

Table 3. Indonesia's GHGs inventory, 1994

Sources and Sinks Categories	Uptake (Gg)	Emission (Gg)		
	CO ₂	CO ₂	CH ₄	N ₂ O
I. Energy (Fuel Combustion and Fugitive)		373,608.71	2,395.73	5.72
FUEL COMBUSTION		170,016.31	357.56	5.72
1. Energy and transformation industries		50,702.24	0.77	0.28
2. Industry		50,014.38	2.29	0.23
3. Transportation		47,047.16	7.49	0.44
4. Small combustion in residential and commercial		22,252.5	347.01	4.77
FUGITIVE FUEL EMISSIONS		203,592.40	2,038.17	
1. Solid Fuels		17,814.20	20.40	
2. Oil and Natural Gas		185,778.20	2,017.77	
II. Industrial Processes		19,120.00	0.51	0.01
III. Agriculture			3,243.84	52.86
1. Livestock			947.21	0.00
2. Rice field			2,280.90	
3. Agricultural soil				52.34
4. Prescribed burning savanna				
5. Agricultural residues			15.73	0.52
IV. Land Use Change and Forestry	403,846.00	559,471.00	367.00	2.52
1. Forest and other woody biomass stock changes	334,239.00	198,994.00		
2. Forest Conversion		303,237.00		
3. Abandoned Land	69,607.00			
4. Forest Fire		57,240.00		
V. Waste/Landfill			402.00	
Total	403,846.00	952,199.71	6,409.08	61.11

Source: Indonesia: First National Communication to UNFCCC (1999)

In general, energy plays a big role in the greenhouse gases emissions in Indonesia though it is smaller than the activities related to land use changes. As party to the UNFCCC, Indonesia realises its role in the "common but differentiated responsibilities". This can be seen in some voluntary actions being undertaken, such as activities implemented jointly (AIJ) for renewable energy as well as some energy efficiency measures which are not directly aiming to reduce GHGs. Currently, some projects are being prepared to be CDM-able projects –projects that can be recognized as clean development mechanism projects.

Sustainable Energy Indicators

To analyze whether the energy sector still contribute to sustainable development, a set of indicators are applied, namely indicators for environmental sustainability, social sustainability, economic sustainability and technological sustainability.

Environmental sustainability considers the progress of per capita carbon dioxides emissions related to the energy sector and the progress of the most significant energy related local pollutants. The social sustainability is considering the progress of the number of households with access to electricity, and the progress of investment in clean energy. However, since we failed to gather the data on investment in clean energy, this indicator is left out.

Economic sustainability considered mostly the dependency on imported non-renewable energy. Since Indonesia is still a net energy exporter country, it is sustainable in this case. Another aspect to be considered in the economic sustainability is the burden of energy investment. Similar problem has been faced in gathering the investment data, therefore this aspect has been left out as well.

Last but not least, technologically, energy sector should be sustainable. Aspects being considered are the progress of energy productivity –energy consumed for each US\$ GDP, and the progress of renewable energy deployment.

The year 1995 was chosen to be the baseline and for some indicators the year 1998 was chosen as the second year to evaluate the progress instead of the year 2000.

►Indicator 1: Per capita CO2 emissions from the energy sector

Based on the IEA database on CO2 emission from energy related sector, the per capita emissions for Indonesia in 1990 was 200.03 kgC. This number increased during the ten years period to 325.64 kgC in the year 2000.

Using the equation prepared by HELIO with:

W= the global average emission of CO2 per capita of 1,130 kgC

Y= 30% W

Z= 70% W

X= Indonesia's CO2 emission per capita for each year of 1995 and 1998

The indicator:

$$I = (X - Y) : Z$$

Using the data, for the year 1990, $I_{(1990)} = -0.18$ and for the year 2000, $I_{(2000)} = -0.05$.

Having those numbers, one can say that compared to the global emissions per capita, Indonesia's is still far below the average, yet there was an increase during that period of about 63% or almost 5% annually.

►Indicator 2: Most significant local pollutant

As mentioned earlier, transportation is the major source of air pollutants in the urban area. This is the reason why the data being used in reviewing local pollutants are those coming from transportation sector. Yet not all air pollutants data are available at the national level, therefore the evaluation is done for emissions of hydrocarbon (HC), nitrogen oxides (NOx) and carbon monoxide (CO) only. This does not mean that particulate is not a significant local pollutant, yet the availability of data has played a very important role for the evaluation.

For the consistency of the evaluation, both the year of 1990 and 1998 are used.

The equation for this indicator is as follow:

I= relative value of the combined index from HC, NOx, and CO

W= data of 1990

Y= the national objective of sustainability achievement –such value is not available, therefore 10% of 1990's emission be targeted as Y.

Z=W-Y

X= Indonesia's CO2 emission per capita for each year of 1998

The indicator:

$I = (X - Y) : Z$

Table 4. Per capita local pollutants

Year	HC (000 tons)	NOx (000 tons)	CO (000 tons)	Population (million)	HC (kg/capit a)	NOx (kg/capit a)	CO (kg/capit a)
1990	154	124	146	179	0.86	0.70	0.82
1998	1,056	586	1,205	201	5.24	2.91	5.99

Source: Biro Pusat Statistik, Statistik Lingkungan Indonesia 1993 and 1999.

Hydrocarbon:

W= 0.86

Y= 10% W = 0.086

Z= W - Y = 0.77

X= 5.24

$I_{(HC)} = 6.68$

Nitrogen oxides:

$$W = 0.70$$

$$Y = 10\% W = 0.07$$

$$Z = W - Y = 0.63$$

$$X = 2.91$$

$$I_{(\text{NO}_x)} = 4.54$$

Carbon monoxide:

$$W = 0.82$$

$$Y = 10\% W = 0.082$$

$$Z = W - Y = 0.74$$

$$X = 5.99$$

$$I_{(\text{CO})} = 8.03$$

Relative value of the combination of three pollutants:

$$I = (I_{(\text{HC})} + I_{(\text{NO}_x)} + I_{(\text{CO})}) : 3 = \mathbf{(6.68 + 4.54 + 8.03) = 6.42}$$

The indicator basically shows that there is no sustainability in transportation sector in the island of Java considering the local pollutants. Instead of improving the air quality, the transportation sector has made it five-time worse during this eight years period. This means an average annual increase of about 26%.

► Indicator 3: Reliable access to electricity

The portion of households with access to electricity has been increasing. Based on the electrification ratio published by the Directorate General of Electricity and Energy Development, for the year 1990, 29% households have access to electricity and increased to 56% in 1998.⁶

The equation for this indicator is as follow:

X= number of households with access to electricity in 1990

Y= total number of households in 1990

P= number of households with access to electricity in 1998

Q= total number of households in 1998

The indicator:

$$I_{(1990)} = 1 - (X/Y)$$

$$I_{(1998)} = 1 - (P/Q)$$

Using the available data:

$$I_{(1990)} = 1 - 26\% = \mathbf{74\%}$$

$$I_{(1998)} = 1 - 56\% = \mathbf{44\%}$$

This means that in the case of access to electricity, Indonesia is moving towards a sustainable direction. During the period of eight years, the increase was 115% which equal to 10% increase annually.

⁶ <http://www.djlpe.go.id/statistik>

► **Indicator 4: Investment in clean energy**

There are several investments being made in the case of clean energy and this number is increasing. However, analysis can not be undertaken as there is no published data available.

► **Indicator 5: Energy vulnerability**

Indonesia is still a net exporter country in term of non-renewable energy. Based on the IEA Energy Outlook, in the year 1990 the contribution of non-renewable energy export to the national export is 43.1% -around US\$ 11.10 billion out of almost US\$ 25.68 billion.

The share of non-renewable energy in national exports is declining to 15% in 1998. This means that from almost US\$ 50.50 billion total export, non renewable only contributed less than US\$ 7.50. This means that during the eight years period, there was a decrease of 65% or equal to an annual decrease of 12%.

The numbers show that the dependency on non-renewable energy is getting less significant, this means Indonesia is moving towards a more sustainable development.

$I_{(1990)} = 43\%$

$I_{(1998)} = 15\%$

► **Indicator 6: Importance of the public sector in energy investment**

There is no published data available in this respect. Therefore, analysis for this was not undertaken.

► Indicator 7: Energy productivity

This indicator is referring to the quantities of economic activity –in GDP– per unit of energy consumed. Compared to the global average, the energy productivity in Indonesia is still very inefficient. For the same amount of GDP, Indonesia consumed more energy.

Table 5. Energy productivity in Indonesia

Year	Energy consumption (MJ)	GDP (billion US\$)	Energy/GDP (MJ/billion US\$)
1990	1,425	143.20	9.95
2000	2,677	209.40	12.79

Source: calculation ⁷

The indicator was calculated using the equation:

$W = \text{average global energy consumption in 1990} = 10.64 \text{ MJ/US\$}$

$Y = 10\% W = 1.064 \text{ MJ/US\$}$

$Z = 90\% W = 9.58 \text{ MJ/US\$}$

$X = \text{energy consumption/GDP}$

$I = (X - Y) : Z$

Using the data $X_{(1990)} = 9.95$ while $X_{(2000)} = 12.79$:

$I_{(1990)} = 0.84$

$I_{(2000)} = 1.11$

This means that the energy consumed for each unit of GDP increased and moved towards an un-sustainable direction. However, one can argue that the instability of currency rate has overshadowed the numbers.

⁷ calculation based on http://www.djilpe.go.id/informasi/frame_informasi.htm and <http://www.eia.doe.gov/emeu/international/other.html#IntIGDP>

► **Indicator 8: Deployment of renewable energy**

Renewable energy has been recognised in the national primary energy consumption in Indonesia. However, the progress is very slow. Renewable energy in this context is geothermal energy only. The contribution of geothermal energy in the year 1990 was 0.61% and increased to 1.38% in the year 2000.⁸

Taking the numbers into account, the renewable energy deployment is moving towards sustainability, yet, it is still below the targeted sustainability globally. The indicator for renewable energy deployment for the year 1990 was 1.1 and in the year 2000 it was 1.08.

⁸ http://www.djlpe.go.id/informasi/frame_informasi.htm