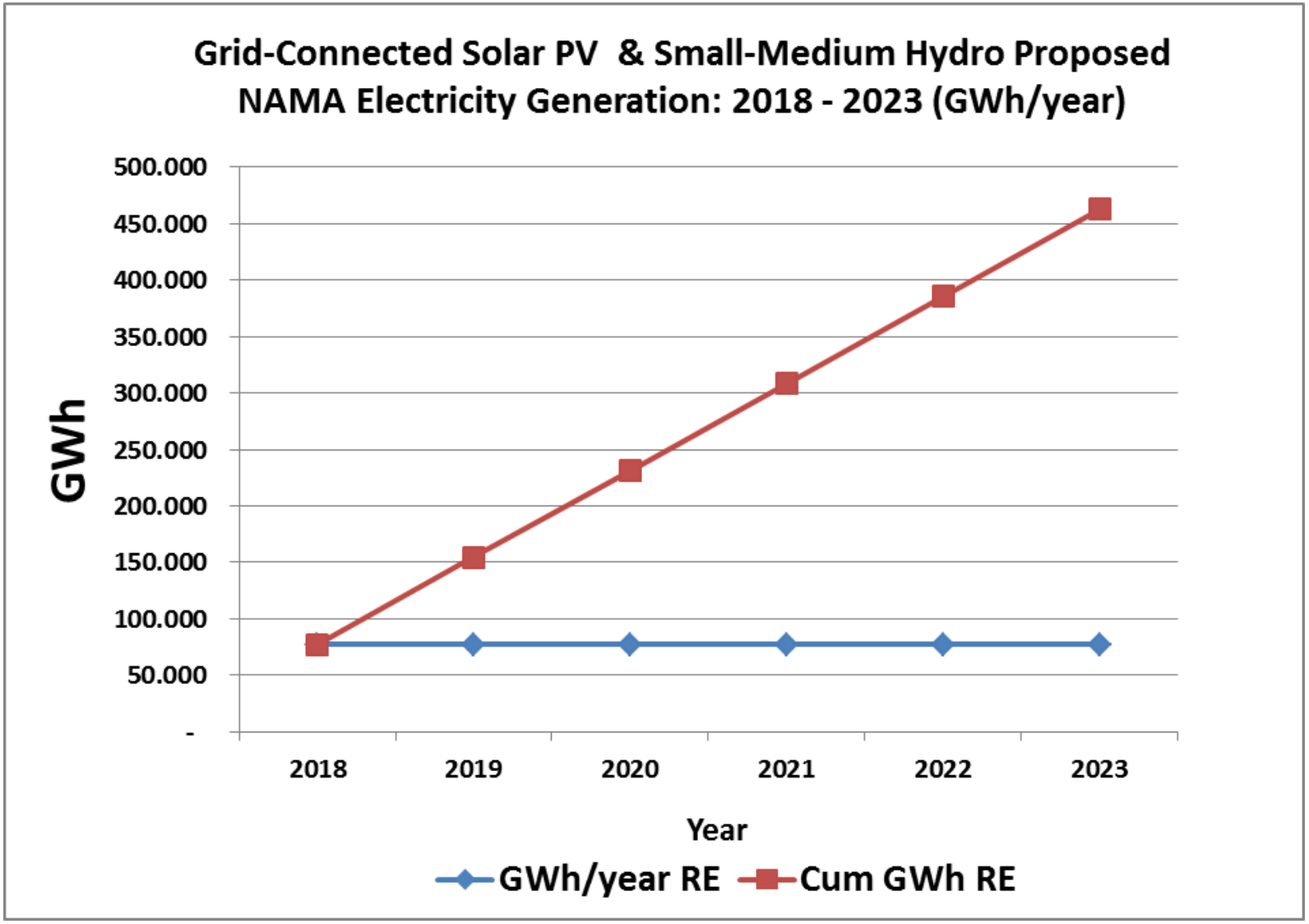
- **Electricity generation from renewable resources:**
  - **Top-down:** Total generation by renewable electricity generators
  - **Bottom-up:** Σ [renewable electricity projects x capacity x hours of generation]

BAU and Projections – Annual & Cumulative Thermal Grid Generation (GWh)

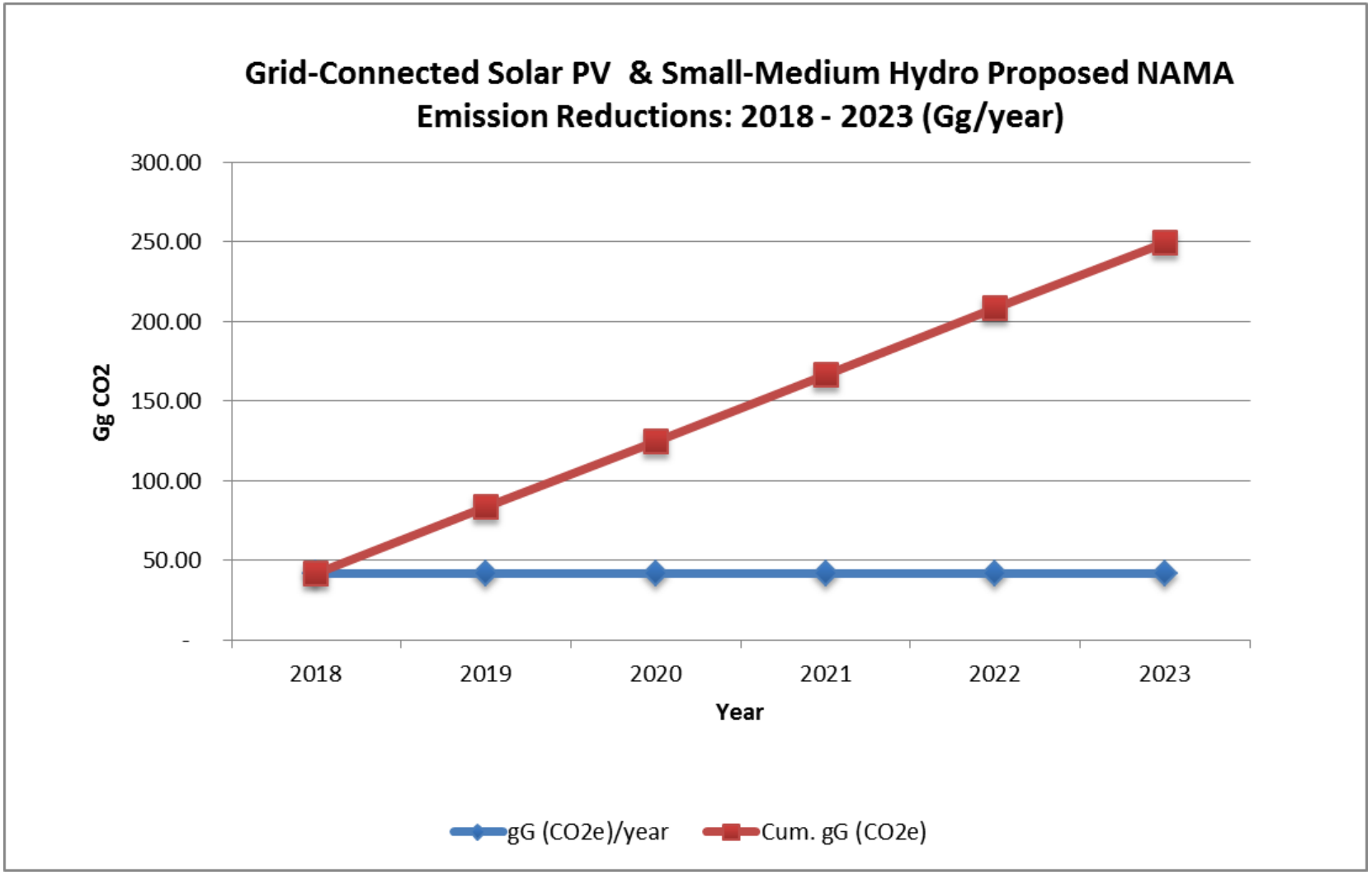


Simple estimate of Thermal (primarily natural gas) Generation on the grid during the six year, proposed Grid-Connected Electricity from Solar PV & Small-Medium Hydropower/SMH NAMA from 2018-2023 period WITHOUT introduction of NAMA Solar PV & SMH stations.

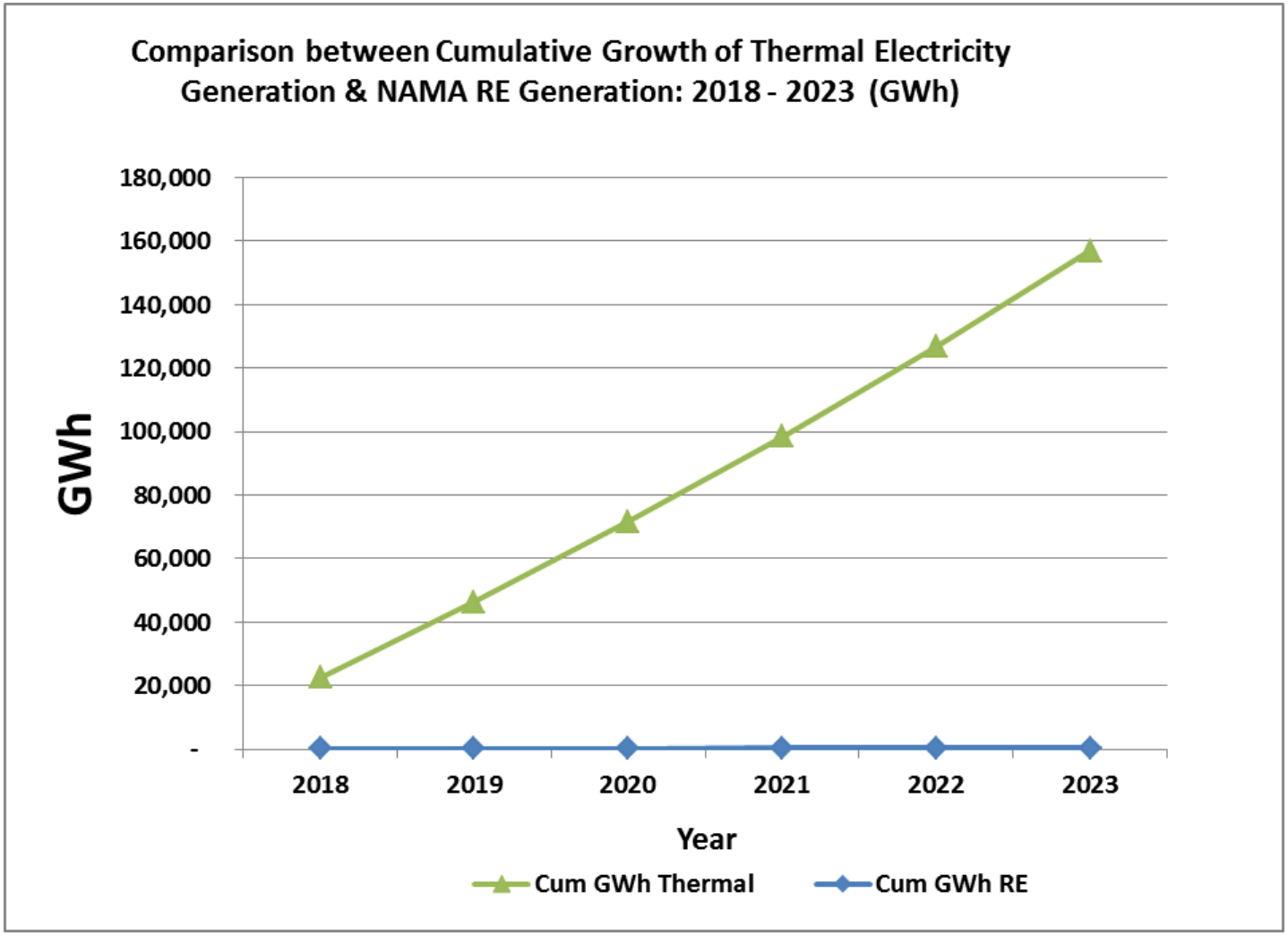
Mitigation Scenario Annual & Cumulative Grid-Connected RE Generation (GWh)



Mitigation Scenario Annual & Cumulative Grid-Connected RE CO_2 Reductions (Gg)



Mitigation Scenario Annual & Cumulative Effect of RE Generation on Thermal Generation (GWh)



Estimated Solar PV & SMH NAMA energy generation's effect on Grid-Connected Thermal (natural gas) electricity generation from 2018 to 2023

3d. Renewable Electricity Generation – Top Down

- Top-down analysis shows whether GHG emissions are increasing or decreasing in the electricity sector as a whole
- Changes cannot be attributed to any cause not represented in the driver variables (e.g., generator capacity, efficiency of generators, hours of generation, etc.)
- GHG production process must be further broken down into disaggregated components (e.g., electricity generation, networks, other)
- Additional variables that cause fuel to be used needs to be identified to identify the intervention causing mitigation

3e. Renewable Electricity Generation – Bottom Up

- Electricity generation, (in MWh), with the associated grid emission factor (GEF) are the basic units for GHG (tonnes of carbon dioxide equivalent (tCO_2e)
- The following are needed:
  - Number of renewable electricity generators by type (e.g., solar PV, hydro-electric, wind, etc.)
  - Date generators were commissioned/retro-fitted
  - Generating set rating (kW or MW)
  - Generators' average hours of operation per day or month or year
  - Generating stations' efficiency (%)

3f. Estimate Co-benefits of Mitigation Action

- Increased and improved electricity supplies to entire grid while stabilising & strengthening grid at RE generation points;
- Improved opportunities to expand grid coverage in rural areas, link up to growing number of isolated RE grids;
- Increased opportunities for isolated urban areas & rural areas through strengthened grid electricity supplies;
- New opportunities for urban & rural health improvement through more reliable electricity supplies; and,
- New job opportunities in urban & rural areas.

3g. Baseline Emissions Sources - Monitoring

Source	GHG
Emissions from electricity generated by fossil fuels	**CO_2**
Emissions from electricity displaced by mitigation action in the baseline	**CO_2**

3h. Monitoring Performance Over Time

- Following parameters for each pumping station during the Mitigation Action lifetime for accurate estimation of GHG emission reductions

Parameter
ni - Number of RE generators installed & operational over time
pi - Electrical power generated to the grid by each RE generator
oi - Annual operating hours for each RE generator.
ly - Annual grid losses on transmission and distribution system
Ey – Total annual electricity generation by RE generators
$\mathbf{EF_{CO2,y}}$ – Annual grid electricity emissions factor (GEF) for each year reported.

3i. Monitoring Over Time

Simplified Option

- Develop emission reductions from EACH participating grid-connected RE generating station
  - Use updated grid emission factor (GEF) for electricity supply to calculate emissions reduced by RE generation
  - Use meters to measure electricity generated (kWh/MWh) at stations and sold to the grid
  - Use operating hours per station (e.g., solar PV, small-medium hydro/SMH)
- Aggregate emission reductions (tCO_2) for all generating stations, weighting them on MW installed and for total NAMA project
- Compare emission reductions by station and by NAMA project to baseline emissions, and to projected NAMA project emissions to determine emission reduction of project compared to NAMA project projections

5. Reporting Over Time

- Several types of reports will be required to be generated over time:
  - If the project is a NAMA, then, a report on the mitigation actions taken and the results, including mitigation actions and outcomes must be reported.
  - If the project is funded by government, either partially, or wholly, then, reports will need to highlight investments & performance of renewable electricity stations (specifically electricity generated on to the grid and the CO_2 emission reductions associated with that generation), as well as financial and management reporting.
  - Same information will be reported if project is donor-financed.
  - Sustainable Development Co-Benefits will need to be reported both to the UNFCCC, to the government and to the donors/financiers of the activity.

Thank you!

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