DEVELOPING SMALL SCALE FLARE GAS RECOVERY UNIT TO UTILIZE NOT ECONOMICALLY FEASIBLE GAS FLARE

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ABSTRACT

The World Bank's flare gas utilization evaluation in Indonesia (2006) excluded the not economically feasible flare gas to be commercially utilized due to various barriers and economic reasons. To implement No Flare Gas Policy in Indonesia, it is necessary to carry out an analysis on the possibility of the not economically feasible flare gas based on the latest technology development and proximity flare gas market next to existing onshore oil/gas fields producing the flare gas.

Small Scale Flare Gas Recovery Unit has been modelled to recover the gas flared and transported the gas to the proximity flare gas market. This concept shows that the not economically feasible flare gas can be commercially utilized in term of small/medium bussiness unit, and therefore No Flare Gas Policy in Indonesia will be achieved.

Key words : flare gas, utilization, gas recovery, ANG

I. INTRODUCTION

Indonesia flares a significant amount of associated gas in from oil/gas production. Flaring contributes to global warming and it is a waste of economically valuable resources.The scattered and remote locations of associated gas fields in Indonesia present a unique challenge for flare gas utilization.

Flare gas utilization can reduce or eliminate visual blight and noise pollution, as well as air pollution due to heavy metal, SOx and NOx emissions from the flare. There are no financial benefits associated with these environmental consequences, and any economic benefit would be highly site specific and of speculative value in the absence of detailed studies.

In 2006, the World Bank has evaluated the possibilities of Indonesia flare gas utilization based on economic feasibility of specific utilization technologies application. The analysis distinguished between onshore and off-shore locations. Qualitative screening of on-shore locations sorts blocks and fields based on practical considerations such as:

- Volume of flaring by block
- Associated gas production volume by field
- Remaining associated gas reserves
- Associated gas production is already committed.
- Assess the importance of Clean Development Mechanism (CDM) mechanisms in making flare gas utilization opportunities attractive.

At the end of the World Bank evaluation, candidate flare gas projects were classified according to and ranked within one of three categories: (i) economically and financially feasible, (ii) economically and financially feasible with intervention, and (iii) not economically feasible. However, the evaluation report excluded the not economically feasible flare gas to be commercially utilized due to various barriers and economic reasons. Therefore, it is necessary to carry out an analysis on the possibility of the not economically feasible flare gas based on the latest technology development in order that Indonesia will be able to implement no flare policy in oil and gas industry. This is because of the issue in Indonesia is not whether or how much gas that could be productively utilized is being flared, but rather how this gas can be productively utilized.

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From the government of Indonesia stand point, flare gas utilization productivity is not only depend on the economic feasibility but more importantly is securing domestic energy supply or subsidy reduction, even though the utilization is not directly generating a revenue for the government

The not economically feasible flare gas is charecterized by very small volume of gas flare (less than 1 MMSCFD) and no proximity gas infrastructure available to utilize the gas using conventional technology. However, the latest technology development will show that these flare gases in Indonesia can be recovered to enhance domestic gas provision.This paper explores the possibility of Adsorbed Natural Gas (ANG) technology application for the onshore not economically feasible flare gas utilization by developing small scale Flare Gas Recovery Unit (FGRU) concept.

II. SMALL SCALE FGRU DEVELOPMENT METHODOLOGY

Method of how to develop small scale FGRU is shown in Figure 1. This method includes:

- Identify proximity gas users. The users may include potential residential gas consumers and or small industry next to oil/gas fields where the onshore flares exist. Identify Not Economically Feasible Flare Gas. This flare gas is characterized by very small gas flowrate i.e. less than 1 MMSCFD,
- Having been identified, the gas flowrate is then being known.

  Based on the flowrate, small scale FGRU can be modelled. The FGRU mainly comprises portable gas compression, residential and/or industrial Adsorbed Natural Gas, to meet proximity gas users and entry metering & controls.
- Portable Gas Compression : small gas fired prime mover, portable gas compressor, optionally portable dehydration unit and small chiller. The prime mover is a small reciprocating gas engines type available commercially in the market. This is the technology choice throughout Indonesia for small, gas powered electricity generation to provide power for portable gas compressor. Specific fuel consumption of the prime mover is assumed to be around 8.83 scf/kWh (0.25 Nm3/kWh), and annual Operating & Maintenance cost is assumed to be around 5% of capital costs. Dehydration is required to remove moisture from the gas stream to meet the prime mover and/or portable feed gas

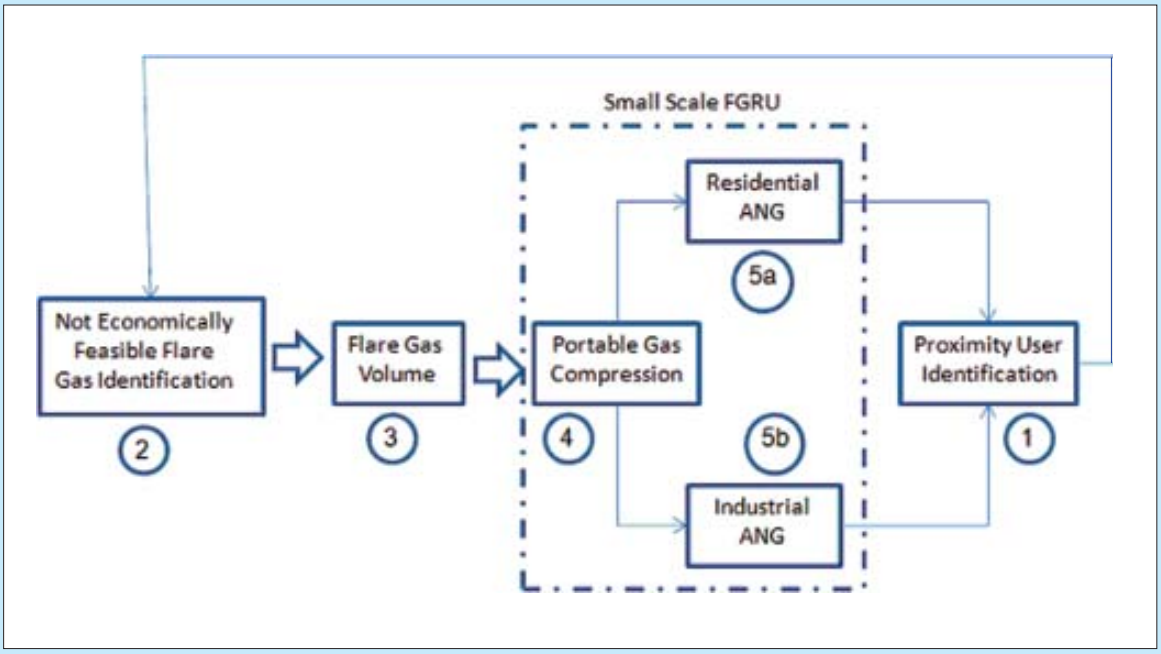

Figure 1
Small Scale FGRU Development Methodology

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Figure 2
Example of (Developing) Residential Adsorbed Natural Gas.

specifications. Installation cost for the dehydration depends on feed gas flowrate. Chiller entails the use of a compression cooling system to remove condensates from the gas stream to meet the prime mover and/or portable feed gas specifications. Installation cost for chilling relies on feed gas flowrate as well. Entry metering is required to measure gas flowrate while pressure & flow control need to be installed for safety protection purposes. Portable gas compressor pressurizes gas to approximately 15 Bar of residential ANG and/or 100 Bar of industrial ANG.The energy consumption of this compression is assumed to be 1.6% of the gas stream, and the annual O&M cost is assumed to be 5% of the total capital costs (i.e. including cost of dehydration, compressors, chilling, etc.).

- Residential/Industrial ANG is required for the storage of gas recovered from the flares. Residential ANG will be used to distribute the recovered gas to residential gas consumers as a complement to subsidized LPG 3 kg. While Industrial ANG will be required to transport the recovered gas to small industry next to the flare locations.

Figure 1 shows that capital cost will be required for portable gas compressor and ANG modules provision. The cost of portable gas compression is assumed to be [1]USD 50,000. Residential and Industrial ANG modules are now being developed in "Lemigas" R & D Center for Oil and Gas Technology. The cost of a Residential and an Industrial ANG modules are estimated to be around US$ 60 and US$ 20.750 respectively.

III. RESIDENTIAL AND INDUSTRIAL ADSORBED NATURAL GAS MODULES

Residential and/or Industrial Adsorbed Natural Gas Modules are an active carbon based adsorbent being developed by "Lemigas" R & D Center for Oil and Gas Technology for residential and/or industrial natural gas storage and distribution. The residential module is being developed as a complement to subsidized LPG 3 kg and therefore having around 15 Bar working pressure. Storage capacity of the residential module is equivalent to 4,16 m^3 gas (3 kg of subsidized LPG). Weight of the residential module is around 23.9 kg. Example of the residential module is shown in Figure 2. While Industrial Adsorbed Natural Gas Module operates at 100 Bar working pressure with storage capacity account for 1,436 m^3 (0,05 MMCF). Weight of the industrial module is around 1,000 kg.

Since the gas is compressed in both modules, it is necessary to estimate compression cost in order that

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total price of gas can be determined prior to be transported to end consumers. The compression cost is estimated based on average gas compression cost per energy content at 200 Bar. If the average compression cost account for Rp 8.100 /MMBTU/200 Bar, gas compression cost at 15 Bar will be around Rp 735. When initial residential gas price is Rp 2.507/ m^3, the price of 4.16 m^3 gas stored and distributes in Residential ANG module will be Rp 11,140. This price is cheaper than subsidized LPG 3 kg price of Rp 13.500 per bottle.

IV. NO FLARE GAS POLICY

The government of Indonesia c.q. Directorate General of Oil and Gas established Flare Gas Reduction Program to achieve zero flare gas in 2012 such as depicted in Figure 4. Flare gas utilization in the program will be in the form of :

a. Fuel Gas
b. Mini CNG Plant
c. Mini LPG Plant
d. Enhanced Oil Recovery

Therefore, proximity market identification is required to implement the program in order that the target can be achieved.

V. PROXIMITY FLARE GAS MARKET

Proximity flare gas domestic market identification is definitely required for utilizating the recovered gas from not economically feasible flare gas, in order that No Flare Gas Policy can be implemented in Indonesia. This market is available next to onshore oil/gas fields producing the flared gas. The identification is carried out in administratively provincial based in Indonesia. The following proximity flare gas market has been identified for flare gas reduction program in Indonesia.

Proximity flare gas market in Nangroe Aceh Darussalam account for 154,1 m^3/Day. The market is divided into eight segments (NAD-1 to NAD-8) based on existing volume of flare gas. In general, it will be required around 42 residential ANG modules to bring all the recovered gas to the market, such as shown in Table 1. The table indicates that, for instance, it will require 7 Residential ANG Modules per Day to transport around 28,1 m^3/Day the recovered gas.at NAD-1 segment market.

Proximity flare gas market in North Sumatra is

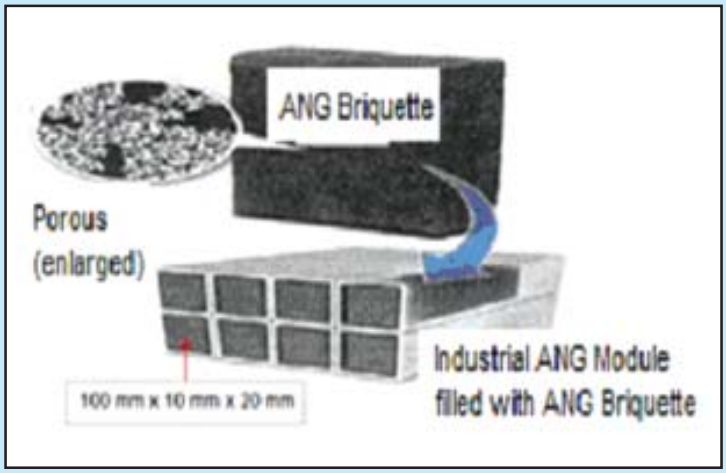
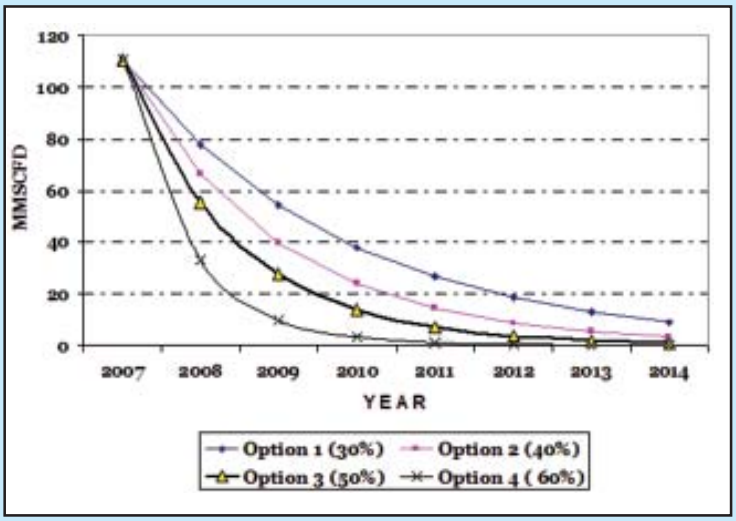


Figure 3
Example of Industrial Adsorbed Natural Gas
(Burchell et al, 2000)



Source : Directorate General of Oil and Gas

Figure 4
Flare gas reduction program in Indonesia.

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pointed out in Table 2. The market is divided into twelve segments (North Sumatra-1 to North Sumatra-12) based on existing volume of flare gas. Total gas recovered from the flare will account for 17952,7 m^3/Day and 4322 residential ANG modules will be required to distribute the recovered gas to the market. However, industrial ANG modules can be alternatively applied for North Sumatra-1, North Sumatra-3, North Sumatra-4, North Sumatra-6, North Sumatra-10 and North Sumatra-11 proximity markets if industrial consumer is available in the region.

There are only three proximity flare gas markets in Central Sumatra. The markets are classified into Central Sumatra Cluster-1, Central Sumatra Cluster-2 and Central Sumatra Cluster 3 such as shown in Table 3. Total gas recovered from the flare in Central Sumatra will be around 14.817,2 m^3/Day. The cluster-1 proximity market will require 15 residential ANG modules only. While both residential and industrial ANG modules can be applied to meet the cluster-2 and cluster-3 market. These account for 613 and 2936 or 2 and 9 respectively.

Proximity gas market in South Sumatra is divided into residential and industrial segments. The residential segment is pointed out in Table 3a while the industrial segment is seen in Table 3b. South Sumatera residential market comprises of 9 segments (South Sumatra-1 to South Sumatra-9). South Sumatra industrial market comprises of 21 segments (South Sumatra-10 to South Sumatra-30). Total gas recovered from the flare and to be delivered to residential proximity market using about 1800 residential modules in South Sumatra will be around 7.430,3 m^3/Day. The gas recovered from the flare gas in South Sumatra will account for 194.789,9 m^3/Day. This gas can be transported to industrial segment market using 137 industrial ANG modules.

Proximity gas market in Java island includes West Java and East Java (Table 4). The market is divided into 14 segments (West Java-1 to West Java-13 and East Java-1). The recovered gas in West Java will be around 127.088,8 m^3/Day. The gas can be distributed to residential

Table 1
Proximity market in Nangroe Aceh Darussalam

Proximity market segment	Gas Flare (m^3/Day)	Residential ANG Module/Day
NAD-1	28,1	7
NAD-2	28,2	7
NAD-3	29,4	8
NAD-4	27,8	7
NAD-5	6,7	2
NAD-6	2,8	1
NAD-7	25,5	7
NAD-8	5,7	2

Table 2
Proximity market in North Sumatra

Proximity Market Segment	Gas Flare (m^3/Day)	Residential ANG Module/Day	Industrial ANG Module/Day
North Sumatra-1	2.888,29	695	2
North Sumatra-2	566,33	137	-
North Sumatra-3	1.755,63	422	1
North Sumatra-4	1.999,15	481	2
North Sumatra-5	999,58	241	-
North Sumatra-6	2.800,51	674	2
North Sumatra-7	198,22	48	-
North Sumatra-8	201,05	49	-
North Sumatra-9	455,9	110	-
North Sumatra-10	4.527,82	1.089	4
North Sumatra-11	1.458,30	351	1
North Sumatra-12	101,94	25	-

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Table 3
Proximity market in Central Sumatra

Proximity Market Segment	Gas Flare (m^3/Day)	Residential ANG Module/Day	Industrial ANG Module/Day
Central Sumatra Cluster-1	58,898485	15	-
Central Sumatra Cluster-2	2.548,49	613	2
Central Sumatra Cluster-3	12.209,83	2936	9

Table 3a
Residential Proximity Market in South Sumatra

Proximity Market Segment	Gas Flare (m^3/Day)	Residential ANG Module/Day
South Sumatra-1	1.132,70	273
South Sumatra-2	1.132,70	273
South Sumatra-3	1.415,80	341
South Sumatra-4	424,7	103
South Sumatra-5	387,9	94
South Sumatra-6	1.132,70	273
South Sumatra-7	1.415,80	341
South Sumatra-8	104,8	26
South Sumatra 9	283,2	69

Table 3b
Industrial Proximity Market in South Sumatra

Proximity Market Segment	Gas Flare (m^3/Day)	Industrial ANG Module/Day
South Sumatra-10	16.989,90	12
South Sumatra-11	22.653,30	16
South Sumatra-12	11.326,60	8
South Sumatra-13	16.989,90	12
South Sumatra-14	11.326,60	8
South Sumatra-15	11.893,00	9
South Sumatra-16	16.989,90	12
South Sumatra-17	9.910,80	3
South Sumatra-18	4.247,50	7
South Sumatra-19	5.663,30	3
South Sumatra-20	2.831,70	2
South Sumatra-21	2.831,70	2
South Sumatra-22	2.831,70	2
South Sumatra-23	2.831,70	2
South Sumatra-24	2.831,70	2
South Sumatra 25	14.158,30	10
South Sumatra 26	24.040,80	17
South Sumatra 27	5.663,30	3
South Sumatra-28	2.548,50	2
South Sumatra-29	3.398,00	3
South Sumatra-30	2.831,70	2
	194.789,90	**137**

market using 30,555 Residential ANG Modules or alternatively 13 Industrial ANG Modules. There is only one not economically feasible flare gas in East Java in which around 283.2 m^3/Day gas can be recovered. This recovered gas can be delivered to proximity end users using 69 Residential ANG Modules.

Proximity gas market in Eastern Indonesia is seen in Table 5 comprises Kalimantan and Papua. The recovered gas from the flare gas in Kalimantan will account for 103.671,3 m^3/Day. The recovered gas can be transported to proximity market in Kalimantan using residential 2921 ANG Modules or alternatively using 18 Industrial ANG Modules. There is only one not economically feasible flare gas in Papua. The recovered gas in Papua will be about 5,663.3 m^3/Day.

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This gas can be conveyed using 1,362 Residential ANG Modules or alternatively 4 Industrial ANG Modules to proximity flare gas market in Papua.

VI. CONCLUSIONS

Having the discussion above, the following important points can be summarized:

- Small Scale Flare Gas Recovery Unit can be practically developed to recover the not economically feasible flare gas.
- Industrial and/or Residential Adsorbed Natural Gas Modules can be applied to transport the recovered gas flared to the proximity flare gas market.
- The price of 4.16 m^3 recovered flare gas stored (equivalent to subsidized LPG 3 kg) and distribute in a Residential ANG module will be around Rp 11,140 which is cheaper than existing subsidized LPG 3 kg of Rp 13.500 per bottle.
- Proximity flare gas market is available next to existing oil/gas fields producing the not economically feasible flare gas.
- No Flare Gas Policy in Indonesia will be able to be achieved if the not economically feasible flare gas can be commercially utilized.

Table 4
Proximity Flare Gas Market In Java Island

Proximity Market Segment	Gas Flare (m^3/Day)	Residential ANG Module/Day	Industrial ANG Module/Day
West Java-1	12.884,10	3098	3
West Java-2	4.247,50	1021	-
West Java-3	2.831,70	681	-
West Java-4	14.543,70	3497	3
West Java-5	3.054,80	735	-
West Java-6	22.653,30	5446	4
West Java-7	95,1	23	-
West Java-8	9.705,20	2333	2
West Java-9	13.136,90	3158	3
West Java-10	11.326,60	2723	2
West Java-11	25.898,90	6226	5
West Java-12	6.711,00	1614	1
East Java-1	283.2	69	-

Table 5
Proximity Flare Gas Market In Eastern Indonesia

Proximity Market Segment	Gas Flare (m^3/Day)	Residential ANG Module/Day	Industrial ANG Module/Day
Borneo-1	8.495,00	2043	6
Borneo-2	5.802,60	1395	4
Borneo-3	5.802,60	1395	4
Borneo-4	1.833,30	441	2
Borneo-5	2.496,30	601	2
Borneo-6	2.496,30	601	2
Borneo-7	21.978,20	5284	15
Borneo-8	7.556,20	1817	6
Borneo-9	23.108,70	5555	16
Borneo-10	154,2	38	-
Borneo-11	9.210,30	2214	7
Borneo-12	12.852,40	3090	9
Borneo-13	1.885,20	454	2
Papua-1	5.663,30	1362	4

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