Climate MRV for Africa – Phase 2
MRV of Mitigation Actions
Energy Efficiency in Water Pumping for Irrigation: Case Study

Lead partner

Project of the European Commission
DG Clima Action
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Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti
Team Leader and Key Experts
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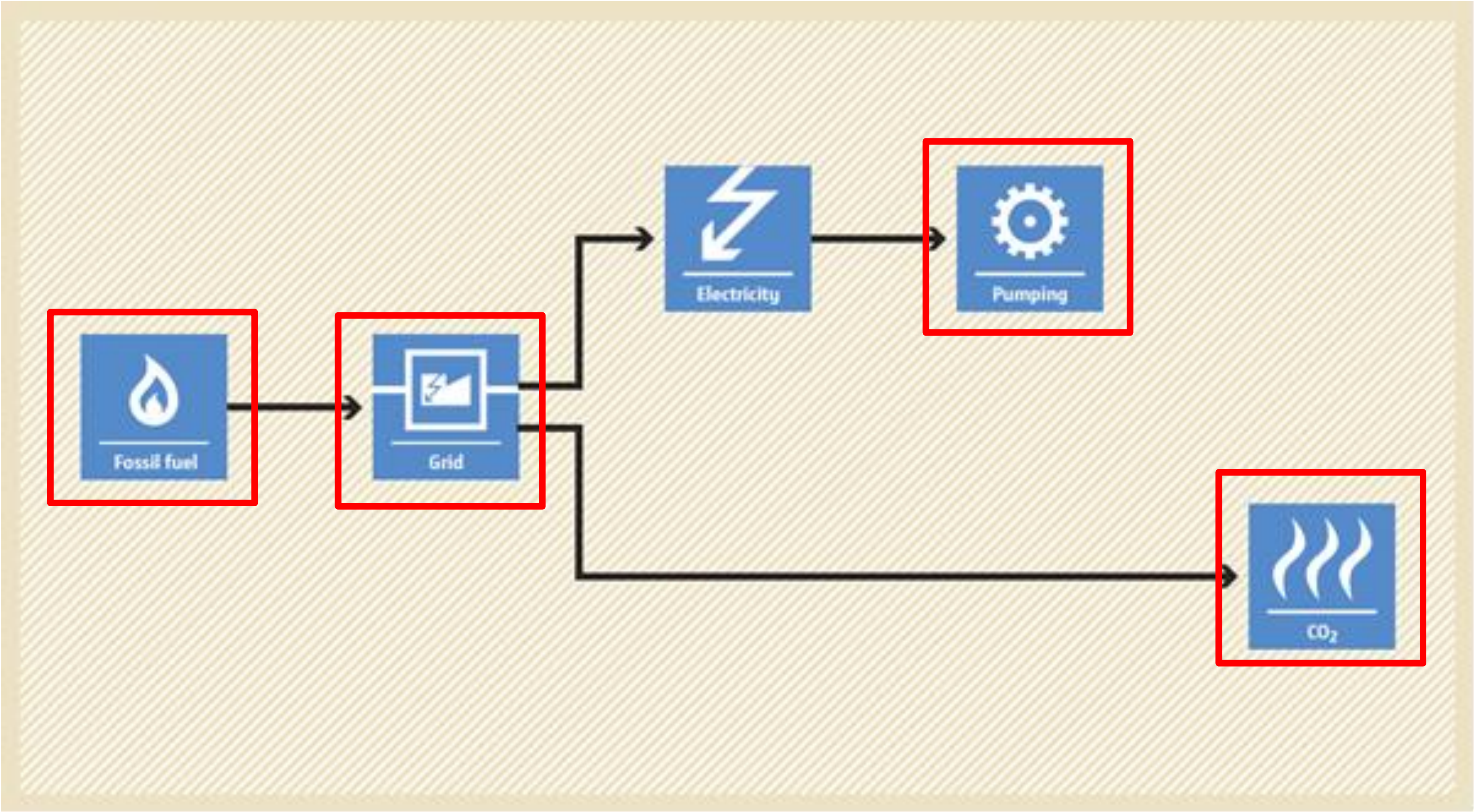
Agenda

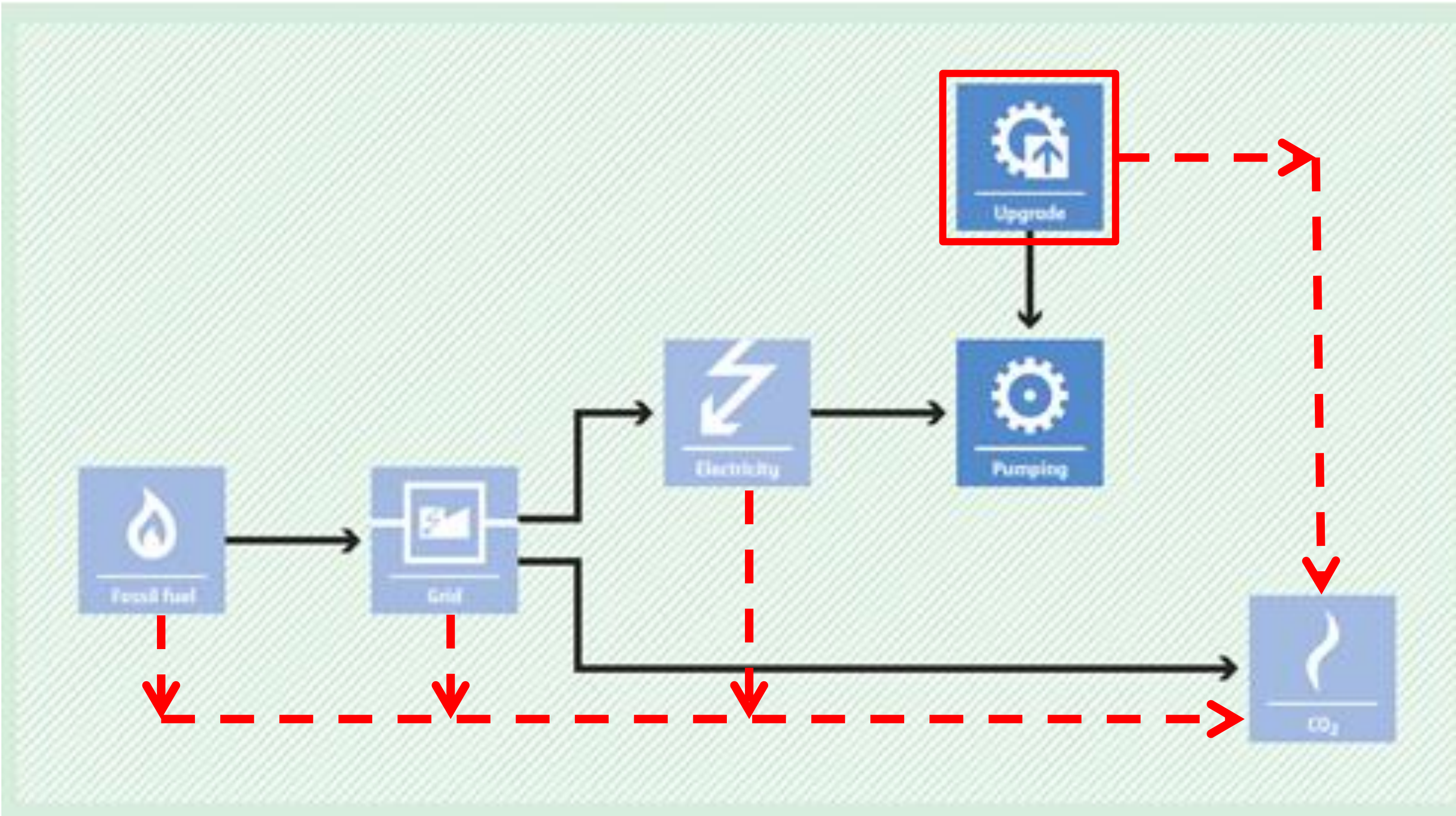
- Define Mitigation Action
- Co-Benefits of Mitigation Action
- Define the GHG Assessment Boundary
- Baseline Emissions
- Mitigation Action Emissions
- Monitoring & Reporting Performance over Time

1a. Define Mitigation Actions – Energy Efficiency in Irrigation Pumping - Before



“Ex-ante” - Current Situation: Old, Inefficient Pumps

1b. Define Mitigation Action – Energy Efficiency in Irrigation Pumping - After



"Ex-post": Energy Efficient Pumps - *Reduced* CO_2

1c. Define Policy/Action

Information	Example
The title of the policy/action	**Improved efficiency in irrigation pumping and water management**
Type of policy or action	1. Regulations covering provision of water for irrigation. 2. Regulations controlling how much water can be utilised. 3. National Energy Efficiency Action Plan.
Geographical coverage	Nationwide coverage within the borders of the Arab Republic of Egypt
The status of the policy or action	Proposed
Targeted GHG	CO_2
Key performance indicators	• Increased irrigation water (m^3) per unit of energy consumted (kWh or MJ) • Reduction in CO_2 per unit of water provided for irrigation.

1d. Mitigation Activities for Electric Water Pumps for Irrigation

- **Complete Rehabilitation (CR):** Replacement of all low efficiency pumps & equipment with new ones using same buildings/stations. Efficiency improvement - 70% to 80%

- **Partial Rehabilitation (PR):** Replacement of low efficiency equipment (e.g., motors or controllers) & keeping other older equipment operating - 15% to 20% efficiency improvement expected.

- **Spare Parts and Maintenance application (SP):** Maintaining poor efficiency stations and installing new spare parts to increase efficiency -10% to 15% efficiency improvement expected.

1e. Mitigation Technologies for Emissions from Inefficient Water Pumps for Irrigation

- Variable Speed Drives
- Improved Main Pumps
- Reduction Gears
- Dewatering Equipment
- Weed Cleaning Systems
- Air Coolers for motors
- Switchgears
- Transformers
- Capacitors – Load Limiters
- Landfill Aeration
- New thrust Bearings (with rotating disks)

2a. Define GHG Assessment Boundary

- Pumping stations owned and operated by the Mechanical and Electrical Department (MED), Ministry of Water Resources & Irrigation (MWRI)
- Electrical water pumps connected to the national electricity grids
- Selected, high priority, agricultural irrigation and land drainage pumping stations in Lower and Central Egypt.

2b. Define GHG Assessment Boundary

Assess the significance of potential GHG effects

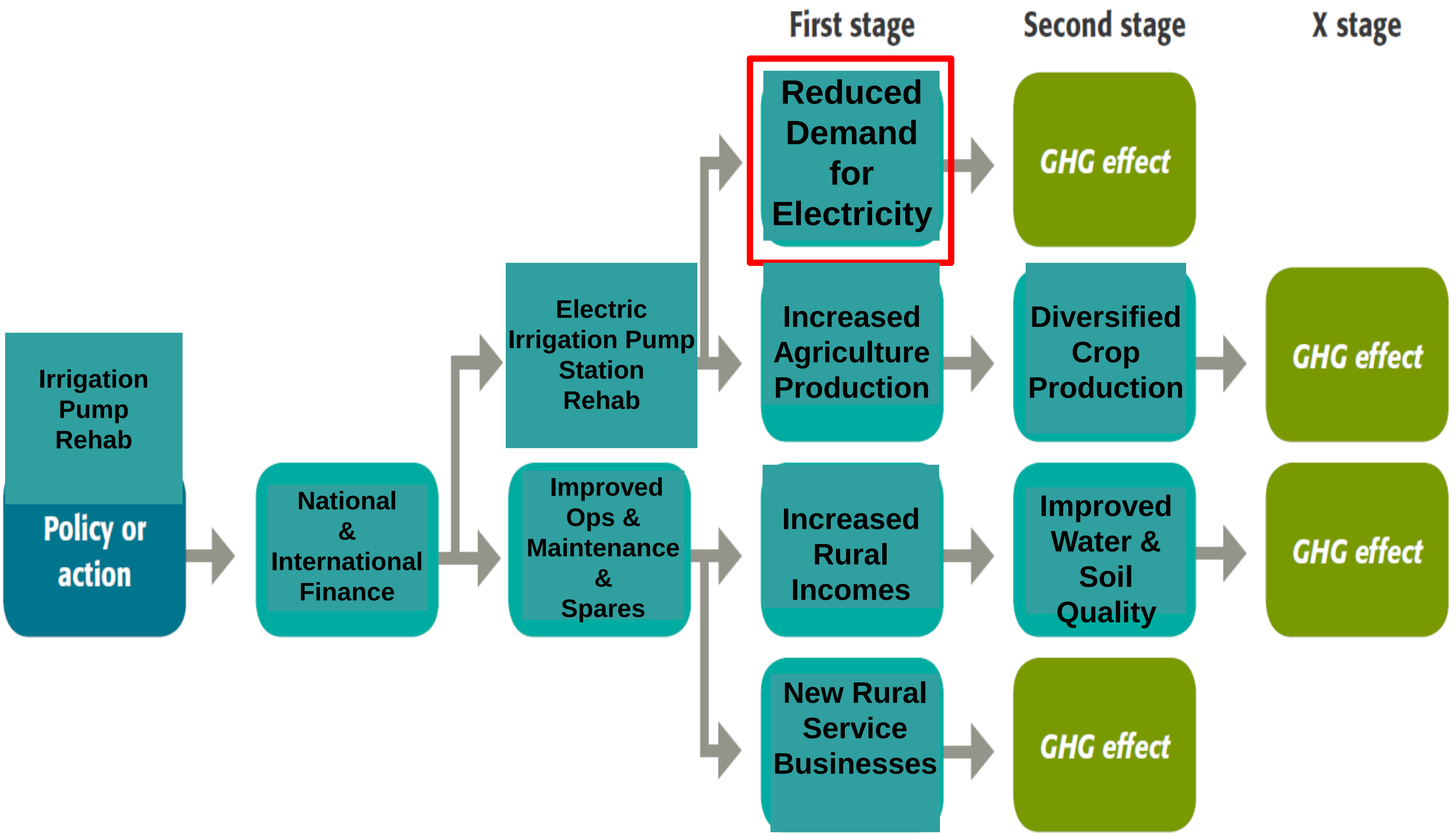
GHG effect	Likelihood	Magnitude	Included?
CO2	Very likely	Major	Included
CH4	Very likely	Minor	Excluded
N2O	Very likely	Minor	Excluded

List GHG to be included in Assessment Boundary

GHG effect	GHG Sources	GHG sinks	Greenhouse gas(es)
1 Reduced emission from electric power stations due to reduced electricty demand for irrigation pumping	Electric power stations; electricity grid.	N/A	CO_2

List GHG sinks: None

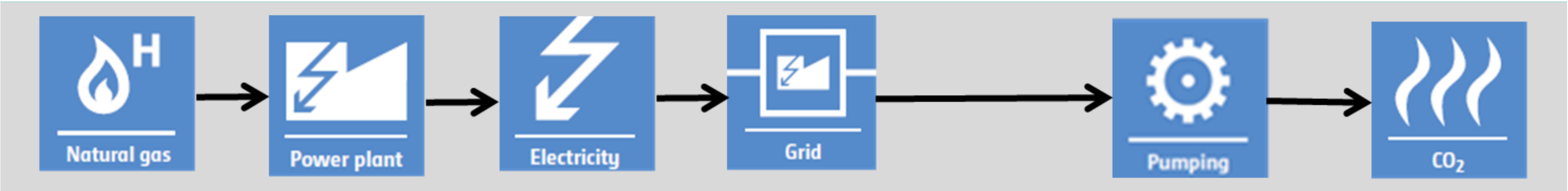
2c. Simplified GHG Causal Chain



3a. Baseline Emissions

Baseline Scenario

Increasing amounts of CO_2 are released into the atmosphere from power stations supplying inefficient irrigation pumps



Use CDM Methodology AMS-II.C, "Demand-side energy efficiency activities for specific technologies", v.15

Source: CDM Methodology Booklet , Eighth Edition, November 2016

3b. CDM Methodology: AMS.II-C

AMS.II-C: Demand side energy efficiency activities for specific technologies

Typical project(s)	Installation of new energy-efficient equipment (e.g. lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems and chillers) at one or more project sites, as retrofit or new construction (Greenfield) projects.
Type of GHG emissions	• Energy efficiency. Displacement of more-GHG-intensive service by use of more-efficient technology.
Important conditions under which the	• The service level (e.g. rated capacity or output) of the installed project energy-efficient equipment is between 90% and 150% of the service level of the baseline equipment; • If applicable: refrigerant used in the project activity shall have no ozone depleting potential (ODP).

Source: CDM Methodology Booklet , Eighth Edition, November 2016

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

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

$$E_{BL,y} = \frac{\sum_i n_i * p_i * o_i}{1 - l_y}$$

Parameter	Definition
$BE_{CO_2,y}$	Baseline emissions of carbon dioxide from electricity generation for the grid in year y (t CO_2e/yr)
$E_{BL,y}$	Energy consumption for the baseline in year y (kWh)
$EF_{CO_2,Elect,y}$	Electricity emissions factor (tCO_2/MWh).
n_i	Number of pumps to be replaced
p_i	Electrical power demand of the pump (kW).
o_i	Average annual operating hours of i baseline equipment
l_y	Average annual technical grid losses

3c. Estimate emissions: Baseline

- **Fundamental equation**

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

- **Electricity consumption:**
  - **Top-down:** total consumption by the sector/end-use
  - **Bottom-up: Σ [pumps x capacity x hours of use]**

3d. Efficient Irrigation Pump 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 (e.g., efficiency of pumps, hours of utilisation of pumps, 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. Efficient Irrigation Pump Model – Bottom Up

- Volume of water pumped per any unit of time (usually cubic metres per second (cusec – m^3/sec) or cubit meters per hour (m^3/hr)
- Electricity consumption, (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 MW)
  - Pump average hours of operation per day or month or year
  - Pump estimated efficiency (%)

3f. Estimate Co-benefits of Mitigation Action

- Increased and improved water supplies and water flows to farmers for irrigated agriculture;
- Improved agricultural production from better supplies of irrigated water;
- Increased amount of water available to farmers due to improved efficiencies of water supply;
- Capacity building in both the public & private water irrigation sector
- Creation of new job opportunities in 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 pumps installed over time
pi -	Electrical power consumed by each pump
oi -	Annual operating hours for each pump.
ly -	Annual grid losses on transmission and distribution to pump sites
Ey –	Total annual electricity consumption by pumps
$EF_{CO2,y}$ –	Annual electricity emissions factor for each year reported.

3i. Monitoring Over Time

Simplified Option

- Develop emission factor (EF) from EACH participating pumping station
  - Use updated grid emission factor for electricity supply
  - Use meters on electricity consumption at stations
  - Use pumped water at stations
  - Use operating hours per station
- Aggregate EF for all pumping stations, weighting them on MW installed
- Calculate emission for each station, and for total NAMA project
- Compare emissions 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, 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 consumption), 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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