CDM SUSAC PROJECT - ZAMBIA

RECOMMENDED METHODOLOGY FOR BASELINE CALCULATIONS

1.0 INTRODUCTION

As part of capacity building in methodological development, this report attempts to recommend a methodology for baseline calculations for CO_2 emissions. To determine CO_2 emissions requires using IPCC methodology (1996 guidelines), which is basically CO_2 emission from liquid fuel-methodology.

2.0 CO_2 EMISSIONS

To determine the amount of CO_2 requires to use the following equation:

$$\text{Amount of } CO_2 = \text{Emission Factor} \times \text{Quantity of fuel} \qquad (2.1)$$

In accordance with IPCC methodology (1996 guidelines), CO_2 emissions are calculated using the following equation:

$$CO_2 \text{ (tonnes)} = [(\text{Fuel consumed} - \text{carbon stored}) \times (\text{energy convesion factor}) \times (\text{carbon factor}) \times (\% \text{ carbon oxidised})] \times {}^{44}/_{12} \qquad (2.2)$$

Fuel consumed – tonnes
Energy conversion – GJ/tonne
Emission factor – Kg C/GJ

It is assumed that carbon stored in this case is zero.

Emission Factor

There are three ways of determining an emission factor,

1. Using a default value based on the type of fuel (IPCC Methodology)
2. Using default value based on the type of technology (IPCC Methodoloy)
3. Local specific, which requires measurements (this needs resources necessary to carry out experiments, and thus expensive)

To start with, (1) and (2) will be employed, but should the resources be available, measured emission factors will be used.

Upon calculation of the amount of CO_2 for a given situation using historic data, a standardised emission factor relating specifically to the amount of output (e.g. tonnes, kWh, etc) is calculated using the following relationship:

$$EF = (\text{Amount of } CO_2) / (\text{Amount of output}) \qquad (2.3)$$

Initially, up two projects were considered for discussion. These fall under ZESCO Limited and TAZAMA Pipelines Ltd.

1.0 ZESCO LTD

For projects under ZESCO involving replacement of diesel power stations with hydro based ones, the following equation was used:

Amount of CO_2 = Emission Factor x Power Output (3.1)

Where
Amount of CO_2 = tonnes
Emission factor = tonnes/kWh
Power output = kWh

To determine the amount of CO_2 requires data on fuel consumption. Given in Table 1 is the format of collecting fuel consumption and corresponding power output.

Table 1: Baseline Data for ZESCO Diesel Power Stations - Fuel Consumption

Station: _____ Province: _____ Fuel Used: _____

Engine No.	Type of Engine	Fuel Consumption / kWh Output											
		1995		1996		1997		1998		1999		2000	
		FC	KWh	FC	KWh	FC	KWh	FC	KWh	FC	KWh	FC	KWh
1													
2													
3													
Total													

Note: FC = Fuel Consumption for that year
KWh = Electricity produced for that year

Having collected the data, therefore, the emission factor is calculated based on the following format (Table 2).

Table 2: Calculation of Emission Factor for ZESCO

Year	Amount of Fuel consumed (tonnes)	Amount of CO_2 (tonnes)	Power Output (kWh)	Emission factor (Tonne/kWh)
1995				
1996				
1997				
1998				
1999				
2000				
Average				

The average value of emission factor determined will then be used in equation 3.1 for future baseline calculations.

The problems expected with the data under baseline calculation are:

Differing quality of maintenance and age
Lack of equipment to measure the exact fuel consumption
Determining a common emission factor for different types of engines
Local emission factors require resources to carry out experiments

4.0 TAZAMA PIPELINES LTD

For projects under TAZAMA involving replacement of diesel pump stations with hydro based ones, the following equation was used:

Amount of CO_2 = Emission Factor x amount of crude oil pumped (4.1)

Where
Amount of CO_2 = tonnes
Emission factor = tonne/tonne
Amount of crude oil pumped = tonnes

To determine the amount of CO_2 requires data on fuel consumption. Given in Table 2 is the format of collecting fuel consumption and corresponding crude oil pumped.

Table 3: Baseline Data for TAZAMA Diesel Pump Stations - Fuel Consumption

Station: _____ Country: _____ Fuel Used: _____

Engine No.	Type of Engine	Fuel Consumption and Crude Oil pumped											
		1995		1996		1997		1998		1999		2000	
		FC	CR	FC	CR	FC	CR	FC	CR	FC	CR	FC	CR
1													
2													
3													
Total													

Note: FC = Fuel Consumption for that year
CR = Crude oil pumped for that year

Similar problems as under ZESCO are expected in the baseline calculations.

Having collected the data, therefore, the emission factor is calculated based on the following format (Table 4).

Table 4: Calculation of Emission Factor for TAZAMA

Year	Amount of Fuel consumed (tonnes)	Amount of CO_2 (tonnes)	Crude oil pumped (tonnes)	Emission factor (tonne/tonne)
1995				
1996				
1997				
1998				
1999				
2000				
Average				

The average value of emission factor determined will then be used in equation 4.1 for future baseline calculations.

5.0 DETERMINATION OF BASELINE

Since Zambia is mostly hydro based, the reference would be zero CO_2 emissions. Figure 1 shows the saving that would occur when the diesel pumps are replaced with hydro based.

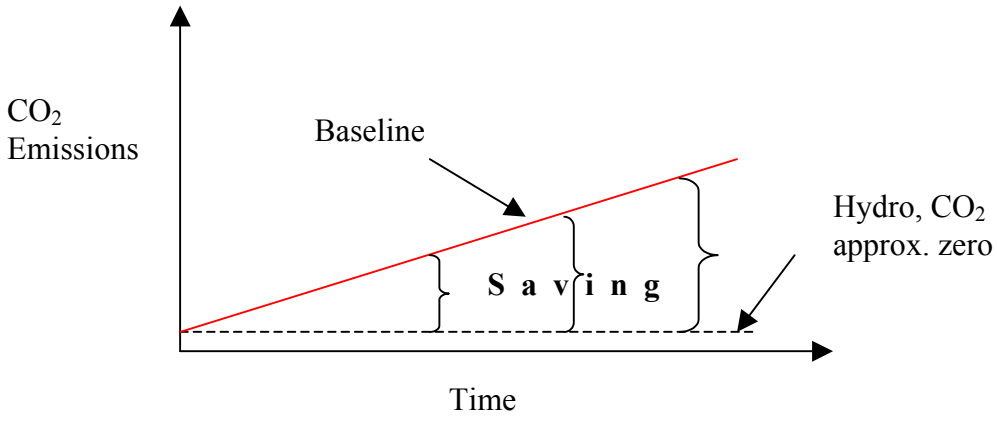

Figure 1: Expected Saving from Baseline

It was agreed that MESAP will be used to determine baselines.

6.0 REFERENCE ENERGY SYSTEM FOR ZESCO PROJECTS

ZESCO has a number of diesel electricity generating stations.

It is assumed that each station will be treated as a separate entity. Below is the general appearance of the RES under ZESCO.

Diesel (Fuel) **Electricity** **CO_2**

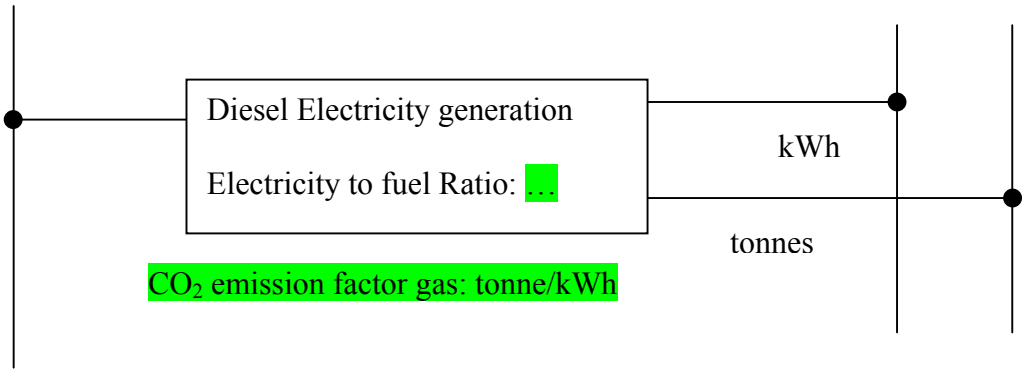

Figure 2: RES for ZESCO Power Stations

7.0 REFERENCE ENERGY SYSTEM FOR TAZAMA PROJECTS

TAZAMA Pipelines has 7 diesel powered pump stations. Two fuels are used in the engines. To start running each engine, diesel is used, then later the crude oil (co-mingled) is partly diverted from the main pipeline to run the engine.

It is assumed that each station will be treated as a separate entity. Below is the general appearance of the RES under TAZAMA.

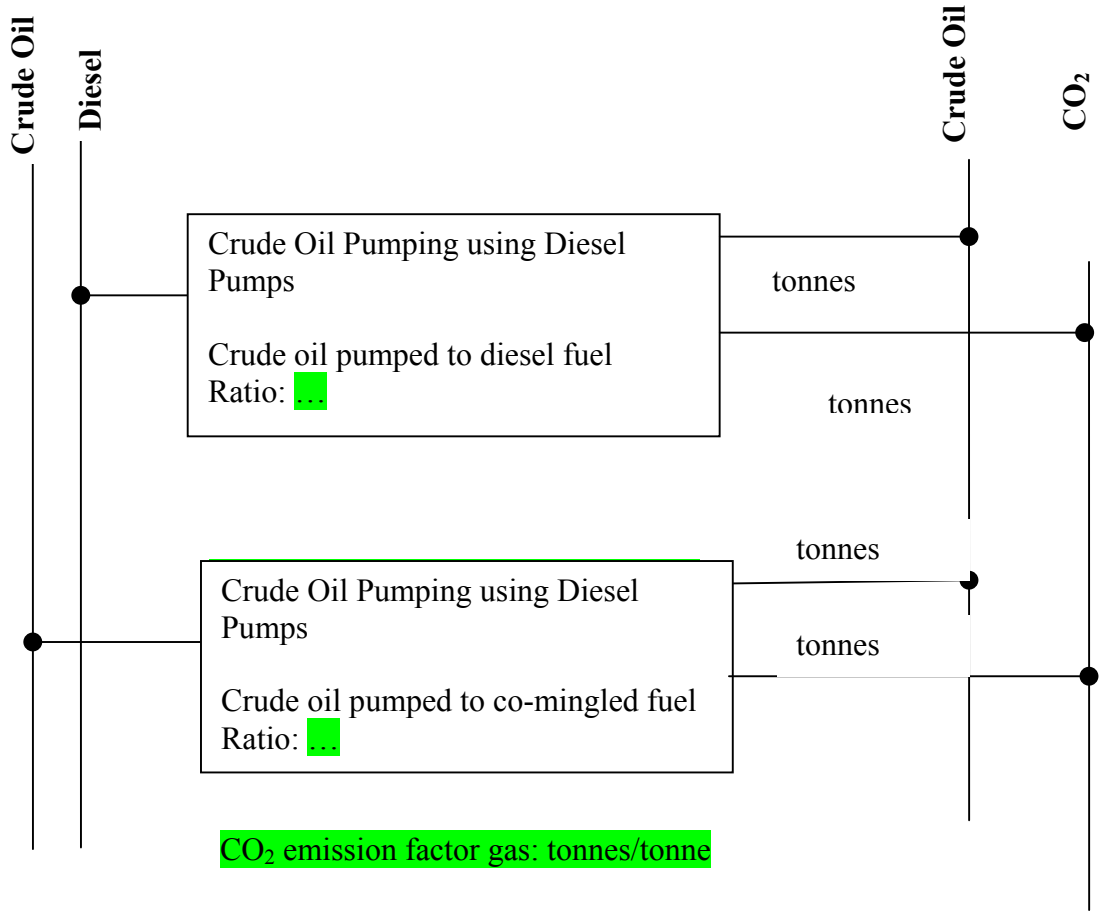

Figure 3: RES for TAZAMA pump Stations

8.0 SCENARIO FOR CO_2 EMISSIONS

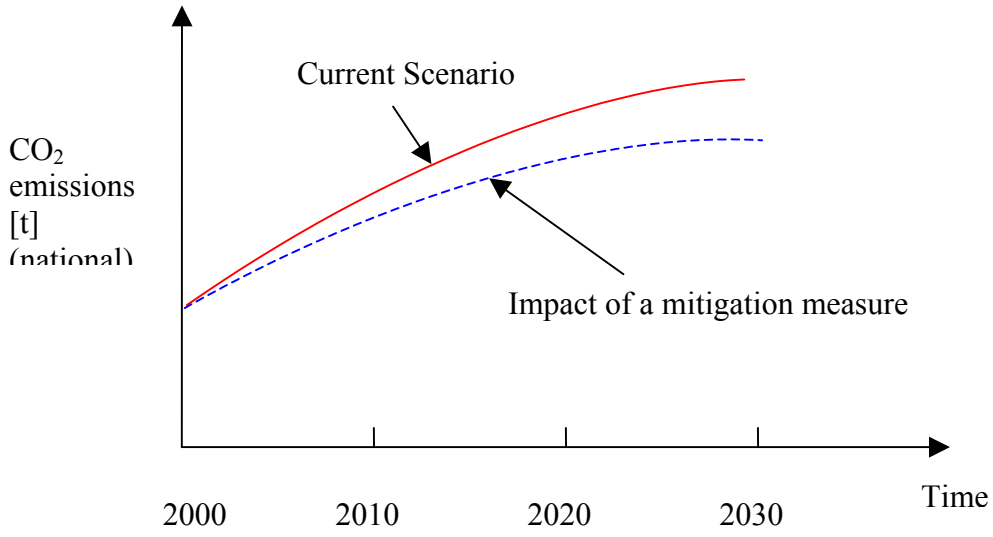

Figure 4: Expected Impact of Mitigation Measures on CO_2

In achieving mitigation analysis, the national energy balance (obtained from the Department of Energy) would be required. The sectors for consideration under scenario development will consist of:

Agriculture
Industry and Commerce
Mining
Transport
Households

The driver for scenario development will be GDP for all sectors, with an exception of household, which will be population.

9.0 CONCLUDING REMARKS

To carry out the work related to data collection, baselines development and mitigation analysis, all stakeholders should be involved so that data is easily accessible, and that the analyses represent the country's position.