

## Baseline Calculation



### WISIONS Sustainable Energy Support Program SEPS

#### Environmental Performance Calculation Procedure:

For addressing the two environmental performance criteria “Reduction of CO<sub>2</sub> emissions” and “Reduction of primary energy input”, please refer to the calculation procedure outlined below. This is kept in a simple, but consistent form for being applicable in the context of **SEPS**.

Tables 1 and 2 are taken from the UNEP-Report “The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organisations” which has been published in 2000. If your country does not appear in Table 2 (CO<sub>2</sub> from electricity production), please refer to the regional figures that are given in the table (e.g. Middle East or Africa).

For better understanding, two examples are given, one for a *wind turbine of 1.5 MW (Morocco)* and one for a *combined heat and power unit of 50 kW<sub>el</sub>/80kW<sub>heat</sub> (Austria)*.

#### Calculation procedure:

##### Step 1:

Determination of the fossil primary energy input (PEI) of the project

##### Step 2:

Determination of the direct CO<sub>2</sub> emissions produced by the project: please make use of table 1 or table 2.

##### Step 3:

Definition of the project baseline: The project baseline describes a scenario for the production of electricity, heat etc. that would probably take place if the project would not be realized.

##### Step 4:

Calculation of the PEI baseline: resulting from the production of heat, electricity etc. as described in the project baseline by the same amount as the project's production.

If no specific values for a typical baseline are available for electricity generation please apply an efficiency factor of 38% for OECD-countries and 32% for non-OECD-countries for the electricity production and 80% for heat production.

##### Step 5:

Calculation of the CO<sub>2</sub> emissions baseline: Please make use of Table 1 (emission factor for emissions from fuel use) or Table 2 (electricity emission factor EF<sub>el</sub>) for calculating the CO<sub>2</sub> emissions: PEI x Emission Factor (EF) = baseline. With electricity emission factor: annual electricity production X Emission Factor (EF)

##### Step 6:

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Calculation of the reduction in PEI and CO<sub>2</sub> emissions:

PEI: baseline (Step 4) – PEI (Step 1)

CO<sub>2</sub> emissions: baseline (Step 5) – project's emissions (Step 2)

## Example 1

### Example 1: Wind turbine (1.5 MW) in Morocco

Assumptions: operating hours 3000 hours/year  $\Rightarrow$  electricity production of 4.5 GWh/year

#### Step 1:

Determination of the fossil primary energy input (PEI) of the project:  
0 (only power from the wind turbine is used)

#### Step 2:

Determination of the CO<sub>2</sub> emissions produced by the project:  
0 (the wind turbine produces no CO<sub>2</sub> emissions for electricity production)

#### Step 3:

*Definition of the baselines:*

The amount of electricity generated by the wind turbine would otherwise come from the electricity grid.

#### Step 4:

*Calculation of the PEI baseline:*

The efficiency factor in the non-OECD country Morocco is assumed with 32%. Thus, the PEI is:

$$4.5 \text{ GWh/year} / 32\% \Rightarrow (4.5 \times 100) / 32 = \mathbf{14.1 \text{ GWh/year}}$$

#### Step 5:

*Calculation of the CO<sub>2</sub> emissions baseline:*

Take the electricity production and multiply it with the country's emission factor in electricity production (Table 2):

$$4.5 \text{ GWh/year} \times 0.000632 \text{ tCO}_2/\text{kWh}$$

$$\Rightarrow 4,500,000 \text{ kWh/year} \times 0.000632 \text{ tCO}_2/\text{kWh} = \mathbf{2844 \text{ tCO}_2/\text{year}}$$

#### Step 6:

*Determination of the reduction in PEI and CO<sub>2</sub> emissions:*

$$\text{PEI: baseline (Step 4) - PEI (Step 1)} \Rightarrow 14,100,000 \text{ kWh/year} - 0 = \mathbf{14,100,000 \text{ kWh}}$$

$$\text{CO}_2: \text{baseline (Step 5) - CO}_2\text{project (Step 2)} \Rightarrow 2844 \text{ tCO}_2 - 0 = \mathbf{2844 \text{ tCO}_2}$$

## Example 2

### Example 2:

Gas-powered Combined Heat and Power Unit (small motor package system), Austria

Capacity: 50 kW<sub>el</sub>/80 kW<sub>heat</sub>

Overall Efficiency Factor: 80%

Operating hours: 5000 h/a ⇒ 250 MWh of electricity produced; 400 MWh of Heat produced

#### Step 1:

Determination of the fossil primary energy input (PEI) of the project:

$W = (250 \text{ MWh} + 400 \text{ MWh})/\text{year}/\text{efficiency factor} \Rightarrow (250 \text{ MWh} + 400 \text{ MWh})/\text{year}/80\% = 812.5 \text{ MWh/year}$

#### Step 2:

Determination of the CO<sub>2</sub> emissions produced by the project:

PEI x EF (Table 1, Natural Gas)

⇒ 812,500 kWh/year x 0.0002020 tCO<sub>2</sub>/kWh = 164.1 tCO<sub>2</sub>/year

#### Step 3:

Definition of the baselines:

The amount of electricity produced by the Combined Heat and Power Unit would be purchased in average from the grid, the heat would be produced by small Diesel Oil-fired heating systems with an efficiency factor of 80%. The emission factor for the Diesel Oil-fired plant is 0.0002496 tCO<sub>2</sub>/kWh (see table 1).

#### Step 4:

Calculation of the PEI-baseline:

Electricity production:

As the efficiency factor in OECD-countries is assumed with 38%, the PEI is calculated as follows:

$250 \text{ MWh/year}/38\% \Rightarrow 250 \text{ MWh/year} \times 100/38 = 657.9 \text{ MWh/year PEI}$

Heat production:

As the efficiency factor of the Diesel Oil-fuelled plant is 80%, calculate:

$400 \text{ MWh/year}/80\% \Rightarrow 400 \text{ MWh/year} \times 100/80 = 500 \text{ MWh/year PEI}$

In total, the PEI-baseline is: 657.9 MWh/year + 500 MWh/year = **1157.9 MWh/year**

#### Step 5:

Calculation of the CO<sub>2</sub> emissions baseline:

CO<sub>2</sub> emissions from electricity:

As the emission factor for Austria is 0.000155 (Table 2), the CO<sub>2</sub> emissions baseline is:

$250,000 \text{ kWh/year} \times 0.000155 \text{ tCO}_2/\text{kWh} = 38,75 \text{ tCO}_2/\text{year}$

CO<sub>2</sub> emissions from heat:

As the emission factor for the Diesel Oil-fuelled plant is 0.0002496 tCO<sub>2</sub>/kWh, the CO<sub>2</sub> emissions baseline is:  $500,000 \text{ kWh/year} \times 0.0002667 \text{ tCO}_2/\text{kWh} = 133.5 \text{ tCO}_2/\text{year}$

Total CO<sub>2</sub> emissions baseline:

$38.75 \text{ tCO}_2/\text{year} + 133.5 \text{ tCO}_2/\text{year} = \mathbf{172.25 \text{ tCO}_2/\text{year}}$

#### Step 6:

Calculation of the reduction in PEI and CO<sub>2</sub> emissions:

PEI reduction: baseline (Step 4) – PEI (Step 1) ⇒  $1117.9 \text{ MWh/year} - 812.5 \text{ MWh/year} = \mathbf{305.4 \text{ MWh/year}}$

CO<sub>2</sub> emissions reduction: baseline (Step 5) – CO<sub>2</sub> (Step 2)

⇒  $172.25 \text{ tCO}_2/\text{year} - 164.1 \text{ tCO}_2/\text{year} = \mathbf{8.15 \text{ tCO}_2/\text{year}}$

Table 1: CO<sub>2</sub> Emissions from Fuel Use

Fuel Types	Emission factors ②			
	tCO <sub>2</sub> /therm	tCO <sub>2</sub> /litre	tCO <sub>2</sub> /kWh	tCO <sub>2</sub> /Tonne
Coal			0.0003413	1.84 <sup>1</sup>
Petrol		0.00222	0.0002496	3.07
Natural Gas	0.005919		0.0002020	2.93
Gas/ Diesel Oil		0.00268	0.0002667	3.19
Residual Fuel Oil		0.00300	0.0002786	3.08
LPG	0.006654	0.00165	0.0002271	2.95
Jet Kerosene		0.00258	0.0002575	3.17
Shale oil			0.0002218	2.61
Ethane			0.0002641	2.90
Naphtha		0.00224	0.0002905	3.27
Bitumen			0.0002641	3.21
Lubricants		0.00263	0.0003631	2.92
Petroleum Coke			0.0002641	3.09
Refinery Feedstock			0.0002641	3.25
Refinery Gas	0.007041		0.0002403	2.92
Other Oil Products		0.00254	0.0002641	2.92

**Table 2: Electricity emission factors for different countries for 1996 (tCO<sub>2</sub>/kWh)**

COUNTRY	1996 Emission factor	COUNTRY	1996 Emission factor
Albania	0.00019	Korea	0.000297
Algeria	0.000620	Kuwait	0.000512
Argentina	0.000301	Kyrgyzstan	0.000106
Armenia	0.000247	Latvia	0.000172
Australia	0.000791	Lebanon	0.000652
Austria	0.000155	Libya	0.000626
Azerbaijan	0.000150	Lithuania	0.000142
Bahrain	0.000767	Luxembourg	0.000425
Bangladesh	0.000540	Malaysia	0.000594
Belarus	0.000301	Mexico	0.000508
Belgium	0.000281	Moldova	0.000535
Bolivia	0.000269	Morocco	0.000632
Bosnia-Herzegovina	0.000943	Nepal	0.000017
Brazil	0.000032	Netherlands	0.000435
Brunei	0.000711	New Zealand	0.000099
Bulgaria	0.000419	Norway	0.000002
Canada	0.000163	Pakistan	0.000438
Chile	0.000318	Paraguay	0.000133
China	0.000772	Peru	0.000014
Colombia	0.000117	Poland	0.000609
Croatia	0.000217	Portugal	0.000384
Cuba	0.000654	Romania	0.000304
Czech Republic	0.000420	Russia	0.000282
Denmark	0.000446	Singapore	0.000622
Ecuador	0.000307	Slovak Republic	0.000297
Egypt	0.000561	South Africa	0.000770
Estonia	0.000747	Spain	0.000322
Finland	0.000249	Sri Lanka	0.000205
France	0.000040	Sweden	0.000062
FYROM	0.000825	Switzerland	0.000003
Georgia	0.000049	Syria	0.000650
Germany	0.000419*	Tajikistan	0.000068
Greece	0.000812	Thailand	0.000618
Hungary	0.000362	Tunisia	0.000522
Iceland	0.000001	Turkey	0.000461
India	0.000890	Turkmenistan	0.000731
Iran	0.000534	UK	0.000477
Iraq	0.000554	Ukraine	0.000376
Ireland	0.000716	United Arab Emirates	0.000783
Israel	0.000801	Uruguay	0.000100
Italy	0.000420	USA	0.000503
Japan	0.000321	Uzbekistan	0.000432
Jordan	0.000791	Venezuela	0.000176
Kazakhstan	0.001312		
World	<b>0.000466</b>	Non-OECD Europe	<b>0.000420</b>
Africa	<b>0.000663</b>	Former USSR	<b>0.000328</b>
Middle East	<b>0.000650</b>	Latin America	<b>0.000164</b>
		Asia (excl. China)	<b>0.000724</b>

\* **Important note:** the emission factor for Germany proved to be wrong. Please apply a factor of 0,611 t CO<sub>2</sub>/Mwh (according to GEMIS 4.13)