HELIO INTERNATIONAL

INDONESIA

Sustainable Energy Watch
2002 Report

Energy and Sustainable Development in Indonesia

A report

by Kuki Soejachmoen

kuki @ pelangi.or.id

Most indicators show that Indonesia moved towards an un-sustainable direction. However, one can argue that the instability of currency rates has overshadowed the numbers.

Table of contents

- **Executive Summary** ..... p. 3
  Table 1. Sustainability Indicators for Indonesia

- **Overview** ..... p. 5

  ►Socio-Economic Background

  ►Energy Background
  Figure 1. Primary Energy Consumption in Indonesia
  Table 2. Renewable Energy Potential and Utilisation in Indonesia

  ►Climate Change and Environmental Background
  Table 3. Indonesia's GHGs inventory

- **Sustainable Energy Indicators** ..... p. 11

  ►Indicator 1: Per Capita CO2 Emissions from the Energy Sector

  ►Indicator 2: Most Significant Local Pollutant
  Table 4. Per capita local pollutants

  ►Indicator 3: Reliable Access to Electricity

  ►Indicator 4: Investment in Clean Energy

  ►Indicator 5: Energy Vulnerability

  ►Indicator 6: Importance of the Public Sector in Energy Investment

  ►Indicator 7: Energy Productivity
  Table 5. Energy productivity in Indonesia

  ►Indicator 8: Deployment of Renewable Energy

- **Star of Indonesia** ..... p. 21
  Figure 2. Sustainability Status of Energy Sector in Indonesia

Executive Summary

The development of the energy sector has negative as well as positive impacts on sustainable development. This paper is prepared by Pelangi to analyse the role of the energy sector in supporting sustainable development in Indonesia as part of the HELIO International Sustainable Energy Watch report.

The year 1990 was chosen to be the baseline and for some indicators the year 1998 was chosen instead of 2000. Yet there is no published data available on investment in clean energy or public sector share in energy investment.

Table 1. Sustainability Indicators for Indonesia

Year	SUSTAINABLE DEVELOPMENT INDICATORS FOR ENERGY SECTOR IN INDONESIA							
	Environmental		Social		Economic		Technology	
	1 (kg C/cap)	2 (kg/cap)	3 (%)	4 (%)	5 (%)	6 (mill US$)	7 (MJ/$ GDP)	8 (%)
1990	200.03	HC : 0.86 NOx: 0.70 CO : 0.82	26	-	43	-	9.95	0.61
2000	325.64	HC : 5.24* NOx: 2.91* CO : 5.99*	56*	-	15*	-	12.79	1.38

Note :

Indicator 1 : per capita carbon emission from the energy sector ;
Indicator 2 : most significant energy related local pollutants ;
Indicator 3 : households with access to electricity ;
Indicator 4 : investment in clean energy ;
Indicator 5 : energy security or energy trade ;
Indicator 6 : burden of energy investment ; Indicator 7 : energy productivity ;
Indicator 8 : renewable energy deployment ; * using 1998's data

- The table, above, shows that there was no significant progress towards sustainability in the energy sector. All four pollutants – local and global – demonstrated increasing trends on a per capita basis. Similar pattern is demonstrated by the energy intensity (energy consumption per economic output).

- On average, carbon dioxide emissions (in terms of carbon) per capita in Indonesia increased at 5 percent annually, while other local pollutants increased at 26 percent annually.

- Access to electricity has progressed modestly. In eight years, the number of households that gained access to electricity increased by 115 percent, equivalent to a growth rate of about 10 percent per year.

- As a net exporter country, Indonesia has reduced its dependency to non-renewable sector. The contribution of non-renewable energy in national export was reduced by 65 percent in three years, equivalent to 12 percent annually.

- Contribution of renewable energy in the energy sector in the period of 1990 - 1998 was increased considerably from 0.61 percent to 1.38 percent. The numbers are only for geothermal resources. While there was an increase in the installed capacity and consumption, there had been almost no progress in the role of renewable energy in Indonesia**.**

Overview

Indonesia is an archipelagic country consists of 17,508 islands stretching from latitude of 06°08' N to 11°15' S, and longitude of 94°45' E to 141°05' E. As Indonesia is located at the equator, its climate is tropical and therefore Indonesia only has two seasons namely dry season (June-September) and rainy season (December-March). Meanwhile, in April to May and October to November the climate is in monsoon which is the transition from one type of climate to another.

►Socio-economic Background

Based on the national population census, which was held in 1990, Indonesia is inhabited by 179.4 million people; this means that in the period of 1980 to 1990, the annual population growth rate was 1.98%. In the last decade (1990-2000), the annual population growth rate was a bit smaller around 1.6%; this means that the population in the year 2000 was around 207 million. If the rate will still be the same, in the year 2030, the population in Indonesia is projected to be more than 300 million.

In the year 1997, Indonesia was hit by the Asian economic crisis which resulted in an increased number of poor people (almost 100 million people –which is about half of the population- living in poverty). Those people living in poverty have very limited, if any, access to any infrastructure and services, including energy. As the population is not distributed well throughout Indonesia where more than 50% live in Java with an area not more than 7% of the Indonesia's total land, the development was focused in this area. This has increased the disparity both economic and social.

Recently, Indonesia's economic growth slowed modestly in 2001 in response to the global economic slowdown, which reduced demand for the country's exports. Indonesia's real gross domestic product (GDP) grew at a rate of 3.1% in 2001, down from 4.8% in 2000. Real GDP growth is forecast at 3.5% for 2002.[1]

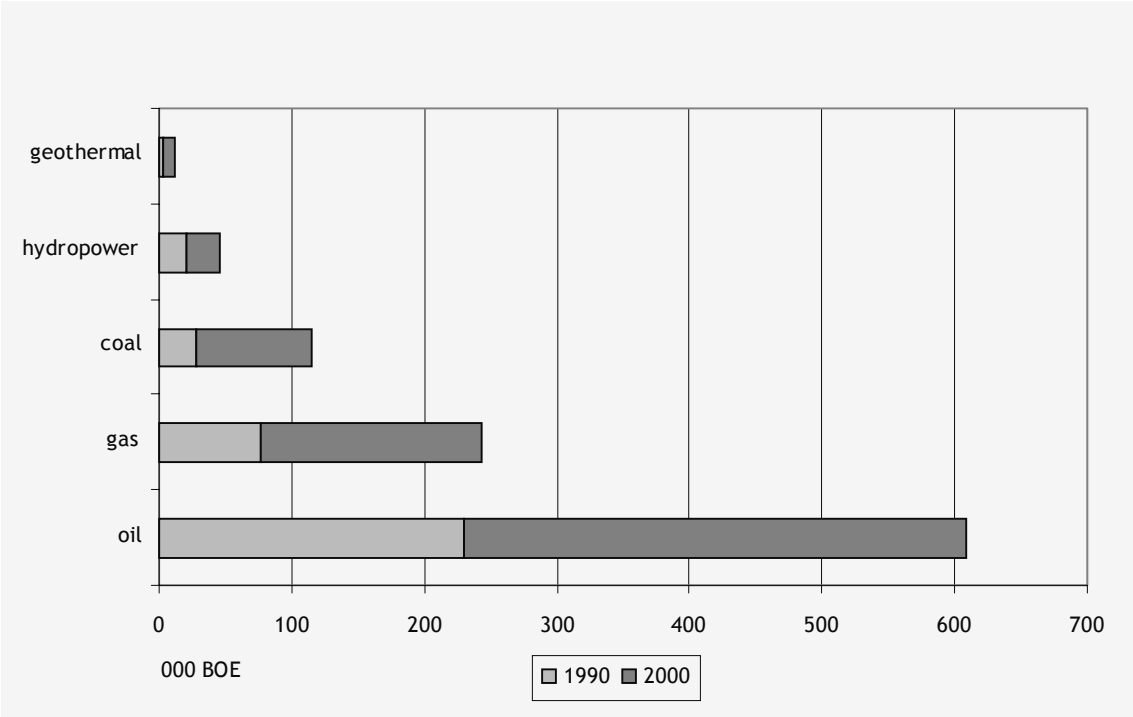
Indonesia is not an energy-efficient country. During the last three decades, the energy intensity to economy was ranging from 1.04 to 1.35 [2], much higher compared to those of industrialised countries which were 0.55 to 0.65. The share of the energy sector to Indonesia export is also declining.

---

[1] URL: http://www.eia.doe.gov/emeu/cabs/indonesia.html

[2] Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources. *Mining and Energy Yearbook of Indonesia.* Jakarta, 1998

►Energy Background



source: **http://www.djlpe.go.id/statistik**

Figure 1. Primary Energy Consumption in Indonesia

Oil sector

The current proven oil reserve in Indonesia is around 5 billion barrels. This number represents a 14% decline in proven reserves since 1994. The decline can be explained as crude oil production had ranged between 1.3 and 1.4 million barrels per day (bbl/d) during the last decade of 20th century. In the year 2001, Indonesian crude oil production averaged about 1.22 million bbl/d, which is lower than the rate in 1990-2000. The decrease in 2001 was due mainly to the natural decline of aging oil fields.

The national oil production during the 1990s was relatively flat as smaller fields have helped compensate for declines at many of the country's mature oil fields. In order to meet its goal of increasing production, Indonesia has signed new oil exploration contracts, which are nine new production sharing contracts (PSCs) as well as its plans to offer 17 new blocks in 2002.

To optimise the oil sector development in Indonesia, the liberalisation of downstream oil and gas sector has been under discussion for several years. The new bill on oil and gas sector was passed in October 2001. The bill will remove the monopoly of Pertamina's on upstream oil development within two years, while its monopoly on the distribution side is to be terminated within four years.

The role of Pertamina in awarding and supervising the PSCs will be taken over by the Ministry of Mines and Energy. Subsidies for domestic petroleum products consumption have been reduced to decrease the government's budget deficit and restrain increases in

domestic consumption. There is one concern of foreign oil companies, which is the granting of a limited authority to regional governments to tax oil companies' profits.

For the downstream side, Indonesia has eight refineries with total capacity of 992,745 bbl/d. A new refinery is now under consideration to be built in South Sulawesi as an export-oriented refinery.

Natural Gas

The proven reserves of natural gas in Indonesia is 92.5 trillion cubic feet (Tcf) which is located mostly in North Sumatra, East Kalimantan, offshore Java, Papua and Natuna. Indonesia is the world's largest exporter of liquefied natural gas (LNG), yet it still relies on oil to supply about 60% of its primary energy demand and around three-quarters of its final energy demand. There has been effort to shift towards using natural gas resources, yet the infrastructure for distribution still is not extensive.

Coal

Similar to oil and gas reserves, Indonesia has 5.75 billion short tons of recoverable coal reserves. Of those reserves 85% is lignite and 15% is anthracite. Roughly two-thirds of the coal reserves is in Sumatra and the rest are in Kalimantan, West Java, and Sulawesi. The export of coal in 1999 was 59.2 million short tons (Mmst), or about 83% of total coal production. The major destinations of these exports are Japan, South Korea, and Taiwan. In the next five years, Indonesia plans to double its coal production. These exports are destined for East Asia and India. The new capacity will come primarily from private mines.

Domestically, coal is being used for power generation and industry. There was an effort to utilize more coal as briquette for households use, but no significant positive progress until now. The share of coal in the primary energy-mix in Indonesia is ranging from 20 to 25% in the last twenty years, while its share in the final energy-mix is less than 10% mostly in industries.[3]

Renewable energy

In the last few years, renewable energy became more popular in the energy sector development in Indonesia. There are two basic reasons for this, one is the economic condition that is not improving yet and the other is the environmental issue. Indonesia has abundant resources of renewable energy, yet only around 6% that has been developed and utilised. Table 2 (next page) shows the situation of the renewable energy sector in Indonesia.

[3] http://www.djlpe.go.id/statistik

Table 2. Renewable Energy Potential and Utilisation in Indonesia

Type of resources	Potential (MW)	Installed Capacity (MW)	Share of Installed Capacity (%)	Share of RE being Utilised
Geothermal	20,000	812	69.2	4.06
Microhydro	459	54	4.6	11.76
Solar Radiation	4.5 kWh/m2/day	5	0.42	
Wind Energy	448	0.5	0.05	
Biomass	50,000	302	25.73	0.6

Source: Sumiarso,L. Government Policy on New and Renewable Energy in Indonesia. August 2001.

The very limited utilisation is heavily influenced by the discouraging environment especially financial mechanism such as subsidy for fossil fuels and luxury tax applied for imported renewable energy equipments. However, there are also several community-based renewable energy programs –the micro hydro based- that have been successfully implemented and even able to sell the generated electricity to PT. PLN (Persero), the national electricity company. However, the utilisation of renewable energy resources for non-electricity generation is still very limited.

Electricity generation

Up to the year 2000, total installed capacity in Indonesia is 39.5 GW of which 56% (20.76 GW) owned by PT. PLN (Persero). About three-quarter of this installed capacity is located in the region of Jawa-Bali with total area less than 10% of Indonesia. Almost 84% of generators in Indonesia are based on fossil fuels, namely coal, oil and gas. Hydropower –macro scale that uses dam- contributes 14% to the system and geothermal –the only resources considered as renewable- contributes only 2%.[4]

Around 59% of households in the island of Jawa are connected to the national electricity grid. This number is much smaller for the rest of the country that is 36%. In national level, number of households connected to the national grid is 58%. This is also the case for rural households, only less than 67.5% has been connected.[5]

[4] PT. PLN (Persero). *Statistik PLN 2000.*

[5] *ibid*

▸Climate Change and Environmental Background

Indonesia has ratified the UNFCCC in the year 1996, Indonesia has even signed the Kyoto Protocol, yet its ratification is another big question. In general, the air pollution level in the urban area is already at alarming levels and this mainly comes from the transportation sector.

Energy consumption in transportation sector has increased as much as 8% annually, and this resulted in an increase of even higher number for hydrocarbon (HC), nitrogen oxides (NOx) and carbon monoxides (CO). Other sectors also contribute in a modest amount of air pollutants.

During the last decades, the development activities in Indonesia have changed the Indonesia's status from net sink of greenhouse gases to net emitter of greenhouse gases. The major reasons for this are the increased of energy use, and the land-use changes such as deforestation. Table 3 (next page) describes the total emission by sector and gas in 1994.

Table 3. Indonesia's GHGs inventory, 1994

Sources and Sinks Categories	Uptake (Gg)	Emission (Gg)		
	CO_2	CO_2	CH_4	N_2O
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, $\mathbf{I_{(1990)}= -0.18}$ and for the year 2000, $\mathbf{I_{(2000)}= -0.05}$.

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/capita)	NOx (kg/capita)	CO (kg/capita)
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

$I_{(NOx)}$= 4.54

Carbon monoxide:

W= 0.82

Y= 10% W = 0.082

Z= W – Y = 0.74

X= 5.99

$I_{(CO)}$= 8.03

Relative value of the combination of three pollutants:

I= ($I_{(HC)}$+ $I_{(NOx)}$ + $I_{(CO)}$) : 3 = **(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:

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

$\mathbf{I_{(1998)}}$= 1 - 56% = **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= average global energy consumption in 1990 = 10.64 MJ/US$

Y= 10% W = 1.064 MJ/US$

Z= 90% W = 9.58 MJ/US$

X= 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.djlpe.go.id/informasi/frame_informasi.htm and http://www.eia.doe.gov/emeu/international/other.html#IntlGDP

►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

Star of Indonesia

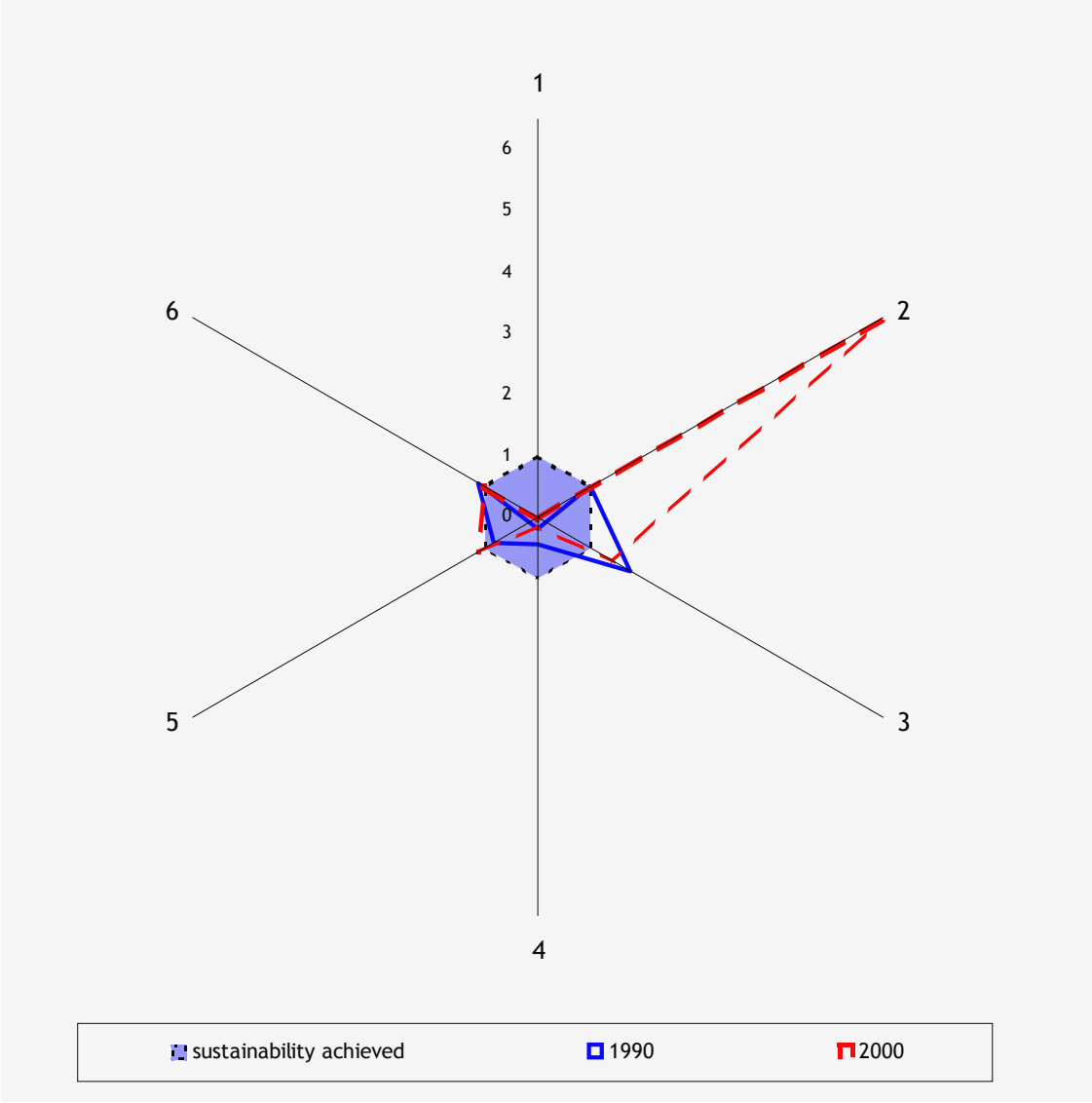


Figure 2. Sustainability Status of Energy Sector in Indonesia

Figure 2 shows the stars of six indicators being evaluated. As mentioned earlier, due to the lack of published data for indicator 4 and 6, both indicators are excluded from the star. The shadowed area is the area of sustainability, while the area outside is the un-sustainability one.

In term of GHG emissions (numbered as 1 in the star), Indonesia is much lower compared to the average global emissions. One can see that for this indicator, Indonesia is in the sustainability area, however it is moving towards un-sustainability (moving outwards in the star diagram).

In contrast, the significant local pollutants (no. 2) are much outside the sustainability area. And the indicator is moving further outwards, which means more un-sustainability.

Access to electricity (no. 3) has not reached 100% yet, this is why Indonesia is still in the un-sustainability area. However, there is a tendency for this towards sustainability as it is moving inwards.

Indonesia can be considered sustainable referring to its dependency on imported energy. As mentioned earlier, Indonesia is still a net exporting country of non-renewable energy. However, the role of non-renewable energy in the national exports is getting smaller, thus it moved toward more sustainability (no. 4 in the stars).

Unlike most developed countries, the energy consumption in Indonesia is considered very inefficient especially in supporting the national development. From the star, one can see that Indonesia is moving outwards which is towards un-sustainability (no. 5 in the star).

As the deployment of renewable energy is still very limited and yet almost stagnant during the evaluation period, Indonesia is considered as un-sustainable for this indicator (no. 6 in the star).

From six, instead of eight, indicators being evaluated only two can be considered to follow the sustainability criteria developed by HELIO, while four others are considered as un-sustainable. In general, except the access to electricity, other indicators are moving towards un-sustainability.