

MITIGATION OF CARBON DIOXIDE AND GREEN HOUSE GAS EMISSION FROM OIL AND GAS INDUSTRY IN INDONESIA

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ABSTRACT

International concern is now focused on reducing green house gas (GHG) emissions which drive climate change. The use of fossil fuels, either flaring natural gas and burning fossil fuels, are predicted contributing GHG emissions. As a consequence, International cooperation through United Nation Framework Convention on Climate Change (UNFCCC) has pointed to increase policy interest in developing CO₂ and GHG emission trading system. The system would allow the countries who have opportunities to reduce CO₂ and GHG emission (generally developing countries) and sell or trade GHG emission reduction to the countries (generally developed countries).

The second part of this paper will be emphasized on oil and gas reserves, production, refineries, and utilization. Indonesia oil resource as of January 1st, 2006 amounts to about 56.60 BBO, while gas resources as of January 1st, 2006 is about 334.5 TSCF. Indonesia has nine refineries owned by PT Pertamina (Persero) and six refineries owned by private.

Indonesia has also voluntarily participated in reducing GHG emissions by formulating energy policy, doing research on carbon capture and storage (CCS), and developing innovative projects. This paper will highlight the energy policy, research program and innovative projects for reducing GHG emission from oil and gas activities in Indonesia.

Key Words: Mitigation, GHG emission, oil and gas, CCS.

I. INTRODUCTION

A. Background

International concern about the potential effects of climate change has been growing significantly and has led to increasing research, policy initiatives, and the development of innovative programs and projects around the countries. These activities have been focused on developing a better understanding of the environmental, economic and social risks due to climate change and seeking ways to reduce Carbon dioxide (CO₂) and green house gas (GHG) emissions that are driving climate change.

International cooperation through United Nation Framework Convention on Climate Change (UNFCCC) indicates the increase of policy interest in developing CO₂ and GHG emission trading sys-

tem. The system would allow the countries who have opportunities to reduce CO₂ and GHG emission (generally developing countries) and sell or trade GHG emission reduction to the countries (generally developed countries).

In Indonesia, oil and gas industries might contribute CO₂ and GHG emissions through flaring natural gas and the use of fossil fuels. The data indicates that in 2006 natural gas which is flared in flare stack is about 111.831.560 MSCF (306.388 MSCFD). This amount comes from oil and gas upstream activities. The other source of CO₂ and GHG emissions comes from the use of fossil fuels. In 2005, the consumption of energy mix in Indonesia shows that the consumption of oil is about 51.66%, gas 28.57%, coal 15.34%, hydropower 3.11%, and geothermal 1.32%.

The opportunities of reducing CO₂ and GHG emissions have been identified in the energy, transportation, agriculture, and forestry sectors. These opportunities vary regionally and nationally, depending on a number of environmental, economic and social variables. In a World Bank sponsored study it was shown that 85 percent of Indonesia's CO₂ emission comes from forestry, followed by energy consumption (9 percent), agriculture (4.6 percent) and waste pollution (1.4 percent). (PEACE 2007:2 Indonesia and Climate Change: Current Status and Policies).

For the above mentioned reasons, the government regulation and policy on GHG emission reduction, the current situation of oil and gas activities, the GHG emission reduction programs would be discussed in this paper, and finally this paper would be concluded by the ways to reduce GHG emission from the oil and gas industries and the policy taken by the Government of Indonesia.

B. Regulations and Policies on Green House Gas Emission Reduction

- 1. The Law Number 22 of 2001 concerning Oil and Gas.** The oil and gas companies shall ensure safety, health and environmental management and comply with the provisions of the prevailing laws and regulations in the oil and gas business activities. The environmental management includes the obligation to perform pollution prevention and mitigation as well as recovery from environmental damage including post mining operation obligations.
- 2. The Law Number 17 of 2004 concerning Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.** By ratifying the Kyoto Protocol, the Government of Indonesia (GOI) has a commitment on climate change convention based on "common but differentiated responsibilities principles". The GOI has also to: (a) conduct sustainable development in order to maintain stabilization of GHG concentration in the atmosphere; (b) give opportunities of new investments from industrial countries to Indonesia through the Clean Development Mechanism (CDM); (c) encourage good cooperation with industrial countries through CDM; (d) accelerate industrial and transportation development with low emission level through clean technology utilization.
- 3. Government Regulation Number 35 of 2004 Concerning Oil and Gas Upstream Activities.** All oil and gas companies are obliged to perform sound technical practices which include fulfilling safety and health as well as environmental requirements; and conservation, including measures to reduce flaring.
- 4. Government Regulation Number 36 of 2004 Concerning Oil and Gas Downstream Activities.** All oil and gas companies carrying out oil and gas processing, transportation, storage, and wholesale activities shall ensure and comply with the regulations and shall perform good practices in managing occupational safety, health, and the environment.
- 5. Government Regulation Number 17 of 1974 Concerning Inspection of Oil and Gas Off-shore Activities.** All oil and gas companies shall perform sound technical practice in oil and gas mining operations, including carrying out pollution prevention and mitigation as well as recovery from environmental damage.
- 6. Government Regulation Number 11 of 1979 Concerning Inspection of Oil and Gas Off-shore Activities.** All oil and gas companies are obliged to perform air pollution prevention due to emitting gas and other toxic pollutants to the air. All toxic pollutants are prohibited to be vented to the air, and unused flammable gases shall be flared.
- 7. Presidential Regulation Number 33 of 2005 Concerning Ratification of Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer.** The Government of Indonesia (GOI) has an obligation to take appropriate measures to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer.
- 8. Presidential Regulation Number 46 of 2005 Concerning Ratification of Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer.** The Government of Indonesia (GOI) has an obligation to take appropriate measures to protect human health and the environment against adverse effects resulting or likely to result from human

activities which modify or are likely to modify the ozone layer.

9. Presidential Regulation Number 5 of 2006 Concerning National Energy Policy. The policy has been focused on the optimization of energy mix composition in 2025 which is also to protect the environment through sustainable development principle.

10. There is another program what we called **“Program Langit Biru” (Blue Sky Program)**. This program has been launched since August 1996. This program is focused on the mitigation of air pollution; hence the ambient air quality shall meet human health standard as well as for other living beings.

II. INDONESIA OIL AND GAS ACTIVITIES

As a mandate by Law No. 22/2001, oil and gas business activities in Indonesia are divided into upstream and downstream activities. Oil and gas upstream activities consist of exploration and exploitation activities, meanwhile the downstream activity consists of processing (refinery), transportation, storage and trading activities.

Oil and gas upstream activities are being implemented by business entities and permanently establishes are in accordance with a contract, while oil and gas downstream activities are being implemented by bussiness entities after obtaining the bussiness license from the government.

1. Oil and Gas Upstream Activities

In accordance with the Law No. 22 of 2001, the ownership of oil and gas companies which eligible to conduct the upstream activities are state-owned companies, cooperative, national private companies, and other permanently established entities.

Indonesia oil resource as of January 1st, 2006 amounts to about 56.60 BBO,

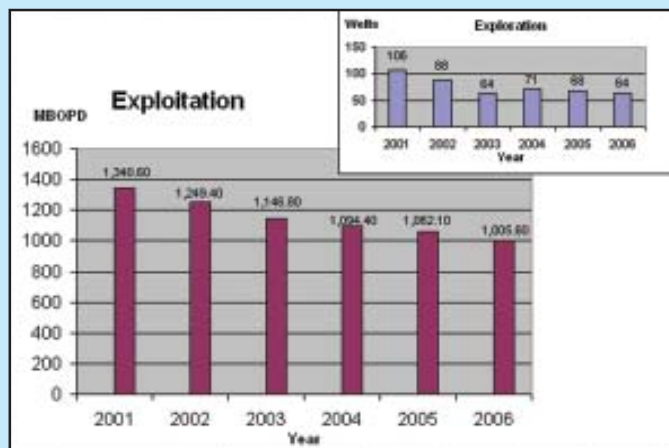


Figure 1
Oil Exploration and Exploitation Trends Over 2001 – 2006

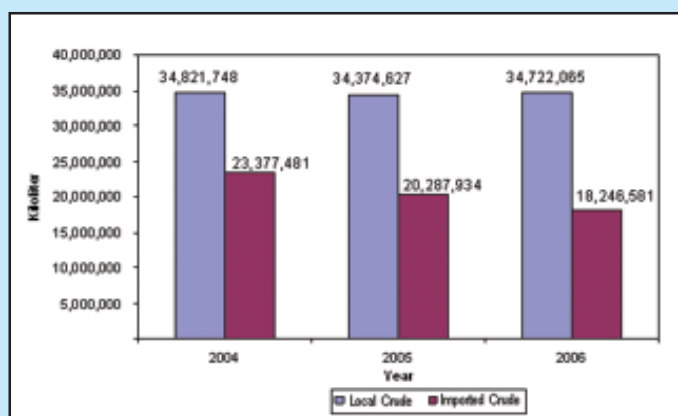


Figure 2
Indonesia Crude Oil Composition, 2004 – 2006

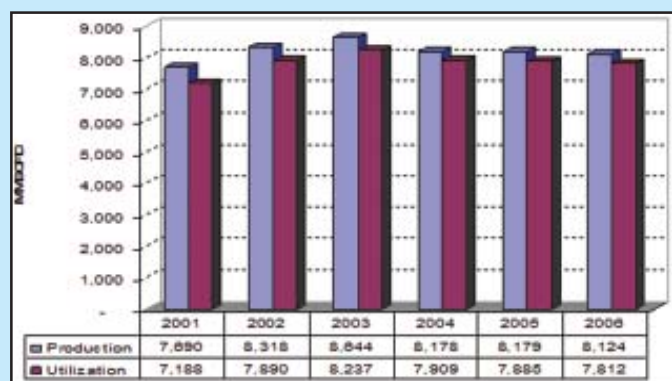


Figure 3
Indonesian Gas Production, 2001 – 2006

while exploration and exploitation trends over 2000 – 2006 are as shown in Figure 1.

The composition of Indonesian crude oil local and crude oil imported is shown in Figure 2. From this figure, it can be seen that Indonesian crude oil during the period of 2004 – 2006, crude oil import is more than 50% compared to local.

Imported crude oil is to balance the demand for domestic refinery feedstock. Regulated petroleum fuels are imported due to insufficient domestic fuels supply availability from local refineries. Meanwhile import of non regulated petroleum fuels shall consider availability of petroleum fuels from domestic refinery. Refinery products can be exported if market has been taken care of and can not be absorbed by the domestic market.

Indonesia gas resources as of January 1st, 2006 is about 334.5 TSCF, while exploration and exploitation trends over 2000–2006 are as shown in Figure 3.

Indonesia gas resources are located spread away from potential customers with limited infrastructure, and low consumer buying power. Therefore, Indonesia will develop an integrated gas transmission and distribution pipeline network to connect multi gas producers and multi gas consumers.

Indonesia has also a policy of putting the priority on natural gas utilization for domestic needs. Natural gas can be exported if domestic of natural gas needs has been fulfilled.

2. Oil and Gas Downstream Activities

Oil and gas downstream business activities may be conducted by the state-owned entity, the regional government-owned business entity, cooperatives, small companies, and private business entities. Business licenses required for oil and gas activities shall be distinguished as follows:

1. Business license for processing
2. Business license for transportation
3. Business license for storage; and
4. Business license for wholesale and trading.

Table 1
Oil and Gas Refineries in Indonesia

No	Location	Capacity
		(Thousand BOPD)
1.	Pangkalan Brandan	5.00
2.	Dumai	120.00
3.	Sungai Pakning	50.00
4.	Musi	135.20
5.	Cilacap	348.00
6.	Balikpapan	260.00
7.	Cepu	3.80
8.	Balongan	125.00
9.	Kasim	10.00
Total capacity		1,057.00

Source: Indonesian Petroleum Statistic,
Directorate General of Oil and Gas

Table 2
New Private Oil and Gas Refineries in Indonesia

No	Company	Location	Capacity	Project Status
			(Thousand BPD)	
1.	PT Trans Pacific Petrochemical Indotama	Tuban, East Java	100.00 (condensate)	Production
2.	PT Intanjaya Agromegah Abadi	Pare-Pare, South Sulawesi	300.00	Economic&Engineering (E&E) Study
3.	PT Petroref Utama Nusantara	Lombok Tengah, West Nusa Tenggara	300.00	E&E Study
4.	PT Kilang Muba	Musi Banyuasin, South Sumatra	800.00	Construction
5.	PT Elnusa Harapan	Tuban, East Java	300.00	E&E Study
6.	PT Situbondo Refinery Industry	Situbondo, East Java	300.00	E&E Study

Deregulation in oil and gas downstream business activities and establishment of regulated and non-regulated petroleum fuel trading are used as tools to ease the impact of subsidy elimination. There are nowadays other business entities in the trading business of regulated petroleum fuels beside PT Pertamina (Persero).

The Government of Indonesia is also still subsidising certain fuels, i.e. Premium, Kerosene, and Diesel Oil, and certain consumer groups such as households, small scale enterprises, fisheries, transportation, and public service. This public service obligation (PSO) is being conducted by PT Pertamina (Persero) as the infrastructures have been operated by PT Pertamina (Persero). The authority of distributing certain fuel by PT Pertamina (Persero) is given by the Minister of Energy and Mineral Resources, even in the other cases PT Pertamina (Persero) has been treated, on the same level as other

downstream entities in the oil and gas business.

In line with deregulation in oil and gas business, private companies are able to take part in domestic fuel production by building oil and gas refineries as the production capacity of the existing refineries has decreased significantly. Table 1 indicates the capac-

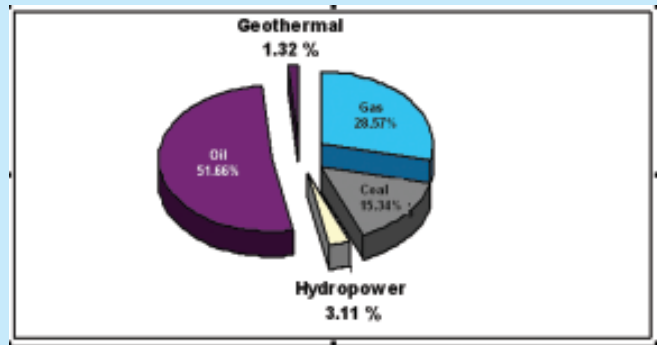


Figure 4
Energy Mix Status 2005



Figure 5
Master Plan of National Natural Gas Transmission and Distribution Network

Table 3
Green House Gas Emission Reduction Programs

No	Oil and Gas Companies	Program	Volume
1.	PT Pertamina (Persero) EP	CO ₂ gas emission is trapped and stored by using CO ₂ removal unit, and the gas is utilized in soft drinks at PT Samator	0.776 MMSCFD
2.	VICO Indonesia	CO ₂ is reduced from blow-down portable compressors, gas instrument replacement by air supply and vapor recovery project	996,000 tonnes
3.	BP West Java Ltd.	Gas to be planned is recovered for gas lift and is sold to consumers	2.5 MMSCFD
4.	Medco E&P Indonesia – Blok Rimau	Associated gas is recovered to LPG	1.961 million tonnes
5.	Kodeco Energy	Gas to be planned is used as fuel for gas turbine compressor and restaging gas compressor, as well as sold to consumers.	Production increases from 15.278MMSCFD (2001) to 44.353 MMSCFD (2006)
6.	PT Pertamina (Persero) UP V Balikpapan	Gas to be planned is recovered at Pertamina UP V Balikpapan	40 tonnes/hour CO ₂ recovered
7.	CNOOC SES Ltd.	Utilizing associated gas for gas turbine	12.2 MMSCFD
8.	Chevron Indonesia Co.	Gas Flaring Reduction	From 14 – 16 MMSCFD to < 1 MMSCFD
9.	PetroChina International Jabung (North Geragai Field)	Injection Gas for Pressure Maintenance. After 2003 the gas is sold to Singapore Power	95.95 BSCF
10.	Santos (Oyong Gas Injection)	Associated Gas is injected into reservoir	3.5 – 20 MMSCFD
11.	PT Pertamina Area Subang	Gas flare – LPG Plant	-
12.	PT Pertamina Area Jambi	Gas lift – EOR	-
13.	TAC Pertamina – Medco Sembakung	Gas flare - Generator	-
14.	BP Berau LPG Tangguh Project	Gas Turbine and Steam Generator	320 MW
15.	Chevron Pacific Indonesia (Central Duri)	Heat Recovery Steam Generator	160,000 lbs/h equivalent 10,000 BCWEPD per Unit
16.	PT Odira Energy Persada	Flare gas converted	36,000 MMBTU/day

ity of the existing refineries. Recently, there is a refinery operated by private companies. For example, Trans Pacific Petrochemical Indotama (TPPI) in Tuban East java, which produces condensate about 300 thousand barrel per day, and five private refineries are under construction and E&E study indicated as shown in Table 2.

As described above, Indonesia has huge natural gas reserves which are spread away from potential natural gas consumers. From Figure 3, it can be assumed that almost 100% of natural gas production can be absorbed for domestic uses. It can be understood that natural gas production activities should be

in line with natural gas demand as natural gas can not be stored after being produced.

3. Oil and Gas Utilization

The consumption of fuel products in 2006 are 61.06 million kiloliter which broken down for utilisation by the following sectors: used for transportation 31.35 million KL (51.39%), industry 9.85 million KL (16.15%), household 9.97 million KL (16.34%), power 9.53 million KL (15.62%), and others 0.31 million KL (0.51%). Oil and gas consumption in the Energy Mix is higher than the use of other energy in 2005, as shown in Figure 4.

However, due to the fact that sources of natural gas are mostly located at remote areas with limited gas infrastructure; natural gas can not economically be produced and delivered to potential customer. To solve this problem, the Government of Indonesia will develop an integrated gas transmission and distribution pipeline network to connect multi gas producers and multi gas consumers. Figure 5 shows a Master Plan of National Natural Gas Transmission and Distribution Network.

Indonesia has also LNG contracts. Currently Indonesia exports 24 million ton LNG to Japan, Korea and Taiwan. In 2007 Indonesia has exported LNG 25.61 million tons, 2008 23.21 million tons and 2009 23.32 million tons. This LNG comes from the existing and planned developments of LNG

Plants including:

1. LNG Arun 6.80 MTPA
2. LNG Bontang 22.59 MTPA
3. LNG Tangguh 7.80 MTPA (under construction).

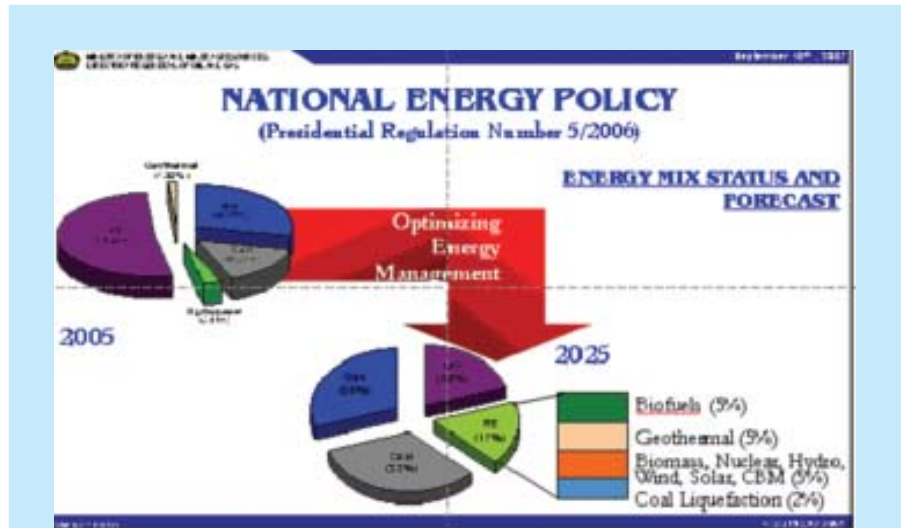


Figure 6
Indonesia Energy Policy

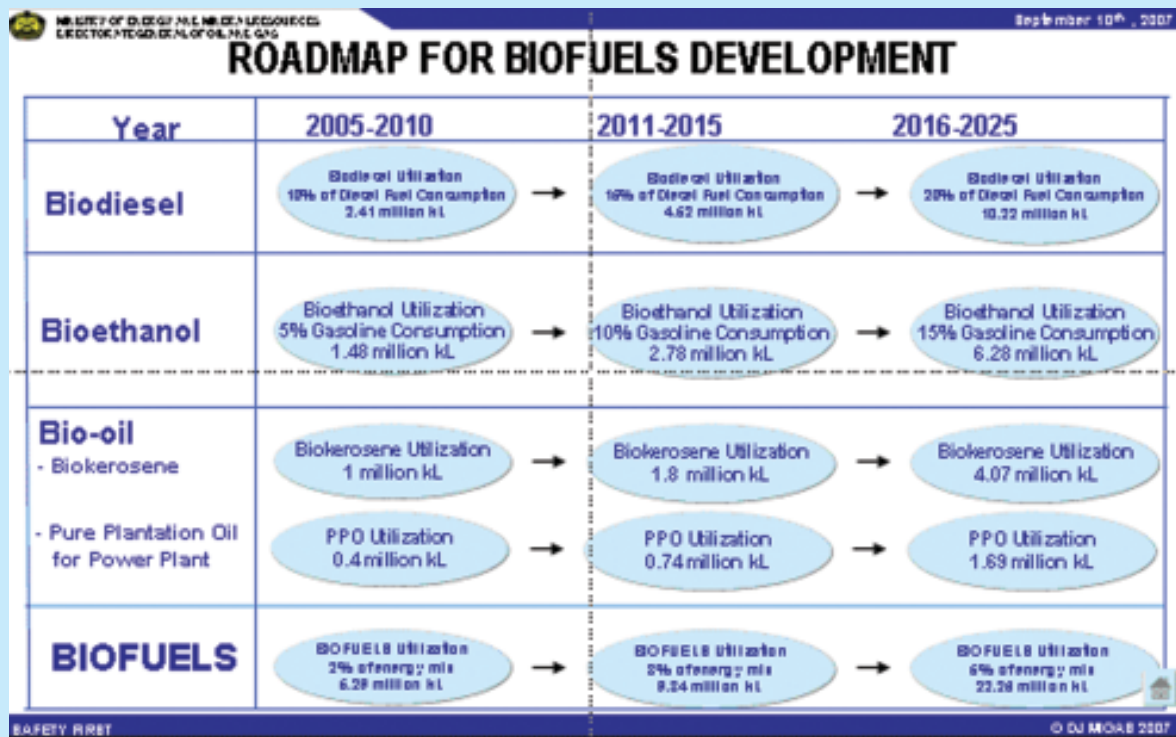


Figure 7
Roadmap for Biofuel Development

III. GREEN HOUSE GAS (GHG) EMISSION REDUCTION PROGRAM

A. Green House Gas Emission Sources

The most sources of CO₂ and GHG emission in the oil and gas industries is due to flaring of natural gas and the use of fossil fuels for transportation and in the industrial sector. The data indicates that natural gas which is flared in flare stacks is about 104.85 MMSCFD.

Transportation and industrial sectors are dedicated fossil fuel consumers. From the data, it can be seen that the consumption of fuel products is dominated by the transportation sector at about 51.39%, industry 16.15%, household 16.34%, power 15.62%, and others 0.51%. The uses of fossil fuel will of course produce CO₂ which is categorized as GHG emissions.

It is therefore desirable that the above sources of GHG emission should be reduced by reducing gas flaring and by using an alternative environmentally friendly fuel for transportation and in the industrial sectors. The following part of this paper will show the program of reducing CO₂ and GHG emission accomplished by the oil and gas industries. GHG

emission reduction in principle consist of GHG emission prevention, mitigation and recovery.

B. Green House Gas Emission Reduction Policy

1. GHG Emission Prevention

Indonesia's GHG emission reduction policy is in general being focused on changing the composition of the energy mix. For 2005, the energy mix status is dominated by the use of fossil fuels. However, Indonesias energy policy has been formulated, through the Presidential Decree Number 05 of 2006 concerning Indonesia's Energy Policy, which has targeted an target optimal energy mix in 2025 as seen in Figure 6. By achieving the targeted GHG emission reduction program, it is automatically being implemented as most GHG emission come from the use of fossil fuels.

Energy conservation and management are directly related to GHG emission prevention for oil and gas activities including the development of coal bed methane (CBM), reducing energy and fossil fuel consumption, enhancing local renewable energy sources, and Enhancing solar energy for urban transportation.

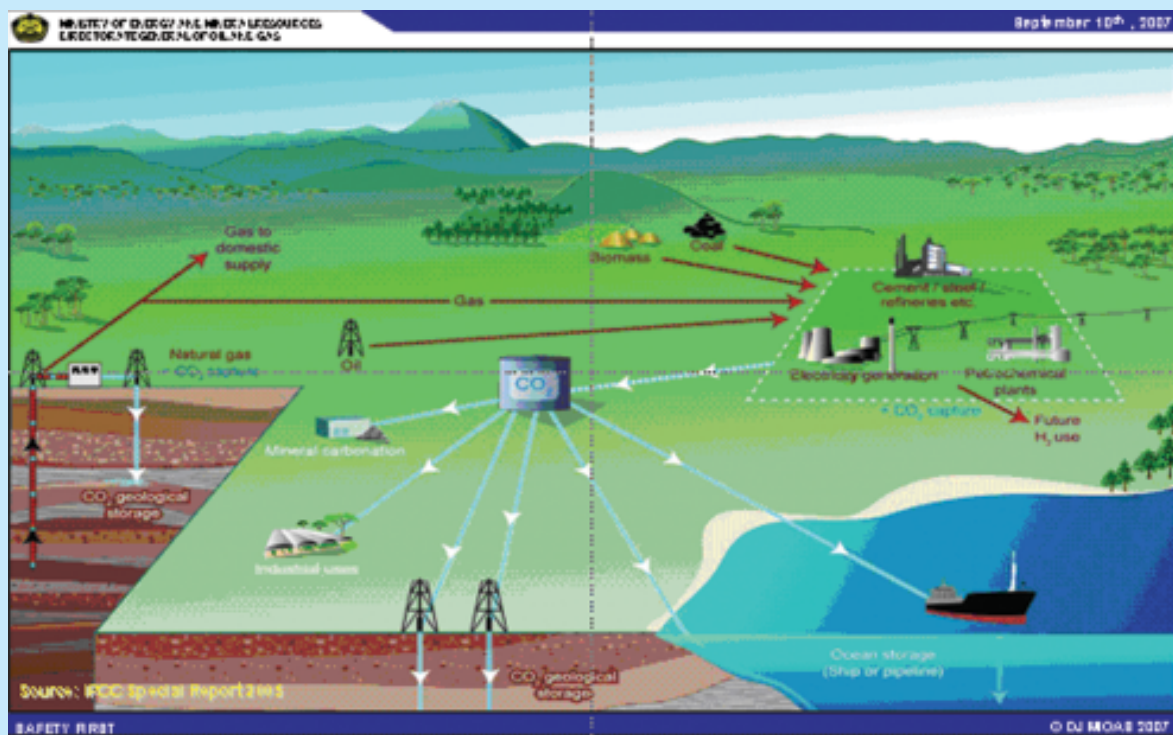


Figure 8
Schematic Diagram for Possible CCS System



Figure 9
Potential Area for CCS System Application in Indonesia

2. GHG Emission Mitigation

Mitigation of GHG emission from oil and gas activities may be conducted by energy diversification policy including gas flaring reduction, fuel switching, and fuel efficiency. The use of alternative environmentally friendly fuels are priority to mitigate GHG emissions.

Reducing gas flaring through the flare stack would hopefully reach zero flare in 2030, while substitution of kerosene with liquefied petroleum gas (LPG) has been started this year (2007). The development of alternative environmentally friendly fuels has been started since the launching of the Blue Sky Program in 1992.

The use of alternative environmentally friendly fuels has been developed as it is inline with the national gas policy in which in 2025 the use of biofuels would be 5% of the national energy mix. The Government of Indonesia has also roadmapped the biofuel development starting from 2005 as seen in Figure 7.

3. Capture and Storage of GHG Emission

GHG emission produced from oil and gas activities could be captured and stored and or injected into the reservoir to increase oil production, and or utilisation by industries. Figure 8 shows carbon cycles starting from its production, storage and utilization.

Carbon capture and storage (CCS) is an approach to mitigate global warming by capturing carbon dioxide (CO₂) from large point sources such as fossil fuel power plants, cement and steel plants, as well as petrochemical plants, and subsequently storing it, instead of releasing it into the atmosphere. Technology for large scale capture of CO₂ is already commercially available and fairly well developed. Potential areas for the CCS system in Indonesia is shown in Figure 9.

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C. Current Green House Gas Emission Reduction Programs

Indonesia has actually been implementing several programs to reduce air pollution and protect ozone depletion through energy conservation and diversification. We have the well known “Blue Sky Program” which has been launched since 1992. This program has been focused on controlling air pollution both from mobile sources and immobile sources. The use of alternative environmentally friendly fuels, such as compressed natural gas (CNG), use of liquefied gas vehicles (LGV), biofuels, dimethyl ether (DME), and gas from gas-to-liquid (GTL) projects, have been prioritized especially for utilisation in the transportation sector.

Biofuel is an alternative fuel for transportation sector which is produced from plant seed called Jarak (*Jatropha curcas*). One product called INA BF 100 (Indonesia Nabati Additive Biofuel 100) can substitute 100% solar. Dimethyl ether (DME) is also a clean-burning alternative to diesel and gasoline. It can be made from natural gas, coal, or biomass. Gas to liquids (GTL) is a refinery process to convert natural gas or other gaseous hydrocarbons into longer-chain hydrocarbons. Gas-to-Liquid fuels are fuels that can

be produced from natural gas, coal and biomass. The resulting GTL diesel can be used neat or blended with today’s diesel fuel and used in existing diesel engines

The other program related to GHG emission reduction is to ban the import of substances that deplete the ozone layer, such as chlorofluorocarbons (CFC) and methyl bromide (MBr). This is a consequence of ratifying the Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer through Presidential Regulation Number 46 of 2005.

The most important program to reduce GHG emission is the clean development mechanism (CDM). CDM is designed for helping Annex I countries to reduce their emission through international or bilateral cooperation. The program will be described in detail in the following sub chapters.

Indonesias Oil and Gas Industries have great potential for GHG emission reduction application projects. For more than two decades Indonesia has been an LNG exporter. By exporting LNG, Indonesia has directly participated in GHG emission reductions in importing countries such as Japan, Taiwan and Korea. Indonesia also has been using EOR technology for increasing oil production. This technology in practice has reduced green house gas emissions to the atmosphere. In addition, Indonesia has a great potential for greenhouse gas reduction financed by the Clean Development Mechanism such as gas flaring reduction, carbon capture and storage (CCS), fuel

**Table 4
Planned Green House Gas Emission Reduction Programs**

No	Oil and Gas Companies	Program
1.	PT Odira Energy Persada	<ul style="list-style-type: none"> • Flare gas reduction • Fuel switching from oil fuel to gas fuel • Electrical power cogeneration
2.	PT Pertamina (Persero)	<ul style="list-style-type: none"> • The Usage of Flaring Gas at Subang Area as the LPG Raw Material (10 MMSCFD) • The Usage of Gas Lift for EOR at Jambi Area (0.8 MMSCFD) • The Usage of Flaring Gas as Generator Fuel at TAC Medco Sembakung (Losses/ Flared Gas : 4.4 MMSCFD) • Substitution of HSD to Gas as Generator Fuel at UBEP Jambi (160 MSCFD) * • The Usage of CO₂ Emission from Oil Well at Pamanukan as Dry Ice (0.5 MMSCFD) *
		<ul style="list-style-type: none"> • The Usage of CO₂ Emission from Cilamaya CO₂ Removal as material of Soft Drink Industry (0.776 MMSCFD) * • Reforestation for Capturing CO₂ Vented from CO₂ Removal Unit at Subang Area (7,300 Ton CO₂ / Year) *
3.	PT Medco Energi Internasional, Tbk	<ul style="list-style-type: none"> • Bioethanol waste recovery (Lampung Feb 2008) • Geothermal development (Sarulla 2011) • Gas flare reduction (Sembakung field) • CO₂ sequestration by injection (Singa, Block A projects) • Biomass conversion (Power plant Singapore) • Effluent heat conversion (Batam Combined Cycle)

switching in the transportation and power sector, energy or fuel efficiency improvement. Table 3 shows the programs that have been running in the oil and gas industries.

D. Planned Green House Gas Emission Reduction Programs

Several oil and gas companies have also plans for GHG emission reduction programs. The programs include flaring reduction and fuel switching in transportation and power sector, energy or fuel efficiency improvement. Table 4 shows the planned GHG emission reduction programs that have been planned by oil and gas industries.

IV. CONCLUSION

From the above discussion, it can be concluded that:

1. Oil and gas activities, on one side, would contribute to the national income, and on the other side would contribute to GHG emission which drives the climate change phenomenon. However, the oil and gas activities are highly committed to manage GHG emission which has become global issues.
 2. The government's policy would be focused on:
 - a. Supporting GHG emission management through energi conservation and diversification;
 - b. Supporting technological exchange in reducing GHG emission;
- c. Supporting the competence of humans resources through joint study and research in accordance with developing countries needs;
 - d. Supporting funding sources for developing countries under UNFCCC or the Kyoto Protocol.

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