

# POTENCY OF COAL LIQUEFACTION INDUSTRY

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Energy reserves in Indonesia are currently limited. Indonesia only has 4.300 million tons of oil reserves or only equal to 0.36% of 1.208.200 million tons from world oil reserves in 2006. With production rate of 390 millions tons per year, oil reserves in Indonesia can be produced only for the next 11 years.

Table 1

## Total Energy Reserves in Indonesia and World 2006

	2004		R/ P	2005		R/ P	2006		R/ P
	Reserve	Production	(Year)	Reserve	Production	(Year)	Reserve	Production	(Year)
<b>Oil</b>									
Thousand Millions Barrels									
World	1,197.30	29.29	40.88	1,209.50	29.66	40.78	1,208.20	29.81	40.53
Indonesia	4.30	0.42	10.24	4.30	0.41	10.49	4.30	0.39	11.03
Percentage in Indonesia	0.36%	1.43%		0.36%	1.38%		0.36%	1.31%	
<b>Natural Gas</b>									
Million Cubic Metres									
World	179,010	2,703	66.23	180,200	2,780	64.82	181,460	2,865	63.34
Indonesia	2,770	73	37.95	2,480	74	33.51	2,630	74	35.54
Percentage in Indonesia	1.55%	2.70%		1.38%	2.66%		1.45%	2.58%	
<b>Coal</b>									
Equal to Million Tons of Oil									
World	909,064	2,766	328.66	909,064	2,917	311.64	909,064	3,080	295.15
Indonesia	4,968	81	61.33	4,968	90	55.20	4,968	120	41.40
Percentage in Indonesia	0.55%	2.93%		0.55%	3.09%		0.55%	3.90%	

Source: Beyond Petroleum 2006, processed

Meanwhile, natural gas as one of energy resources in Indonesia only has reserves which are equivalent to 35.54 years production. As for coal, Indonesia relatively also has limited reserved, only 4,968 million tons or equivalent to 0.55% of world coal reserves. With production rate of 120 millions tons per year, so it is roughly estimated that coal in Indonesia can be produced for 41.43 years.

Realizing those concern, Indonesian government responded by issued related policies in area of research & development for alternative energy resources in beginning of 2006. The policies were stated in 3 regulations, namely President Regulation (Perpres) No. 5/2006 about National Energy Policy, Perpres No. 1/ 2006 about vegetable oil and President Instruction (Inpres) No. 2/2006 about Coal Liquefaction as another source of energy. With those policies, government requires to stimulate role of enterprises to develop alternative fuels as substitution oil fuel. One of government's goals is to develop coal liquefaction.

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## Research & Development of Coal Liquefaction

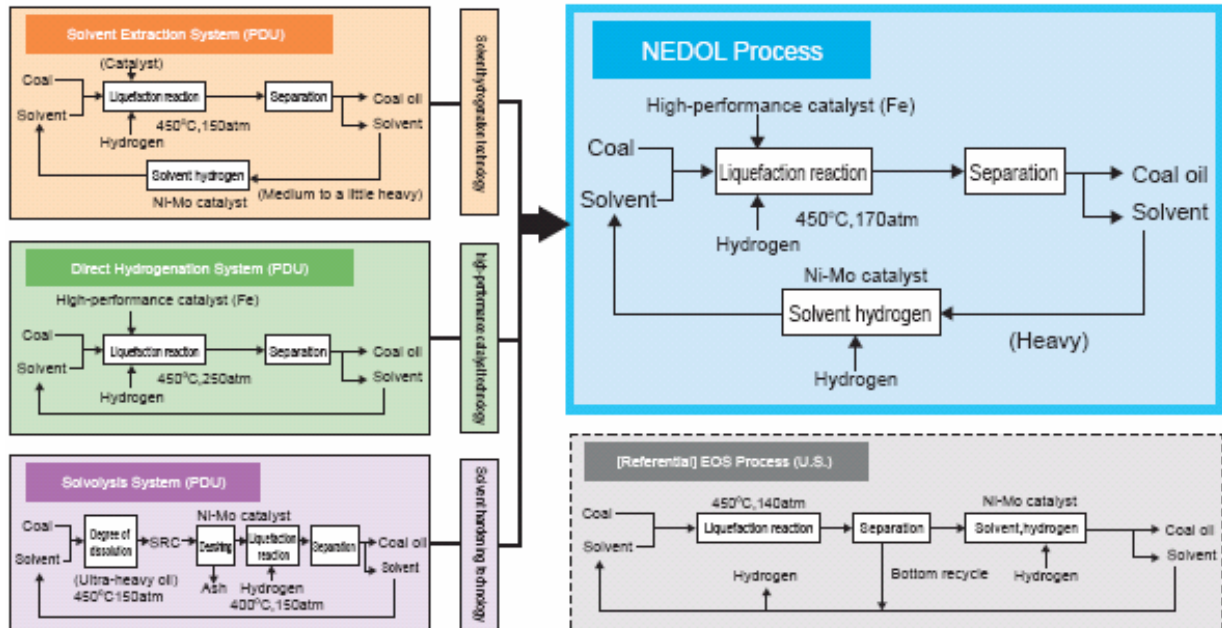
As an alternative fuel to replace oil energy, it has currently been developed coal liquefaction technology as fuel with output almost the same with oil. The development of synthetic fuel based on coal had been done in Germany in 1900 with Fischer – Tropsch process, developed by Franz Fischer and Hans Tropsch. At around 1930, besides the direct coal liquefaction method (Fischer Process), the Bergius Process was used as an indirect coal liquefaction method to study coal liquefaction technology and to produce synthetic oil. Meanwhile, Japan has inaugurated *Sunshine* Project, to devise liquefaction technology unique to Japan as part of an oil-alternative energy development program.

In 1983, NEDO (the New Energy Development Organization), an organization that focuses on technology development to create new energy, had developed new bituminous coal liquefaction technology using three processes, as follows : solvolysis system, solvent extraction system and direct hydrogenation to liquefy bituminous coal – as seen in exhibit 1. These three processes were amalgamated on the strength of their features into the NEDOL (NEDO Liquefaction) process, liquefaction coal process developed by NEDO with purpose to acquire high temperature liquefaction process.

During the time, NEDO scientists identified coal reserved in world are not in good quality coal, nearly half of which is comprised of low grade coal such as sub-bituminous coal and brown coal. Both types of coal contain a large amount of water but has an auto ignition property in a dry state compared with bituminous coal and other higher grade coals. Japan scientist developed Brown Coal Liquefaction Technology (BCL) as shown in figures 2 to answer the challenge to contribute to a stable supply of energy in Japan by converting the difficult-to-use low-grade coal into an easy-handling and useful product, or by producing clean transportation fuels such as gasoline and kerosene from the low-grade coal.

The BCL process has four stages : the slurry dewatering stage where the water is efficiently removed from low grade coal; the liquefaction stage where liquefied oil production yield is increased by using a highly active limonite catalyst and the bottoms recycling technology; the simultaneous hydrogenation stage where the hetero atoms (sulphur-laden compounds, nitrogen-laden compounds, etc.) in the coal-liquefied oil are removed to obtain high quality gasoline, kerosene and other light fractions; and the solvent dashing stage where the ash in coal and the added catalysts are efficiently discharged from the process system.

Figures 1  
Basic Philosophy of NEDOL Process

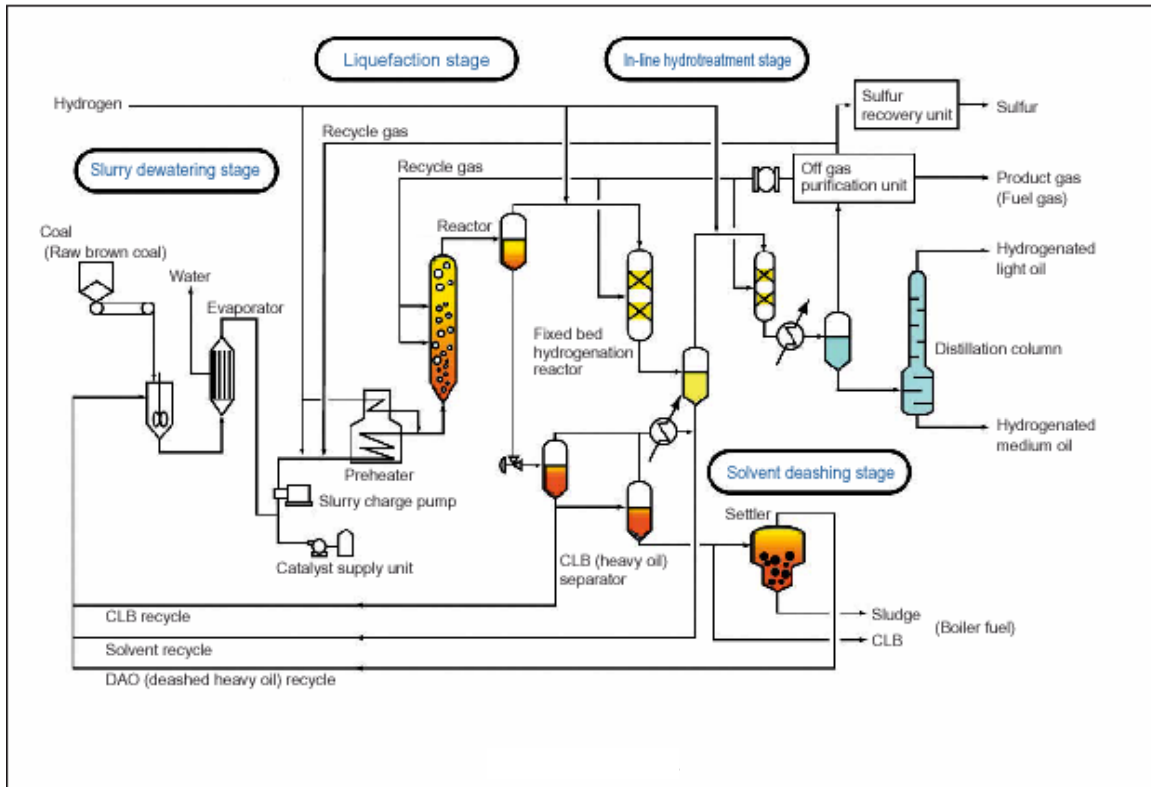


### Benefits of Coal Liquefaction

Scientists have continuously improved the technology to acquire high quality coal liquefaction. In the future, the development of coal liquefaction becomes one of the prospective industries for enterprise to invest because of the following reasons:

1. Low production cost; coal liquefaction only needs less than US\$ 15 per barrel of production cost. Meanwhile, average oil productions are US\$ 23 per barrel.
2. Difficult-to-use low-grade coal (less than 5.100 calories) could be used as raw material in coal liquefaction process.
3. For each ton solid coal produced in Bergius reactor could produce 6.2 barrels high quality synthesis fuels. These fuels could be used for jet fuel, diesel fuel, and gasoline.

Figures 2  
Flowchart of *Brown Coal Liquefaction* (BCL)



4. Coal liquefaction process is using environment friendly technology. Output of production process does not produce CO<sub>2</sub>. Meanwhile the ash and other related output as resulted from production process could be used as material for producing asphalt. Finally, hydrogen gas as result of production process could be sold and used as fuel.
5. If technology and cost of coal liquefaction process are no longer competitive, company can fully concentrate producing hydrogen gas and electric power which have good prospects. Using a high technology solar system panel (*Photovoltaic*), energy that could be acquired 100 times higher than ordinary solar system panel. Each panel could produce 1 Mega Watt power with cost of only US\$ 5, 100 times cheaper than using ordinary solar system panel.

### Future Prospect of World Coal Liquefaction

China, expecting stringency in its oil supply-demand situation for sometimes in the future, takes an active stance toward the development of coal liquefaction

technology. NEDO, as part of its International cooperation program, installed liquefaction equipment in China in 1982 for subsequent utilization such as in liquefaction tests of Chinese coal, exploration of catalysts for liquefaction and human capacity building. Since 1997, at the request of China, cooperation has been offered for the implementation of feasibility studies on the location of a coal liquefaction plant using Yilan coal of Heilongjiang Province. It is further considered certain that Indonesia will become a net oil-importing country in the near future. In 1992, the Indonesian government requested cooperation in coal liquefaction research on Indonesia brown coal. In response, NEDO signed in 1994 a memorandum on cooperative coal liquefaction research with Agency for Research and Application of Technology of Indonesia (BPPT) and began a new round of brown coal liquefaction technology development that aimed at the realization of commercial plants for Indonesian brown coal.

### **Coal Liquefaction Production in Indonesia**

In Indonesia, development of coal liquefaction was responded by government regulation (Inpres) No. 2/ 2006 of Coal Liquefaction. One investor, Sugico MOK Energy, has initiated to build coal liquefaction factory in South Sumatra. Sugico MOK Energy is a joint venture company between PT. Sugico Graha (mine Coal Company in South Sumatra) and Mok Industries LLC from America (company which manufactures cheap and efficient solar energy Technology). Coal liquefaction production process which used by Sugico MOK is hydrogenation system by solar energy. Using Photovoltaic innovation, solar energy acquired by solar cell is converted to electricity which produces energy in each panel for 1 megawatt within 1 hour and cost less than US\$ 5 per barrel. There are two kinds of electric power that are produced Alternating Current (AC) for lighting and other needs and Direct Current (DC) for converting water (H<sub>2</sub>O) to oxygen and hydrogen. Hydrogen is used in hydrogenation process, converting solid coal to liquid coal. Hydrogenation process is used in Bergius reactor. For one ton solid coal manufactured in this reactor will produce 6.2 barrels high quality synthesis fuel. In 2011, Sugico MOK will improve its production capacity to 20 million barrels of coal liquefaction per day.

### **Investment in Coal Liquefaction**

Currently, 11 companies have signed memorandum of understanding (MOU) of establishing consortium to participate in coal liquefaction program in Indonesia which need approximately US\$ 9.6 billions investment. The consortium is type of business to business which consists of Japan and Indonesia companies. The companies involved are

as follows: PT Adaro Indonesia, PT Jorong Barutama Gestron, PT Berau Coal, PT Bumi Resources, PT DH Power, PT Bayan Resources, PT Ilthabi Bara Utama, PT ReKayasa Industri, PT Tambang Batubara Bukit Asam (Persero) Tbk., PT Pertamina (Persero), AES Asia & Middle East. The consortium will cooperate with some institutions from Japan such as: METI, NEDO, JBIC, JCOAL, Kobe Steel Ltd, dan Sojitz. The brown coal liquefaction (BCL) technology from Japan will be used for coal liquefaction process.

It is estimated to build coal liquefaction factory with capacity of 13.500 barrel per day will need investment cost of IDR 11.7 trillion, assuming rate of IDR. 9.000 per USD. Head of Research & Development – Department of Energy and Mineral, Nenny Sri Utami, said until 2025 at least Indonesia needs to operate 7 plans in order to achieve 2 percent of coal exploitation target. Liquid fuel, as output of coal liquefaction process, will be standardized equally to oil fuel.

Head of Research and Development Mineral and Coal Technology – Department of Energy and Mineral, Bukin Daulay, said that coal liquefaction process will be divided in three phases. Phase one, build plant for semi commercial in 2009 with capacity of 13.500 barrel per day and investment cost US\$ 1.3 billion. Faze two, additional plant with same capacity and investment cost of US\$ 800 juta, in 2017 it is roughly estimated that capacity will achieve 27.000 barrel. Phase three, build commercial plant with capacity of 6 units and investment cost of US\$ 9.6 billion.

Related to funding the program, Bukin said Japan government has committed to give grant US\$ 110 million for process supporting unit. While, 60% fund from loans will be funded from Japan Bank for International Cooperation (JBIC). Director of Division 2 International Finance Department JBIC, Shin Oya, has confirmed the commitment of loans. As guarantee, JBIC wants the remaining loans are coming from commercial bank in Japan or Indonesia as private guarantee.

### **Government Incentives**

Based on experience of companies involved in coal liquefaction industry in other countries, investors need incentives from government to stimulate investment in this industry. Form of incentives can be financial support, such as tax incentive (*including tax holiday and royalty*) and price scheme of coal. Directorate General of Department of Energy and Mineral - Simon Felix Sembiring said government will give incentives based President's Instruction (Inpres) No. 2/2006, namely tax incentive. In the implementation, Mineral and Energy Department will consult with Finance Department which has an authority in tax to decide form of incentives. While the price scheme as most important factor for its sustainability will be formulated in order to make coal

liquefaction competitive with market oil price. Roughly estimation for price for coal liquefaction to be competitive are US\$ 42/barrels, with assuming that oil price in the world will not have significant changes, between US\$ 60 to US\$ 70 per barrels.