Climate MRV for Africa – Phase 2
MRV of Mitigation Actions
Ethiopia - Solar Photovoltaics (PV) Water Pumping: Case Study

NIRAS Lead partner GreenStream TÜVRheinland® Precisely Right. camco clean energy

Project of the European Commission DG Clima Action

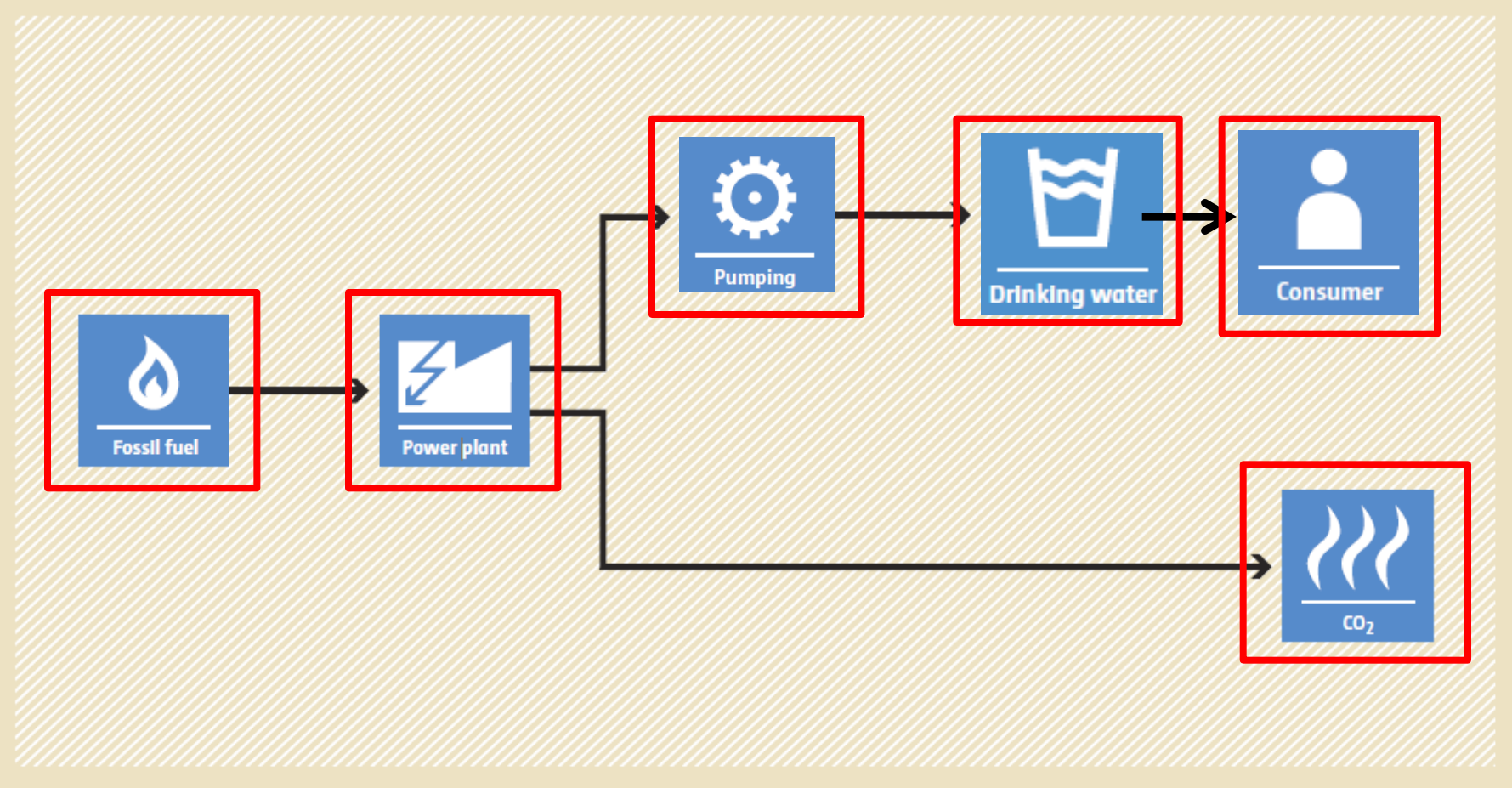
EuropeAid/136245/DH/SER/MULTI

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti
Team Leader and Key Experts
June 2017

Agenda

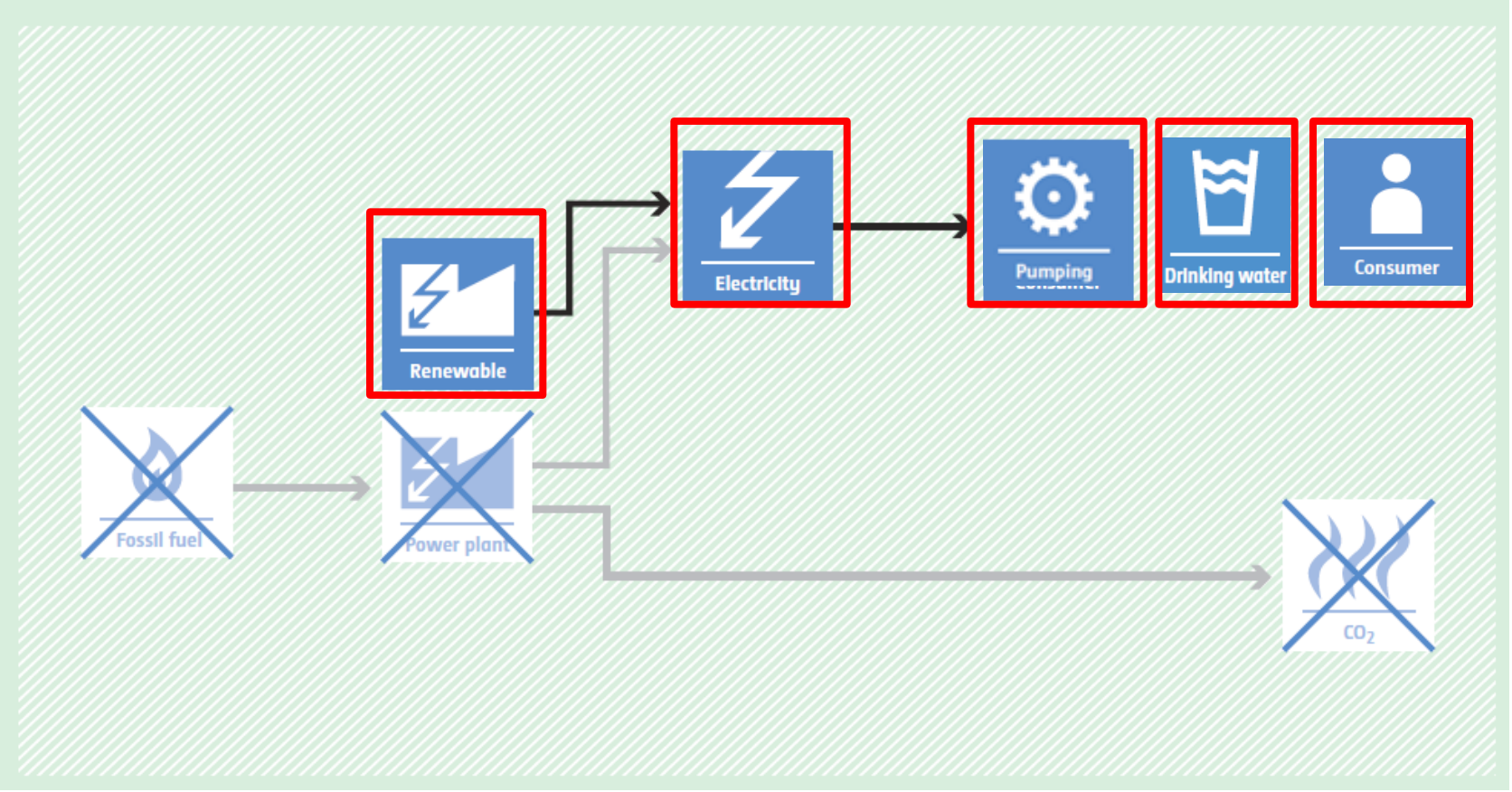
- Define Mitigation Action
- Co-Benefits of Mitigation Action
- Define the GHG Assessment Boundary
- Baseline Emissions
- Comparison of Baseline (BAU) & Mitigation Action (MA)
- Mitigation Action Emissions
- Monitoring & Reporting Performance over Time

1a. Define Mitigation Actions – Renewable Energy (Solar PV) for Water Pumping - Before



"Ex-ante" - Current Situation: Diesel Water Pumps ("Power Plants")

1b. Define Mitigation Action – Renewable Energy for Water Pumping - After



"Ex-post": Renewable = Solar PV Water Pumps
Replace Diesel (fossil fuel) = *No* CO_2

1c. Define Policy/Action

Information	Example
The title of the policy/action	**Renewable energy for water pumping for potable water**
Type of policy or action	1. CRGE framework for climate change mitigation. 2. GTP_II focus on improved access to water. 3. MoWIE, regional, woreda & local policies promoting improved water access.
Geographical coverage	Nationwide coverage within the borders of the Federal Democratic Republic of Ethiopia (FDRE)
The status of the policy or action	Underway
Targeted GHG	CO_2
Key performance indicators	• Increased water (m^3) per unit of energy consumed (kWh or MJ) • Reduction in CO_2 per unit of water provided for drinking and irrigation.

1d. Mitigation Activities for Water Pumping

- Size diesel pumps properly to meet the load, increase efficiency & reduce CO_2 emissions
- Improve diesel pump maintenance to improve efficiency & reduce CO_2 emissions
- Replace diesel pumps with solar PV pumps – **eliminate CO_2 emissions**, improve operational efficiency (i.e. reduced down-time) & reduce costs (no fuel costs, far fewer O&M costs compared to diesel)

1e. Mitigation Technologies for Reducting Emissions from Water Pumping

- Solar PV water pumping (renewable energy)
- Wind power water pumping (renewable energy)

2a. Define GHG Assessment Boundary

Boundary for activity is defined by:

- Area served by diesel pump before replacement by renewable energy pump.
- Households served by the former diesel pump, now served by the solar PV water pump (i.e. the “community”).

2b. Define GHG Assessment Boundary

Assess the significance of potential GHG effects

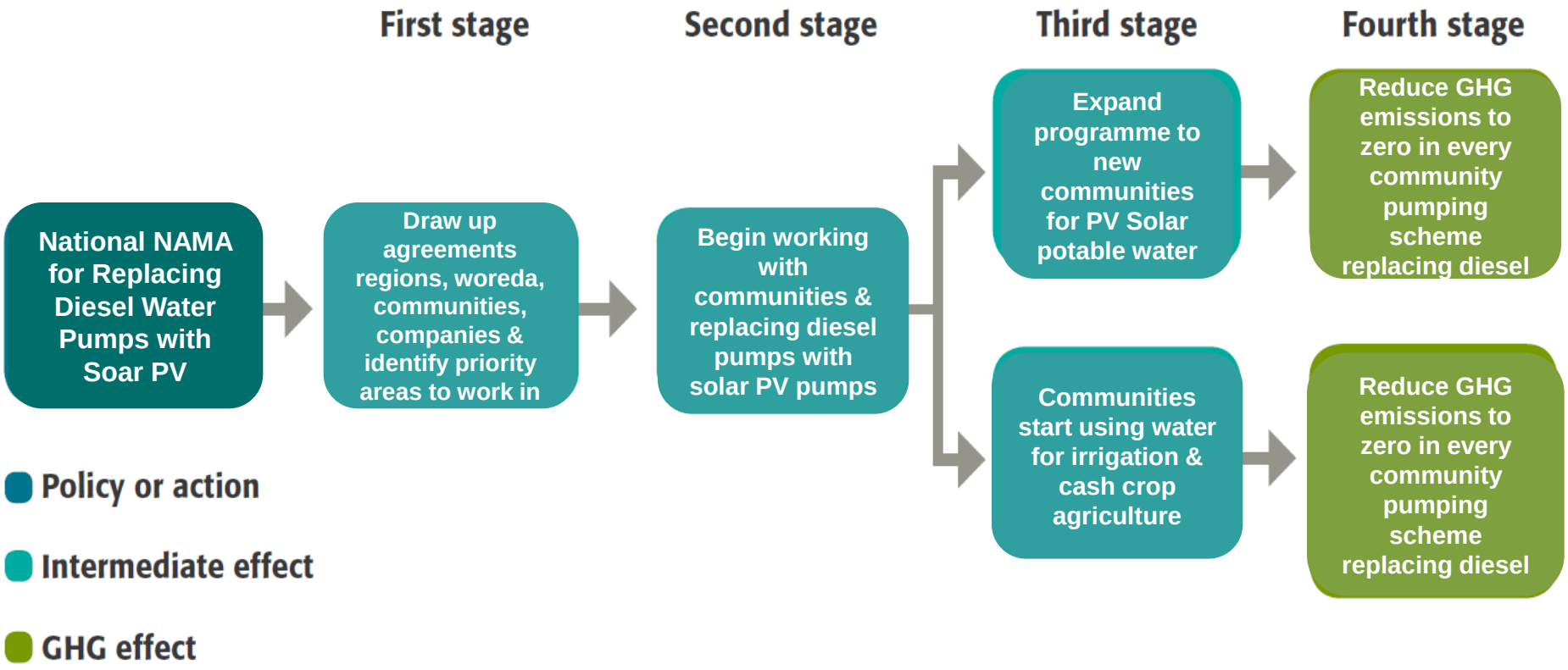
GHG effect	Likelihood	Magnitude	Included?
CO2	**Very likely**	**Major**	**Included**
CH4	**Very likely**	**Minor**	**Excluded**
N2O	**Very likely**	**Minor**	**Excluded**

List GHG to be included in Assessment Boundary

GHG effect	GHG Sources	GHG sinks	Greenhouse gas(es)
Reduced emission from diesel water pumps due to replacement by solar PV pumps	Diesel water pumps	N/A	CO_2

List GHG sinks: None

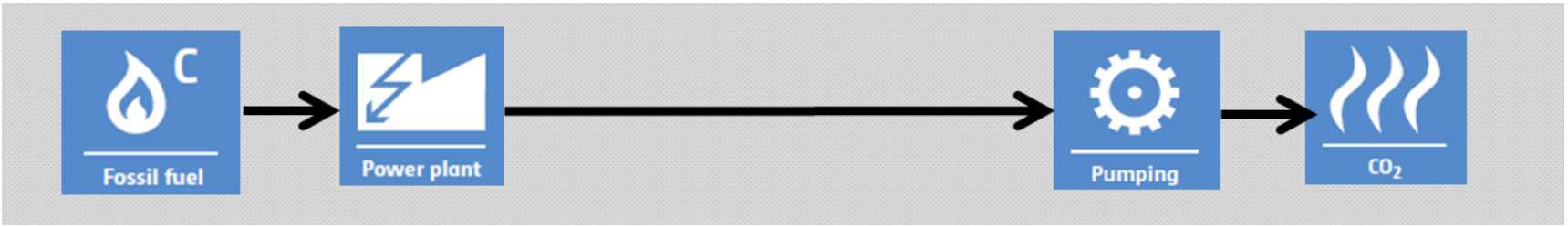
2c. Simplified GHG Causal Chain



3a. Baseline Emissions

Baseline Scenario

Increasing amounts of CO_2 are released into the atmosphere from diesel water pumps for community potable water.



Use CDM Methodology AMS-I.A, "Electricity Generation by the User ", v.16

Source: CDM Methodology Booklet , Eighth Edition, November 2016

3b. CDM Methodology: AMS-I.A

AMS-I.A.: Electricity Generation by the User

Typical project(s)	Installation of renewable energy generation for users (e.g., solar PV lighting, solar water heating, solar PV pumping, wind pumping, etc. wherey the energy generated is used directly by the consumer (household or commercial).
Type of GHG emissions	Renewble Energy. Displacement of all GHG emissions from the activity.
Important conditions under which the mitigation occurs	The service level (e.g., rated capacity or output) of the installed project renewable energy pumping equipment is between 90% and 150% of the service level of the baseline equipment (diesel pumps).

Source: CDM Methodology Booklet , Eighth Edition, November 2016

3b. Baseline Emissions from Electricity for Pump Irrigation - Key equation

$$BE_{CO2\,,y} = E_{BL,y} * EF_{CO_2}$$

$$E_{BL,y} = \sum_i EG_{i,y}/(1 - l)$$

Parameter	Definition
$BE_{CO2,y}$	Baseline emissions of CO2 from diesel generation for water pumping in year y (tCO2e/yr)
$E_{BL,y}$	Annual energy generation baseline (BL) in year y; kWh
EF_{CO2}	Emissions factor in tCO_2e/kWh
$\sum_i$	Sum of I renewable energy technologies (in this case, only solar PV water pumps) implemented in project activity.
$EG_{i,y}$	Annual output in kWh for each renewable technology (in this case, only solar PV water pumps)
l	Not applicable (as only one technology in mitigation activity/MA)

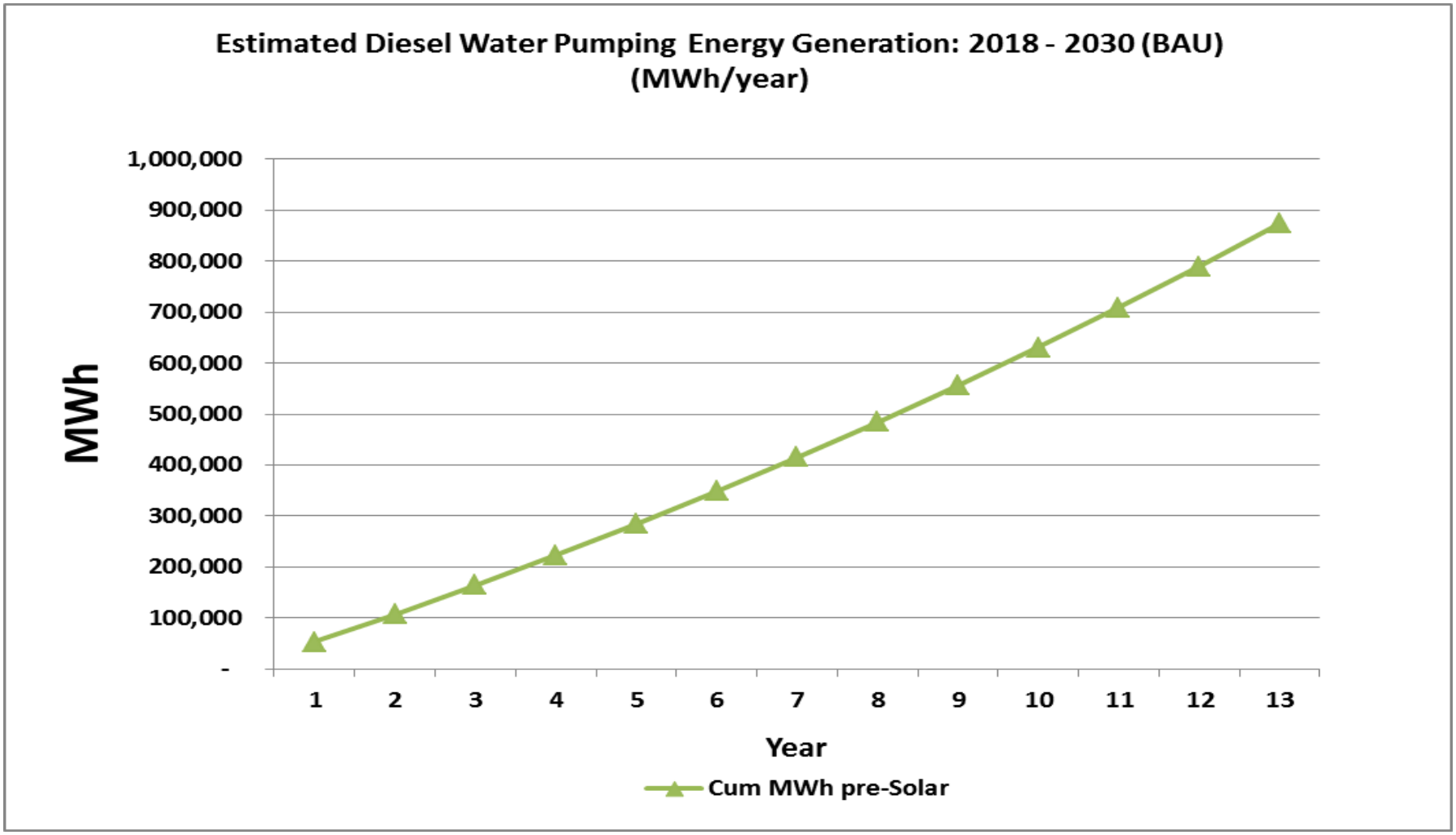
3c. Estimate emissions: Baseline

- **Fundamental equation**

A		B		= A x B
Electricity generation (MWh)	**x**	**Emissions Factor – EF_{CO2} (tCO_2/MWh)**	**=**	**CO_2 emissions (tCO_2)**

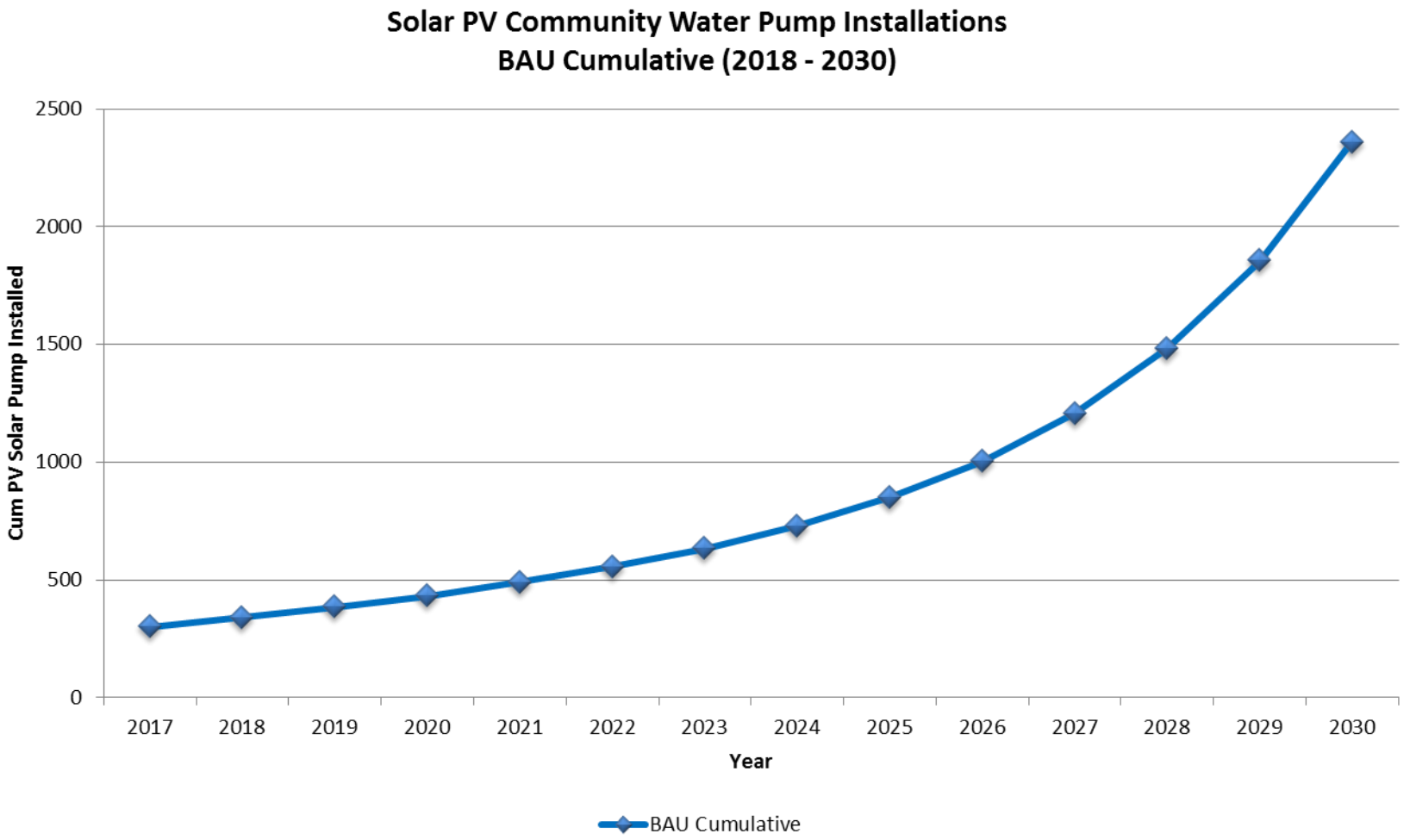
- **Electricity generation:**
  - **Top-down:** total generation by the sector
  - **Bottom-up:** Σ [Pumps x electricity generation in MWh]

BAU and Projections – Diesel Water Pump Penetration without Mitigation Action



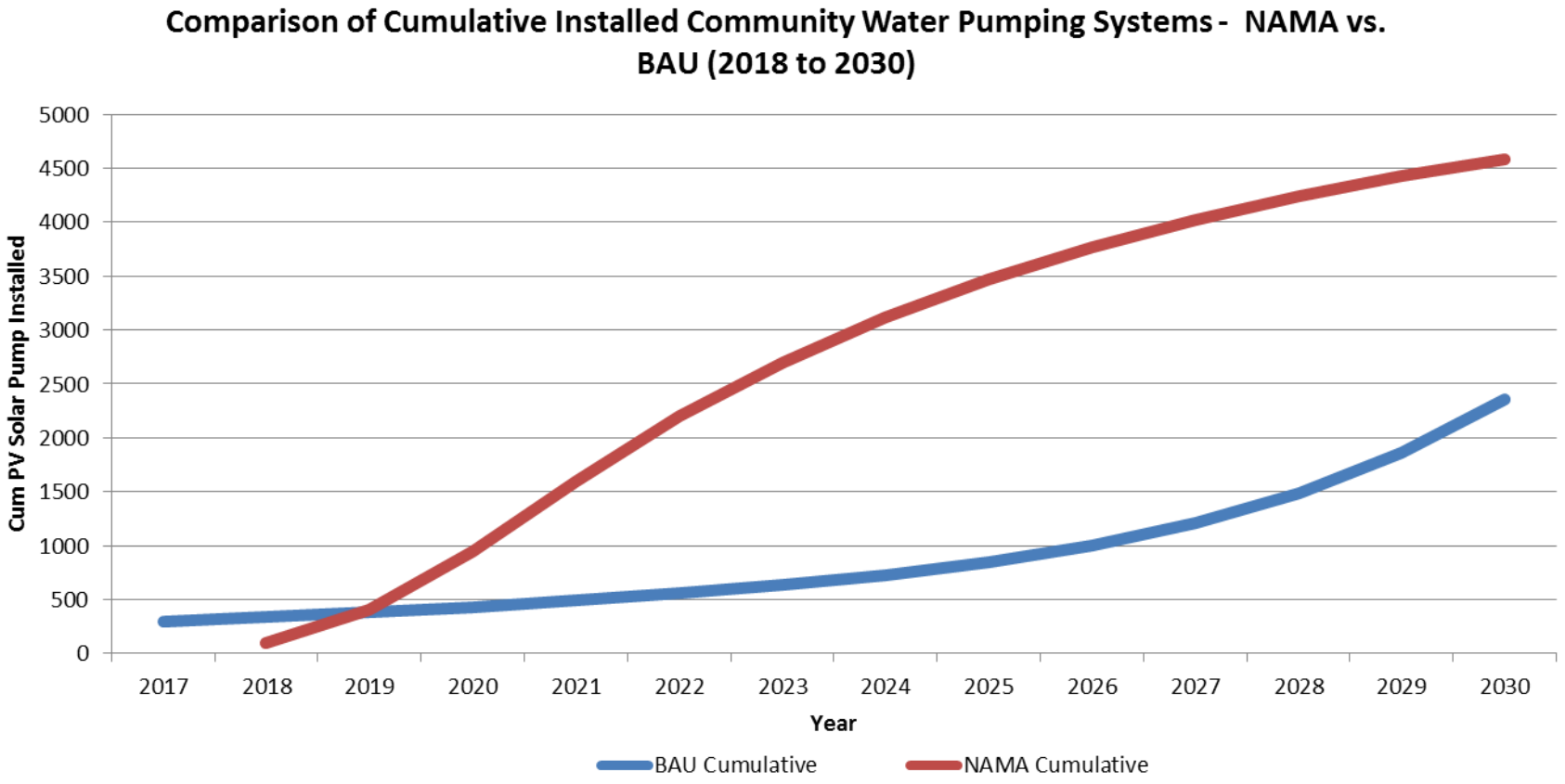
Simple estimate of Diesel Water Pumping in the NAMA target geographic area from 2018-2030 period WITHOUT introduction of NAMA Solar Water PV.

BAU and Projections – Solar PV Water Pump Penetration without Mitigation Action



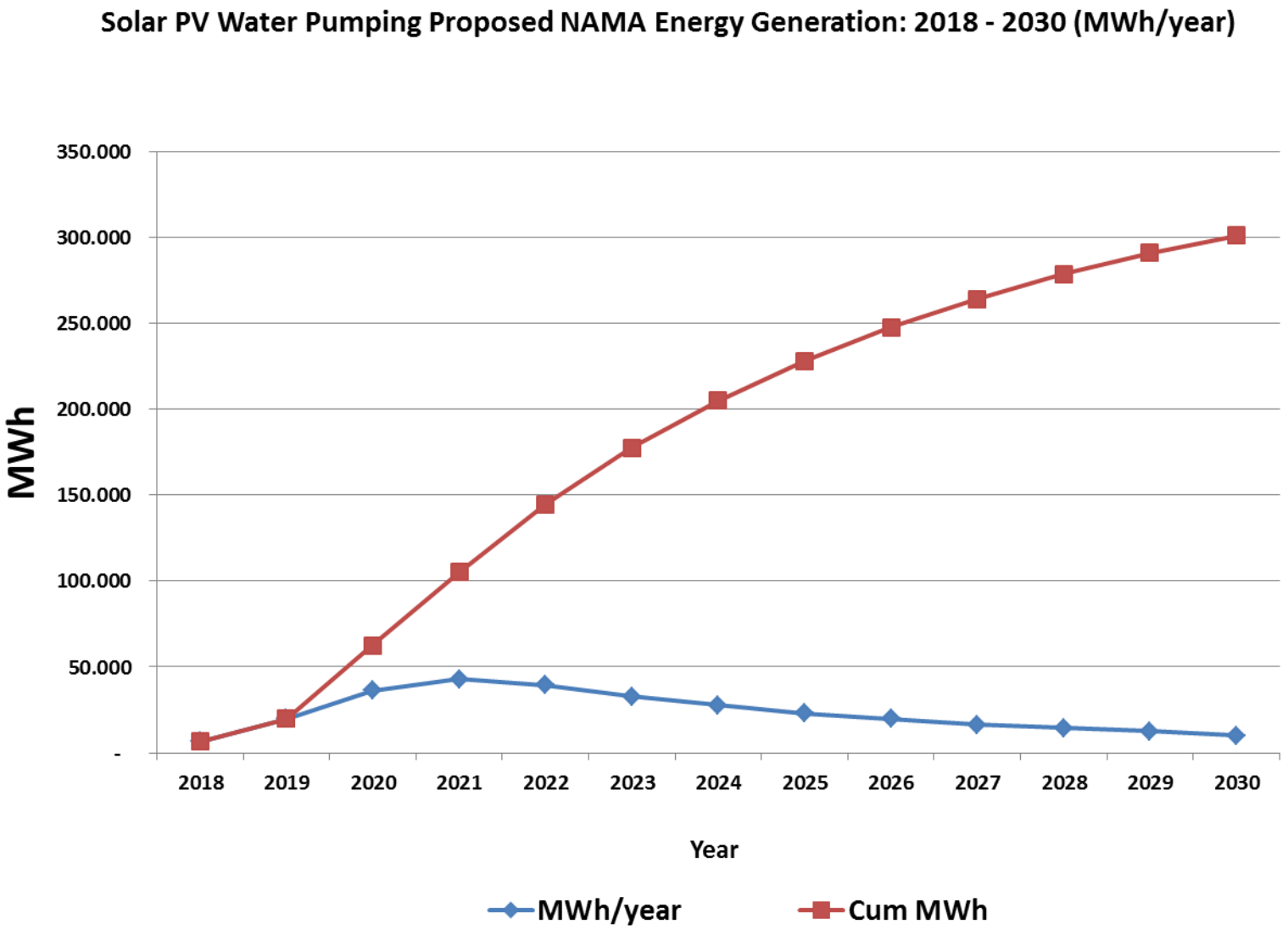
It is estimated that there were approximately 300 operational solar PV community water pumps in operation in Ethiopia. Thus, the base for calculating total installed pumps starts at 300 in 2018.

Comparison Solar PV Water Pump Penetration under BAU & with Mitigation Action

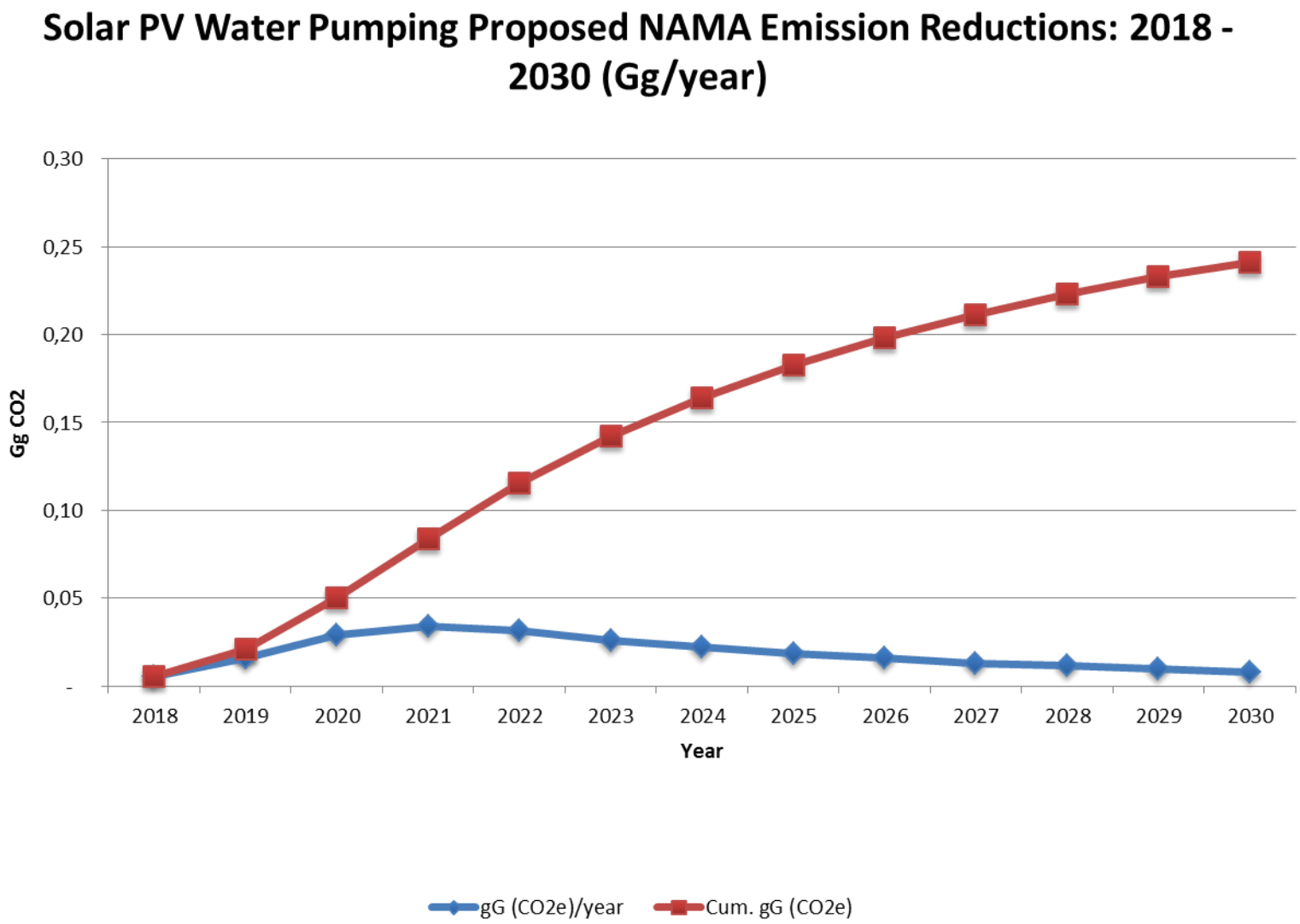


Using CDM Methodology AMS-I.A, "Electricity generation by the user", v.16.0 & diesel emissions from "Table I.F.1 under the category AMS-I.F "Renewable electricity generation for captive use and mini-grid".

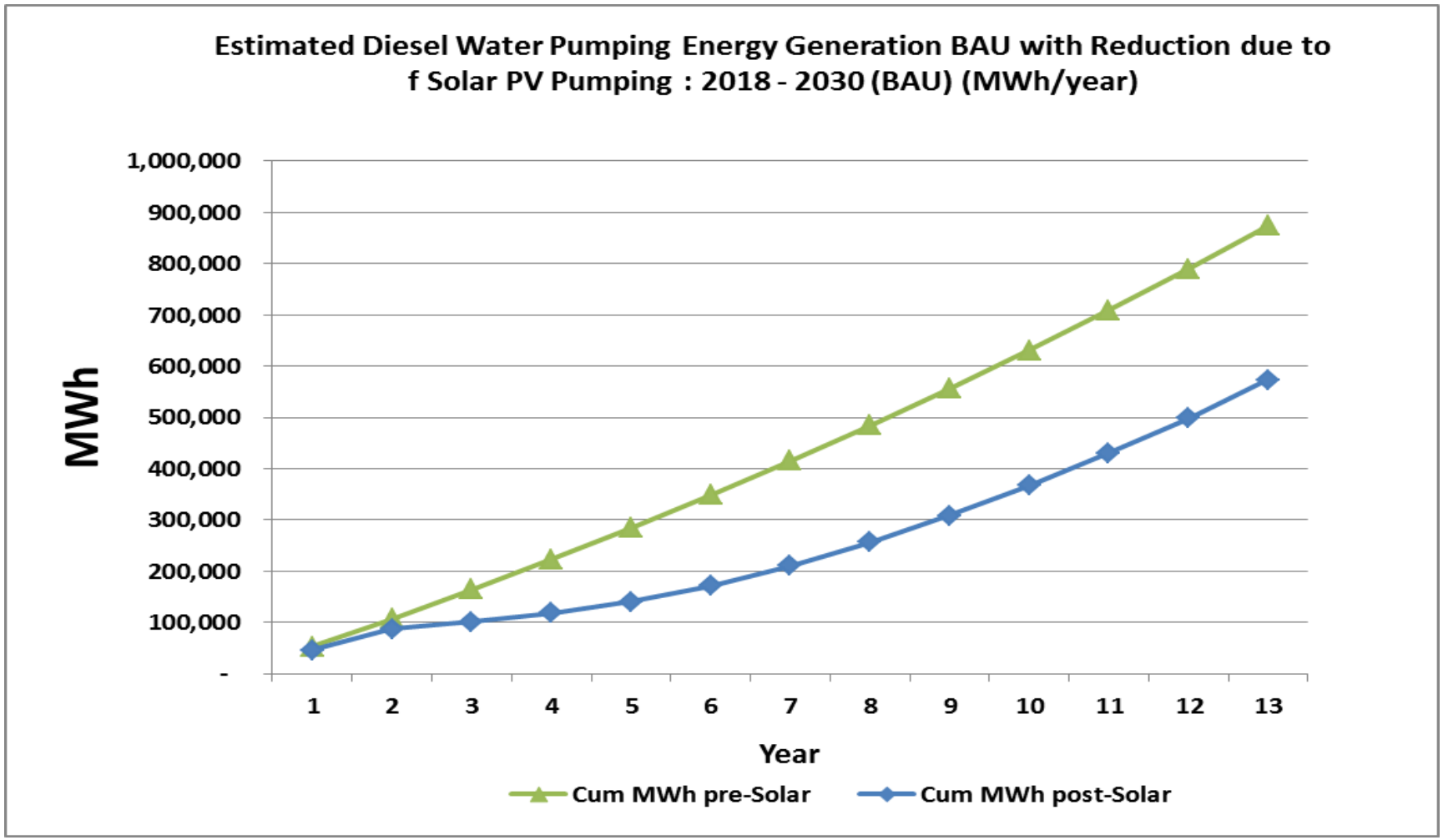
Mitigation Scenario Annual & Cumulative Commuity Solar PV CO_2 Reductions (Gg)



Mitigation Scenario Annual & Cumulative Commuity Solar PV Energy Generation



Mitigation Scenario Annual & Cumulative Effect of Solar PV on Diesel Energy Generation



Estimated Solar PV Water Pumping energy generation's effect on Diesel Water Pumping energy generation from 2018 to 2030.

3d. Water Pumping Model– Top Down

- Top-down analysis shows whether GHG emissions are increasing or decreasing in the sector as a whole
- Changes cannot be attributed to any cause not represented in the driver variables (size/capacity of pumps, hours of utilisation of pumps, etc.)

3e. Water Pumping Model – Bottom Up

- Electricity generation, (usually in MWh), with the associated grid emission factor (EF) are the basic unit for GHGs (tonnes of carbon dioxide equivalent (tCO_2e)
- The following are needed:
  - Number of pumps
  - Pump rating (kW or kVA)
  - Pump average hours of operation per day or month or year
  - Pump fuel consumption (AMS-1.A uses default assumption of 0.8 litres of diesel/MWh for pumps with rating below 50 kW

3f. Estimate Co-benefits of Mitigation Action

- Increased and improved drinking water supplies to consumers;
- Improved health of consumers from reliable supplies of clean drinking water;
- Opportunities for income generation to local solar PV pump suppliers and technicians;
- More community disposable income due to lack of recurrent expenditures on diesel, & better performance, reliability & durability of solar PV pumps compared to diesel.

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 community solar PV water pumping during the Mitigation Action lifetime for accurate estimation of GHG emission reductions

Parameter
ni - Number of pumps installed over time
pi - Electrical power (kWh) generated by each pump
oi - Annual operating hours for each pump.
Ey – Total annual electricity generation by pumps
$\mathbf{EF_{CO2,y}}$ **c** Annual electricity emissions factor for each year reported.

3i. Monitoring Over Time

Simplified Option

- Keep record showing:
  - Where diesel pumps were replaced;
  - When the diesel pump was replaced;
  - What size, specifications of solar PV pump that replaced diesel;
  - Size/rated capaciity of the diesel pumps replaced;
  - Estimated or recorded diesel & O&M costs (including spare parts, lubricants, technician's time or costs) of pumps replaced
  - Estimated hours of operation of diesel pump replaced per year;
  - When the diesel pump was replaced.
- Any other relevant information.

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, shall be reported.
  - If the project is funded by government, either partially, or wholly, then, reports will need to highlight improvements in pumping performance (specifically electricity consumed per unit of water pumped and the CO_2 emissions associated with that electricity 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!

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti