

การใช้ประโยชน์จากก๊าซธรรมชาติซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบบนบกของประเทศไทย



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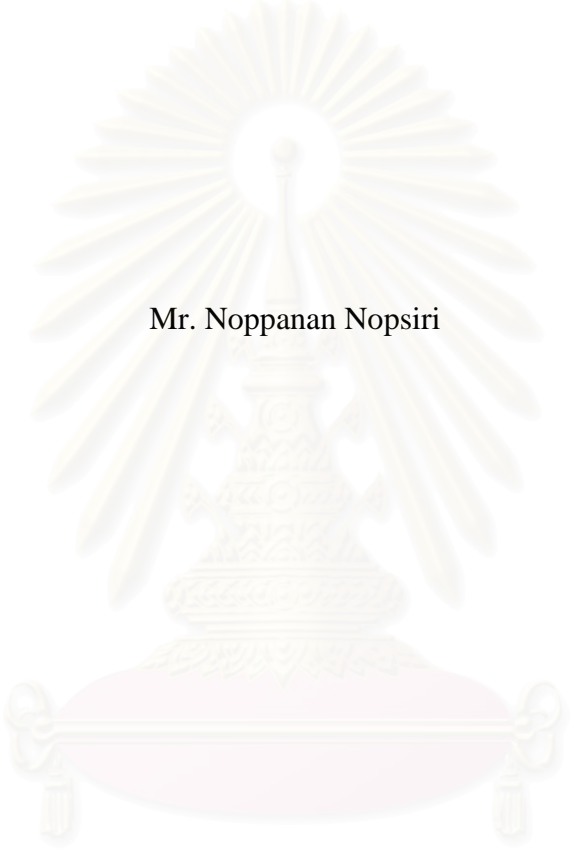
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UTILIZATION OF ASSOCIATED GAS FROM ONSHORE OIL FIELD  
PRODUCTION OF THAILAND



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A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Engineering Program in Petroleum Engineering

Department of Mining and Petroleum Engineering

Faculty of Engineering

Chulalongkorn University


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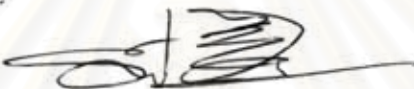
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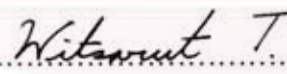
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นพพันธ์ นพศิริ : การใช้ประโยชน์จากก๊าซธรรมชาติซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบ  
บนบกของประเทศไทย. (UTILIZATION OF ASSOCIATED GAS FROM  
ONSHORE OIL FIELD PRODUCTION OF THAILAND) อ. ที่ปริกษาวิทยานิพนธ์  
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ก๊าซธรรมชาติ ซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบโดยทั่วไปจะถูกเผาทิ้ง เนื่องจาก  
น้ำมันดิบเป็นผลผลิตที่มีราคาสูงกว่า และปริมาณก๊าซธรรมชาติดังกล่าวมีน้อยเกินกว่าที่จะลงทุนผลิต  
เพื่อให้ได้ผลคุ้มค่าทางเศรษฐกิจ อย่างไรก็ตาม ก๊าซธรรมชาติซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบ  
จะถูกผลิตในเชิงพาณิชย์เมื่อมีปริมาณการผลิตก๊าซดังกล่าวมากพอที่จะให้ผลคุ้มค่าทางเศรษฐกิจ แต่ใน  
ปัจจุบัน มีเทคโนโลยีที่ถูกปรับปรุงเพื่อใช้ประโยชน์จากก๊าซให้มีประสิทธิภาพมากขึ้น และสามารถ  
นำมาประยุกต์ใช้กับการพัฒนาฐานการผลิตก๊าซธรรมชาติขนาดเล็กได้หลายวิธี เช่น ก๊าซธรรมชาติ  
เหลว (LNG) การแปลงก๊าซเป็นของเหลว (GTL) ก๊าซปิโตรเลียมเหลว (LPG) การใช้ก๊าซเพื่อผลิต  
กระแสไฟฟ้า (GTW) รวมทั้ง การส่งก๊าซธรรมชาติทางท่อ (PNG) ในงานวิจัยนี้ การหาปริมาณสำรอง  
และการพยากรณ์การผลิตของน้ำมันดิบ และก๊าซธรรมชาติซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบ  
รวมทั้งการวิเคราะห์ทางการเงิน จะเป็นเครื่องมือในการคัดเลือกวิธีการที่เหมาะสม

การศึกษาวิธีการและข้อจำกัดของการใช้ประโยชน์จากก๊าซธรรมชาติ ควบคู่กับการศึกษาข้อมูล  
ของฐานการผลิตน้ำมันดิบบนบกโดยรวมในประเทศไทย ทำให้ได้มาซึ่งฐานการผลิตที่ตัวอย่าง และ  
วิธีการใช้ประโยชน์จากก๊าซซึ่งมีปริมาณน้อย ที่เป็นไปได้ในประเทศไทย การศึกษาเกณฑ์การพิจารณา  
ฐานการผลิตพบว่า ปริมาณสำรองก๊าซธรรมชาติซึ่งเป็นผลพลอยได้จากการผลิตน้ำมันดิบและปริมาณ  
การผลิตในอนาคต เป็นตัวแปรสำคัญในการวิจัยนี้ ซึ่งขึ้นอยู่กับปริมาณสำรองและปริมาณการผลิต  
น้ำมันดิบในอนาคต ปริมาณสำรองและการพยากรณ์การผลิตของก๊าซธรรมชาติดังกล่าว ถูกคำนวณใน  
สามกรณี ฐานการผลิตย่อยในฐานการผลิตที่ถูกเลือกมาทำการวิจัย ได้ผ่านเกณฑ์การพิจารณาทั้งหมด  
สองฐานการผลิตย่อย ทั้งนี้ การวิเคราะห์ทางการเงินถูกนำมาใช้เพื่อค้นหาวิธีการที่เหมาะสมและเป็นไป  
ได้สำหรับฐานการผลิตตัวอย่าง งานวิจัยสรุปได้ว่า การใช้ประโยชน์จากก๊าซธรรมชาติซึ่งเป็นผลพลอย  
ได้จากการผลิตน้ำมันดิบบนบกของประเทศไทยนั้น มีศักยภาพเพียงพอที่จะดำเนินการในสถานการณ์  
จริง ซึ่งวิธีการที่เหมาะสมสำหรับสองฐานการผลิตย่อยในฐานผลิตตัวอย่างคือ การผลิตก๊าซธรรมชาติ  
เหลวขนาดเล็ก และการผลิตกระแสไฟฟ้าควบคู่กับการส่งก๊าซธรรมชาติทางท่อไปสู่ชุมชน

ภาควิชา วิศวกรรมเหมืองแร่และปิโตรเลียม.....ลายมือชื่อนิสิต.....  
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## 4871603021 : MAJOR PETROLEUM ENGINEERING

KEY WORD: ASSOCIATED GAS / GAS UTILIZATION / ONSHORE OIL FIELD

NOPPANAN NOPSIRI : UTILIZATION OF ASSOCIATED GAS FROM  
 ONSHORE OIL FIELD PRODUCTION OF THAILAND. THESIS  
 PRINCIPAL ADVISOR : JIRAWAT CHEWAROUNGROAJ, Ph.D., THESIS  
 CO-ADVISOR : WITSARUT THUNGSUNTHORNKHUN, Ph.D., 227 pp.

Associated gas is by-product from crude oil production which is usually flared because crude oil is the more expensive product and too small amount of associated gas produced. However, the field that has large amount of associated gas produced would be developed since it can generate the benefits. Currently, the technology has enhanced gas utilization more efficient and can be applied for small scale natural gas field development by many options such as LNG, GTL, LPG, GTW, including PNG. In this study, reserve determination and production forecast of crude oil and associated gas, and financial analysis will be the tools to identify the suitable option.

Gas utilization options and constraints were studied and listed. The onshore oil fields in Thailand are preliminary previewed and, then a particular case was selected and studied in details. The possible options for small scale gas utilization are considered for the next step of study. The field criteria to considerations are studied which the associated gas reserve and future production are the important parameters for this study, and they depend on reserve and future production of crude oil. The determined associated gas reserve and production forecast was set to 3 different cases of outcome. The sub-fields in the case field are screened by the criteria to get the 2 sub-field candidates. The financial analysis comes into play to determine the feasible fields with the suitable option. The study concludes that the utilization of associated gas from onshore oil field production in Thailand is potent enough to implement. The options of small-scale LNG and, combined of power generation and gas pipeline to community are appropriate for 2 sub-field in the particular case.

Department: Mining and Petroleum Engineering..Student's signature:.....

Field of study: Petroleum Engineering.....Principal Advisor's signature:.....

Academic year: 2008.....Co-advisor's signature:.....

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## LIST OF ABBREVIATIONS

AC	alternating current
BAHX	blazed aluminum heat exchanger
Bbl	barrel
Bcf	billion cubic feet
BPD	barrels per day
BTU	British thermal unit
CHP	combined heat and power
COD	chemical oxygen demand
cum	cumulative
DC	direct current
DCA	Decline Curve Analysis
E&P	exploration and production
EIA	Environmental Impact Assessment
EPPO	Energy Policy and Planning Office
EUR	estimated ultimate recovery
F-T	Fischer-Tropsch
GOR	gas oil ratio
GTL	gas-to-liquid
GTW	gas-to-wire
HDD	horizontal directional drilling
HDPE	high density polyethylene
IOR	improved oil recovery
IRR	internal rate of return
kg	kilo gram
km	kilo meter
kW	kilo watt
kW	kilo watt
LCNG	liquid compressed natural gas
lit	liter
LNG	liquefied natural gas
LPG	liquid petroleum gas

m	meter
MMbbl	million barrels
MMBTU	million British thermal unit
MMscfd	million standard cubic feet
MSTB	thousand stock tank barrels
MW	mega watt
NGH	natural gas hydrate
NGL	natural gas liquid
NPV	net present value
NRS	nitrogen recycle system
O&M	operation and maintenance
OFM	Oil Field Manager
ORV	open rack vaporizers
OTOP	One Tambon One Product
PE	polyethylene
PNG	pipelined natural gas
prod	production
psi	pound per square inch
PVC	polyvinyl chloride
SCV	submerge combustion vaporizer
SNGH	synthetic natural gas hydrate
SPP	small power producer
sq. km.	square meter
Std Dev	standard deviation
STB	stock tank barrels
STB/D	stock tank barrels per day
US	United State
vs	versus
WBG	World Bank Group

## NOMENCLATURE

$G_p$	cumulative gas production
$lb$	pound
$m$	slope
$N_p$	cumulative oil production
$P_2$	probable reserve
$Q_g$	gas rate
$Q_o$	oil rate



สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

# CHAPTER I

## INTRODUCTION

Associated gas is a by-product from production of crude oil. Previously, crude oil has been the primary target for operators to produce therefore, most of the time associated gas has been flared. In general, only in fields where large amount of associated gas is produced the gas would be developed and utilized instead of being flared. Hence, natural gas in the past was used as a fuel in the field and/or sold to buyers via pipeline or build LNG plant. Small amount of associated gas cannot be developed and has to be flared. However, current technology has enhanced petroleum (gas) utilization more efficiently and can be used for small scale development such as Liquefied Natural Gas (LNG), Gas-To-Liquid (GTL), Liquid Petroleum Gas (LPG), Gas-To-Wire (GTW), as well as Pipelined Natural Gas (PNG). Reserve, production forecast, and financial analysis will be the tools to identify the suitable option(s).

In the sense of environmental and health impact, utilization of associated gas instead of flaring can reduce or eliminate visual blight and noise pollution, as well as local air pollution due to heavy metal,  $\text{SO}_x$  and  $\text{NO}_x$  emissions from the flare. In addition, the utilization of associated gas can supply for SME and/or local community

This study will give an overview of criteria to be considered and opportunities for utilizing small amount of associated gas production from onshore oil field instead of being flared. In addition, the study will provide the information of further development of associated gas utilization. The associated gas utilization will be attractive when new technology presented. It could potentially make this approached more economically feasible. Various alternatives for development of associated gas show signs of economical value in further development of the gas utilization. One of onshore oil fields in Thailand will be used as case study to be analyzed and the most suitable gas utilization option will be proposed for use in this oil field.

## 1.1 Objectives

1. Study and review gas utilization projects in other countries in order to define the key criteria for selecting various applications of gas utilization such as LNG, power generation, etc.

2. Study and evaluate the production forecast, reserve, and potential of associated gas in Thailand onshore oil field case that has to be flared.

3. Analyze and study feasibility of the utilization of flared gas in various applications, such as LNG, power generation, etc.

4. Propose the gas utilization project of the associated flared gas for Thailand onshore oil field case with energy efficiency and environmental concerned.

## 1.2 Methodology

The research starts with reviewing and compiling the literature to list the possible use of associated gas and set up criteria for selecting gas utilization options. In parallel, acquisition on flared gas production data is considered to include field details and the opportunities of utilizing associated gas in Thailand. These also include the overview of the Thailand onshore oil field case (the case study) in the sense of reserve, production strategies and flared gas.

Qualitative (technical) screening will be performed. The collected information of Thailand onshore oil field case will be considered using the criteria from the previous section. In this stage, the candidate field comes up with the options of utilization opportunities from the previous section.

So the screened candidate which is the field with the gas utilization options will be processed in the next step of feasibility studies, economic and financial analysis. Economic and financial factor as net present value (NPV) will be determined. At the end of this process, candidate projects are classified in two categories: (i) economically and financially feasible, and (ii) not economically feasible.



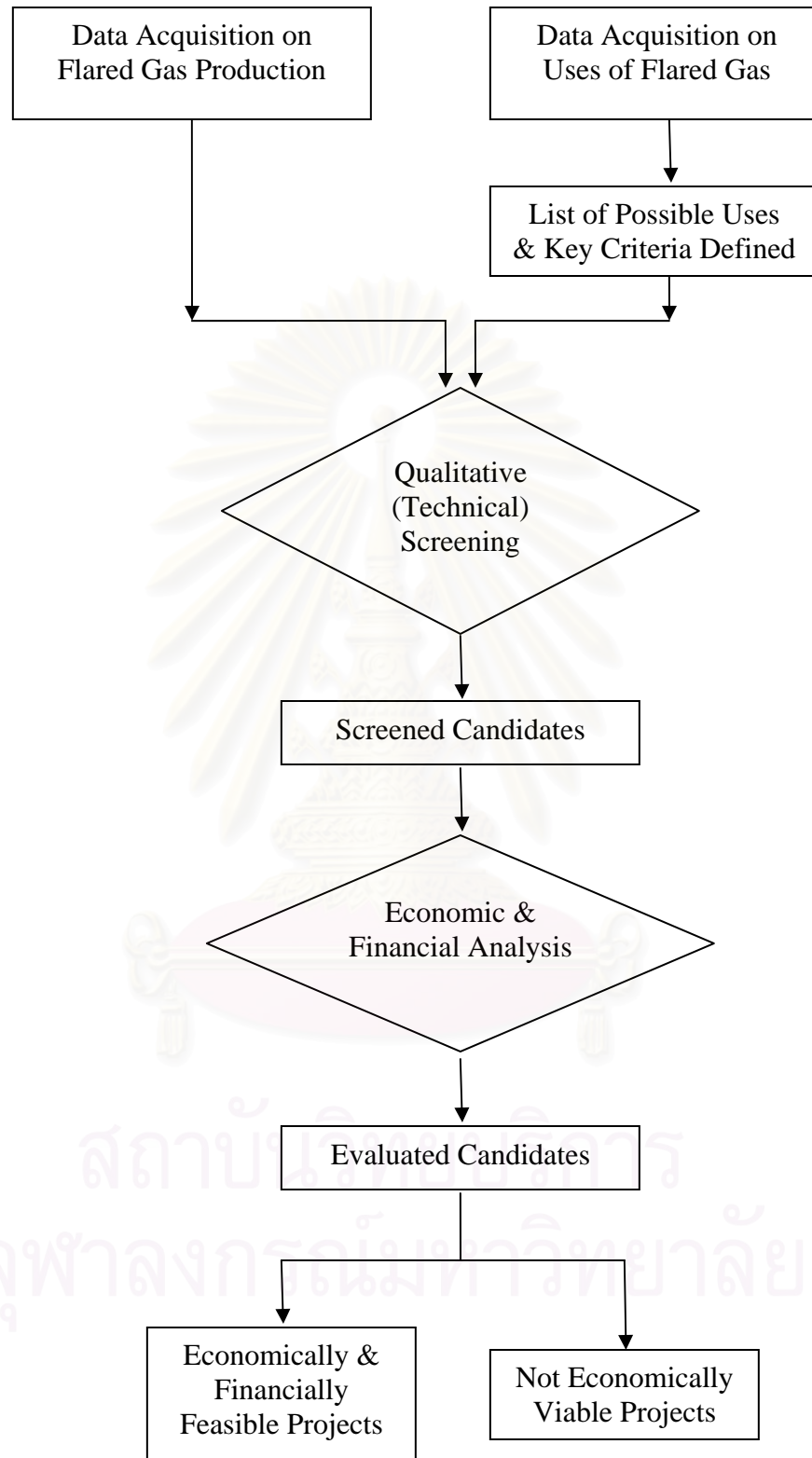


Figure 1-1 Flow chart of methodology

### 1.3 Structure of the Thesis

This thesis consists of six chapters.

Chapter I outlines introduction of associated gas utilization with the background, objectives, and the methodology behind the study process.

Chapter II reviews the previous works concerning with this study which are parted into two sections: (1) gas utilization technologies, and (2) gas utilization case studies in which the criteria considerations from the literatures are shown here.

Chapter III describes Thailand petroleum history and fields in Thailand both onshore and offshore. Thailand onshore oil field case is presented by the details, including reserve, production and flared gas histories, and production strategies of the fields.

Chapter IV discusses the opportunities to utilize associated gas in Thailand, the options which are potential to be implemented for the small scale gas in Thailand. The collected criteria are applied and set for the project of Thailand onshore oil field case. Furthermore, the prospect options are explained with the detail process and each option methods to use of each option. Lastly, the associated gas utilization in community described. That is prospect groups for gas utilization, prospect group criteria, and the utilization opportunities of prospect groups are presented.

Chapter V presents the field screening methodology by the criteria. The screened candidates are then determined the reserve and production forecast by wellbore level. The economic and financial analysis is the last tool to classify each scenarios of the project. The energy efficiency and environmental concerned are also considered as benefits of the project.

# CHAPTER II

## LITERATURES

Normally, oil production usually produces associated gas as by-product which has to be flared. Even though the associated gas can be used like normal natural gas but most associated gas daily productions are quite small. Uses of associated gas are not prevalent and not worth an additional investment, and thus flared. However, the associated gas can be utilized in a similar way as the general natural gas but the feasibility studies are needed to prove the suitability between the technologies and scale of associated gas.

There are 2 main sections in this chapter. One is gas utilization technologies, describing gas utilization options. The other is gas utilization case studies in other countries where different options, daily production and reserve size of gas utilization projects were presented.

Currently, there exist four options for natural gas exploitation and transportation to markets as follows:

1. Gas gathering and transmission by pipelines
  - PNG (Pipeline Natural Gas)
2. Gas to transitory medium by volume reduction
  - LNG (Liquefied Natural Gas)
  - LPG (Liquefied Petroleum Gas)
  - NGH (Natural Gas Hydrate)
3. Conversion to other products
  - GTL (Gas to Liquid), Fischer-Tropsch (F-T) synthetic fuels
4. Conversion to other energy form
  - GTW (Gas to Wire), electric power and transmission by cable

Among the above, the most popular methods for bringing the natural gas to market from distant locations are LNG (Liquefied Natural Gas) and PNG (Pipelined Natural Gas) technologies. However, these technologies require huge proved gas reserves and expensive capital cost for infrastructures. Thus, it is recommended that

other alternative technological options are used for many situations to produce and transport the natural gas to market areas.

## **2.1 Gas Utilization Technologies**

### **2.1.1 Pipeline Natural Gas (PNG)**

The site or remote gas is transported to market or processing station by constructed pipelines. However this option requires a lot of capital cost and huge proved gas reserves. Technology is always available but it may not be economic. Also, in some situations, many critical operation problems might occur in pipelines such as gas condensate occurrence and hydrate deposition blocking the gas flow.

One type of pipeline natural gas type is commonly known as town gas or city gas or piped gas. Natural gas or liquid naphtha is used as input material together with steam, and is then processed by a catalytic chemical reaction through steam reforming in a high temperature reforming box with nickel as catalyst. Lean gas consisting of a major component known as hydrogen is the output from the reformer box following by an enrichment process where the heat value is increased to the requirement for town gas (or city gas or piped gas). Gas is produced and ready to be compressed and sent to the customers.

### **2.1.2 Liquefied Natural Gas (LNG)**

LNG is an odorless, colorless, non-corrosive, non-toxic liquid that is produced when natural gas is cooled to the temperature of  $-161\text{ }^{\circ}\text{C}$  at atmospheric pressure. The liquid takes up about  $1/600^{\text{th}}$  of the volume of natural gas in its gaseous form. This enormous change in volume enables the gas to be transported economically over long distances as a liquid. Over the past 30 years, a considerable world trade in LNG has developed. LNG today is a proven and mature natural gas monetization option.

The typical processes involved in the monetization of gas via LNG include the following:

### 1. Gas treatment step

The gas from reservoir may also contain components such as nitrogen, carbon dioxide and sulfur compounds. The feed gas has to be treated to remove impurities before it can be liquefied. Hence, gas treatment is required for the removal of natural gas liquids and impurities to meet the specifications.

The gas treatment typically comprises of:

- Gas reception facilities
- Acid gas removal and disposal section
- Gas dehydration
- Mercury removal
- Particle filtration

### 2. Liquefaction step

The liquefaction plant is the heart of the LNG value chain. LNG liquefaction plants are generally classified as baseload or peak shaving, depending on their purpose and size. The discussion here is directed towards baseload LNG plants.

The liquefaction process entails cooling the clean feed gas to  $-161^{\circ}\text{C}$  using mechanical refrigeration. A refrigerant gas is compressed, cooled, condensed and let down in pressure through a valve that reduces its temperature by the Joule-Thomson effect. The refrigerant gas is then used to cool the feed gas. The temperature of the feed gas is eventually reduced to  $-161^{\circ}\text{C}$  at which temperature methane, the main constituent of natural gas, liquefies. At this temperature all the other hydrocarbons in the natural gas will also be in liquid form. In the liquefaction process, constituents of the natural gas (propane, ethane and methane) are typically used as component recovery is normally included in the LNG liquefaction facility. LPG and condensate may also be recovered as by-products.

There are three main types of liquefaction cycles namely cascade, mixed refrigerant, and expansion cycle. Most commercially available liquefaction processes are based on these cycles or a combination of these cycles. These processes include the Pure Component Cascade Cycle, Propane Pre-cooled Mixed Refrigerant Cycle, Dual Mixed Refrigerant Cycle, Single Mixed Refrigerant Cycle, Mixed Fluid Cascade Process and others.

The liquefaction plant typically involves the main following steps:

- Initial cooling feed gas to remove heavier hydrocarbons
- Liquid removal



- Total liquefaction of natural gas
- The end flash or nitrogen rejection section to reduce pressure to near atmospheric pressure
- LNG send out and storage

### 3. Re-gasification step

It is sometimes called “re-gas process”. During normal operation, boil-off vapor is produced in the tanks and liquid-filled lines by heat transfer from the surroundings. This vapor is collected in the boil-off header that ties into the boil-off compressor suction drum.

Two types of LNG vaporizers, Open Rack Vaporizers (ORV) are common worldwide and uses water to heat and vaporize the LNG, and Submerge Combustion Vaporizer (SCV) uses send-out gas as fuel for the combustion that provides vaporizing heat. There are sub steps of re-gas process as following:

- LNG unloading system to unload the LNG into the system
- LNG storage tanks
- Vapor handling system for boil-off vapor
- LNG vaporizers
- In-tank and external LNG pumps to deliver the design LNG send-out flow and circulate LNG
- Supporting utilities, piping, valves, control systems, and safety systems

### 2.1.3 Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) is a very attractive way of using associated gas for the benefit of households and other users with a limited demand for energy. LPG is a class of petroleum products produced from natural gas or as a by-product from refine crude oil and which is a mixture of hydrocarbons containing 3 to 4 carbon atoms ( $C_3$  and  $C_4$ ), for example, propane, butane, and iso-butane.

The LPG process is described below:

#### 1. Gas treatment

The natural gas is fed to remove carbon dioxide ( $CO_2$ ) and water content in the natural gas. This can be done by using the Benfield process which uses Potassium

Carbonate ( $K_2CO_3$ ) to catch carbon dioxide ( $CO_2$ ) and absorption process by using molecular sieve which is spongy configuration to absorb the water.

## 2. LPG recovery and fractionation

The dry natural gas will be transferred through turbo-expander (cascade refrigeration) to reduce the temperature from  $250^\circ K$  to  $170^\circ K$  and pressure from 43 bars to 16 bars. The gas stream then flows through de-methanizer column where methane ( $C_1$ ) is separated and the rest is the mixture of ethane plus ( $C_{2+}$ ) hydrocarbon stream in the liquid state. Because of the weight of the liquid, the stream flows out at the bottom of the column to the next de-ethanizer and de-propanizer columns to separate ethane ( $C_2$ ) and propane ( $C_3$ ), respectively. At the de-propanizer column, propane ( $C_3$ ) will be separated and leave at the top of column, LPG which is the mixture of propane ( $C_3$ ) and butane ( $C_4$ ) will be separated at the middle of the column, and the product at the bottom is natural gasoline.

### 2.1.4 Natural Gas Hydrate (NGH)

Natural gas hydrates are solid crystalline compounds, resembling ice or wet snow in appearance, but with less density than ice. They are included in general class of compounds known as clathrates, which have structure wherein guest molecules are entrapped in a cage-like framework of the host molecules without forming a chemical bond. Natural gas hydrates are formed when natural gas components, such as methane, ethane, propane, iso-butane, hydrogen sulfide, carbon dioxide, and nitrogen, enter the water lattice (which is looser than the ice lattice) and occupy the vacant lattice positions, causing the water to solidify at temperatures considerably higher than the freezing point of water. Enough gaseous molecules must enter the lattice and occupy the voids to stabilize the lattice crystal.

To produce gas hydrate, the process consists of 3 steps as following:

#### 1. Reaction step

The first stage of NGH process is compressing the natural gas with water under 30-50 barg inside a bubble type reactor steel cylinder. The liquid catalyst is added as additive to reduce hydrate equilibrium pressure for reaction around 3-4 hours for optimum. The gas / water volume is 140 / 1 and  $1\text{ m}^3$  of natural gas will be produced 7.14 liters of synthetic natural gas hydrate. The cylinder is then

depressurized by venting the un-reacted gas to be fuel or back to natural gas pipeline system.

## 2. Refrigeration step

The next is refrigeration/cooling step, the cylinder is cooled in the refrigeration storage. The ordinary refrigerator as ice cream refrigerator can be used to cool the produced SNGH at  $-20\text{ }^{\circ}\text{C}$  or  $-4\text{ }^{\circ}\text{F}$  of optimum temperature. A  $10\text{ }^{\circ}\text{C}$  temperature raise will not make the gas dissociate from its hydrate form, therefore the transportation container has to be able to keep the temperature below  $-10\text{ }^{\circ}\text{C}$  ( $14\text{ }^{\circ}\text{F}$ ).

## 3. Re-gasification step

Dual chamber storage is used for re-gasification process, the first one will be used for storing NGH from transportation and the second one will be used for dissociation. NGH will be dissociated by providing heat energy to melt the hydrate in the hydrate re-gasification boiler, natural gas and water-additive will be separated. This water-additive mixture can be recycled, so the storage have liquid container to capture it.

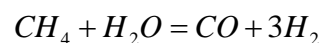
### 2.1.5 Gas to Liquid (GTL)

Gas-to-Liquid technology (GTL) involves the conversion of natural gas to hydrocarbon liquid products for transport action, power generation, and expanded chemical feedstock applications. Catalytic processes are required for gas to liquid conversions. Unlike products refined from crude oil, GTL fuels are often clean and free from sulfur and aromatic pollutants.

The GTL process consists of three main steps:

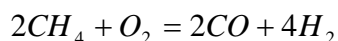
#### 1. Synthesis gas production step

Methane is steam reformed to produce syngas, required for synfuel and other petrochemical products production according to the equation.



It can be concluded from the above equation that steam reforming produces a high hydrogen : carbon monoxide ratio of about 3 which is not optimum for GTL production requiring a ratio of 2. However, the ratio from the steam reforming can be

adjusted by removing the excess hydrogen by membrane separation or pressure swing adsorption. The optimum H<sub>2</sub>:CO ratio for the GTL process can be achieved by Partial Oxidation of natural gas (methane) in which natural gas is burned at high temperature according to the equation:



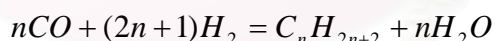
Partial oxidation of methane requires an oxygen plant, using cryogenic air separation, for the production of oxygen from air.

A process technology had been developed in which air is used in place of pure oxygen thus eliminating the cost of oxygen plant.

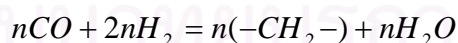
The third process to produce syngas with the required hydrogen : carbon monoxide ratio of 2 is the auto thermal reforming process. This process can be considered as a mixture of the other two processes namely Streaming Reforming and Partial Oxidation. CO<sub>2</sub> can be added to the blend through a recycle stream.

### 2. Synthetic fuel production step (Fischer-Tropsch Process, F-T process)

In this step the carbon monoxide and hydrogen produced in the first step is either passed through a fixed bed catalyst of cobalt : iron or the mixture is bubbled through a hydrocarbon slurry containing a catalyst. The product of reaction is a waxy product send to the upgrading step. Hydrogen is reacted with carbon monoxide to give a long chain waxy product according the equation:



or



In the above equation, the term -CH<sub>2</sub>- represents basic building block of the paraffin molecule. Straight chain paraffins are main products of the F-T process with minor quantities of iso-paraffins and olefins also present in the products. Because of the paraffinic nature of the product, F-T diesel has high cetane number.

### 3. The Hydrocracking (Upgrading) step

In the upgrading step the waxy paraffinic product is cracked in the presence of Hydrogen to require molecular weight products.

The olefin molecules ( $C_nH_{2n}$ ) become saturated with Hydrogen creation a range of paraffins. Thus, Naphtha is hydro treated and olefins are saturated to the corresponding paraffins.

The waxy product from the F-T step can be used for the production of base/special lube oils. Typical product distribution from the GTL process is as follows:

- LPG           7%
- Naphtha      26%
- Kero/Diesel 67%

At period of low crude oil prices, production of synthetic fuel by GTL route was found to be uneconomic as compared to the price of fuel derived from crude oil and application of the process was frozen. The interest in process was regenerates mainly by increase in price of crude oil and by realization that crude oil supplies are finite.

### **2.1.6 Gas to Wire (GTW)**

Associated gas can be used for power generation. If there is demand for heat in addition to demand for power, combined heat and power technologies (CHP) can be used to produce both power and heat.

Electricity can be produced by generators driven by piston engines, gas turbines, or steam turbines. Small power producing units (250–5,000 kW) normally have overall efficiencies of 25–35 percent while larger power plants may have overall efficiencies in excess of 50 percent. For a combined production of heat and power at a larger plant, total energy efficiencies approaching 90 percent can be reached. There is a performance cost trade off between AC and DC transmission. This trade-off boundary is indistinct as it is affected by many factors, which are project dependent. However for distance above approximately 100 km, DC transmission is usually preferred due to voltage drop and power loss considerations suffered by AC systems.



## 2.2 Gas Utilization Case Studies

There have been long several attempts to utilize the natural gas and associated gas for long. Many recent technologies helped small scale of natural gas especially associated gas to be utilized in a wide range of usage. This section discusses some of these related works.

Kia and Sikchi (1984) studied the project of associated gas utilization in Sabah, Malaysia. The State Government of Sabah invested the equivalent of 1 billion US Dollars in a gas utilization project which would stop the venting of associated gas produced offshore Sabah and broaden the state's economy base. The project involved the installation of new platform facilities adjacent to existing oil production platforms for collection, processing and transmission of up to 90 MMscfd of gas to the island where gas would be utilized by a 47MW combined cycle power plant, a 2000 ton/day hot briquette iron plant and a 2,000 ton/day methanol plant.

Moins (1982) performed the research on associated gas treatment onsite. The economic background of associated gas treatment was discussed and available methods for natural gas liquid (NGL) recovery were reviewed and evaluated against technical criteria. Economics of NGL recovery projects were provided for three typical examples: a major onshore project, a combination offshore-onshore project, and an offshore project.

Dehghani and Ehrlich (1999) presented utilization of associated produced gas to improve oil recovery. Associated gas which produced from oil fields in remote locations are costly to transport to market and typically has been flared. Utilization of associated gas may justify some improved oil recovery processes (IOR), which would not be economical if gas had to be purchased at world price. These IOR projects look especially more attractive if the available gas would otherwise be flared.

Global Gas Flaring Reduction, a Public-Private Partnership, World Bank Group (WBG) (2004) launched the report of associated gas utilization opportunities for small-scale uses of gas. The main objective of this study was to assess the technical feasibility and economic viability of using flared gas in various applications ranging from rural electrification to commercial and industrial usage. The field models were set up by the various production rates of 2,500 – 60,000 m<sup>3</sup>/day to determine roughly the threshold for the utilization options. Furthermore, two case studies, one in Chad and one in Ecuador, have been analyzed with the purpose of identifying viable pilot projects which could progress to a detailed feasibility and



implementation phase subsequent to their study, which was concluded in 2002. In addition, the Vilankulu gas distribution project in Mozambique, which uses non-associated gas, was examined for 10 years into its existence for possible lessons learned.

Another study by World Bank Group (2006) is in Indonesia. The scattered and remote locations of associated gas fields in Indonesia presented a unique challenge for flare gas utilization. They evaluated the technical, economic, and financial viability of gas flaring reduction projects in Indonesia. The methodology was begun with field screening called qualitative fields screening such general criteria as reserve and production rate. The utilization technology cost was then studied and quantitative screening was evaluated by financial and economic analysis to get the target fields for implementation. Finally, they provided recommendations for implementing these projects in the near future.

Petrosyan (2004) proposed the constraints on associated gas utilization. Several cases in different countries were looked at with different development options to define constraints still reining in associated gas utilization. The study presented the gas development options with the minimum values of criteria considerations. These will be the common constraints that were needed to be considered for the project feasibility studies.

Adegoke and et al. (2005) investigated economic of natural gas development options, LNG (Liquefied Natural Gas), GTL (Gas-To-Liquid), and GTL-Power Co-production. They developed new strategies of utilizing the associated gas to respond to the Nigeria government's policy to stop gas flaring by 2008. In the study, 1 Bcf/day for 20 years of feed gas used for the development options. Consequently, the economic analysis gave solution to natural gas exploitation in terms of the technological and environmental factors to supply and demand constraints. Furthermore, justifying the technology and economics involved in the utilization of by-product stream for power generation may possibly increase the net revenue and profitability of the GTL projects.

In Thailand, there is no successful associated gas utilization project of E&P business but there is another kind of gas successfully utilized in Thailand. The next case study can be the demonstration for our project in the case of the daily gas production supplying to power generator. The biogas utilization was being mentioned.

Plevin and Donnelly (2004) implemented the biogas power plant to substitute heavy fuel oil used and electrical power in tapioca starch factory in Thailand. The average of 60,000 m<sup>3</sup>/day of biogas at 62% methane supply to the power plant consists of three 1 MW Jenbacher model generator set. Full waste water flowing give maximum 124,000 m<sup>3</sup>/day of biogas production. The biogas power plant system produces required heat for the factory and 3 MW of electricity. Moreover, this removes 99% of wastewater's total chemical oxygen demand (COD) and reduces solid waste produced from the factory.

Studying gas utilization options and investigating case studies in others countries gave the ideas for studying in Thailand. The utilization options, consideration criteria such as reserve and daily production, and cost of investments are applied for this research. The criteria will be used as a screening tool to screen out the non-significant fields and options. The qualified fields will be investigated further in the next step for economic analysis. Because large size scale of petroleum production is typical in other countries compared to that in Thailand, the criteria from the case studies will not include their number. The main criteria to be applied in this study are shown below:

- Associated gas reserve from oil reserve
- Associated gas daily production and flared
- Associated gas depletion period
- Safety and environmental consideration
- Economic consideration

All these criteria will be taken into account in the next step of analysis to investigate appropriate use of associated gas in Thailand as discussed in chapter 4. The gas utilization technologies will be also applied in chapter 4 and to determine for the suitable utilization options.

## **CHAPTER III**

### **THAILAND ONSHORE OIL FIELD CASE**

Petroleum in Thailand was discovered by chance at first in 1918 by villagers in Fang, Chiang Mai. There was crude oil seep on the ground, and the villagers believed it was holy crude so they used it to bathe their body as herbal. After that, in 1921, the exploration in Thailand started by the government. However, that exploration effort by the government from 1921 to 1959 seemed unsuccessful because only one field was discovered, Fang oil field. Fang was discovered in 1953 and given to Defense Energy Department to operate.

Thailand commercial exploration and production was started on 1960 which the government change policy of exploration. The exploration performed by the government at first, then private companies were gotten chance to perform. In 1968, the government opened for oil companies come to explore under mineral act. Petroleum act was released in 1971, and several foreign oil companies were interested and asked for petroleum concession agreement. The first commercial petroleum field in Thailand was discovered in Gulf of Thailand in 1971 and this field got name 'Erawan field' in the next time. In addition, there was other discovery of commercial gas field in 1980, Bongkot field. It is the biggest current gas field in Thailand (2007).

In the beginning of 1979, Thai Shell E & P and Esso Exploration Inc. got the concession to performed onshore exploration. That time, S1 and S2 concessions in the lower northern of Thailand belonged to Thai Shell Exploration & Production, and E1-E5 concessions in north-eastern belonged to Esso Exploration Inc. The result was crude oil in S1 when natural gas from E1-E5 exploration well. They were know as Sirikit oil field and Nam Phong gas field respectively which Sirikit oil field is the biggest oil field in Thailand up to now (2007).

Since the first well in the Gulf of Thailand was drilled in Erawan field, at least 1,800 wells were drilled up to now. At present, there are 28 concessions, 37 exploration blocks, and have discovered more than 30 fields of commercial petroleum fields both onshore and offshore. There 28 fields are still producing which oil, natural gas, and liquid natural gas are products.



Figure 3-1 Thailand petroleum fields

(Source: <http://www.ptit.org/oilbusiness/history/images/photo/mapthailand.gif>)

Table 3-1 Thailand petroleum fields

	Field	Block	Petroleum Product
No.	Offshore		
1	Erawan Group	B10,11,12,13	Natural Gas and Condensate
2	Pailin	B12/27	Natural Gas
3	Bongkot	B15,16,17	Natural Gas and Condensate
4	Nang Nuan	B6/27	Crude oil
5	Tantawan and Benchamas	B8/32	Crude oil and Natural Gas
6	Jasmine	B5/27	Crude oil
No.	Onshore		
1	Fang	DED operator	Crude oil
2	Sirikit et al	S1	Crude oil and Natural Gas
3	Bung Ya, Bung Muang	NC	Crude oil
4	Wichian Buri, Si Thep	SW1	Crude oil
5	U Thong, Kampheang Saen	PTTEP1	Crude oil
6	Nam Phong	E5	Natural Gas
7	Phu Horm	E5 and EU1	Natural Gas

Most offshore fields in Thailand are gas reservoirs and already in gas business which extremely utilized so they are not suitable for gas utilization project. In addition, other criteria considerations give the same way of result. Such as transportation and distance to market, pipe line and tanker are alternatives which the high investment cost needed. If the amount of associated gas to utilize is small, it makes the project uneconomic.

While onshore associated gas can draw from a wide range of recovery options, the offshore associated gas is much more dependent on pipeline connections and volume thresholds. For these reasons, onshore associated gas will be considered for demonstration project. Screened field candidates for economic analysis of next step study must be examined by the shown criteria.

- Production amount of associated gas
- Associated gas reserve
- Associated gas depletion period. This also concern reserves, there have to have associated gas production due to project implemented.



- Pipelines connected to delivery. It was assumed this gas was sold and not flared.
- Distance and transportation to main processing station, these points refer to investment and economic or uneconomic project.

As seen in table 3-1, one of onshore petroleum fields that have potential of being a case study is considered. This onshore oil field is most suitable because they produce both crude oil and natural gas which crude oil as main product and natural gas as by-product. The natural gas in these onshore fields is associated gas which is quite large daily production and large flared. So the research would focus to these flared gas for fully utilized and at the same time to reduce pollution to the environment. While others fields are small size and small amount of oil and gas production, and some fields are natural gas fields which gas has already ultimately used in gas business.

### 3.1 Thailand onshore oil field: The Case Study

Thailand onshore oil field case was first discovered in 1981. The first petroleum production area was 25 sq. km. and the fields were continuously developed in another production area of 189.6 sq. km. in 14 fields. Furthermore, the areas were conserved for additional exploration and production period with the total conserved area of 1,136 sq. km. at the current. The production areas in red boundary were shown in figure 3-2 in red boundary.



Figure 3-2 Production area of Thailand onshore oil field case



### 3.2 Reserve

Reserve estimation of Thailand onshore oil field case and surrounding fields was quite difficult because of the complexity of the field geology. In the first period of discovery, reserve estimation was only around 28 million barrels of crude within 10 years of production. The later result from further surveys showed the previous reserve was much lower than the actual one as seen from the reviewed literature.

Petroleum reserves estimation of Thailand onshore oil field case at the end of year 2006 (25<sup>th</sup> year) shown in table 3-2.

Table 3-2 Petroleum reserve of Thailand onshore oil field case  
at the end of 25<sup>th</sup> year

Petroleum Type	Petroleum Reserve			
	Proved Reserve		Probable	Possible
	Developed	Undeveloped		
Crude Oil (MMbbl)	23.711	17.360	10.970	2.240
Natural Gas (Bcf)	75.970	83.830	203.540	18.542
BOE (MMbbl)	42.080	37.630	21.540	6.720

### 3.3 Petroleum Production

Petroleum production section is divided to be 3 sub sections, production history, production strategies, and associated natural gas flared of the Thailand onshore oil field case. The production history describes the production of oil, gas, and LPG from the starting year. The production strategies describe the facilities in the production area of the field. The associated natural gas flared section shows the amount of gas flared example and the recent few years.

#### 3.3.1 Production History

Thailand onshore oil field case already produced over than 25 years with over 150 million barrels of crude, 399 Bcf of natural gas, and 1.6 million tons of LPG. The average productions at the 25<sup>th</sup> year were 18,800 barrel per day of oil, 56.5 MMscf

per day of natural gas, and 264 tons per day of LPG. Production histories of Thailand onshore oil field case and surroundings fields were shown in figure 3-3, 3-4, and 3-5.

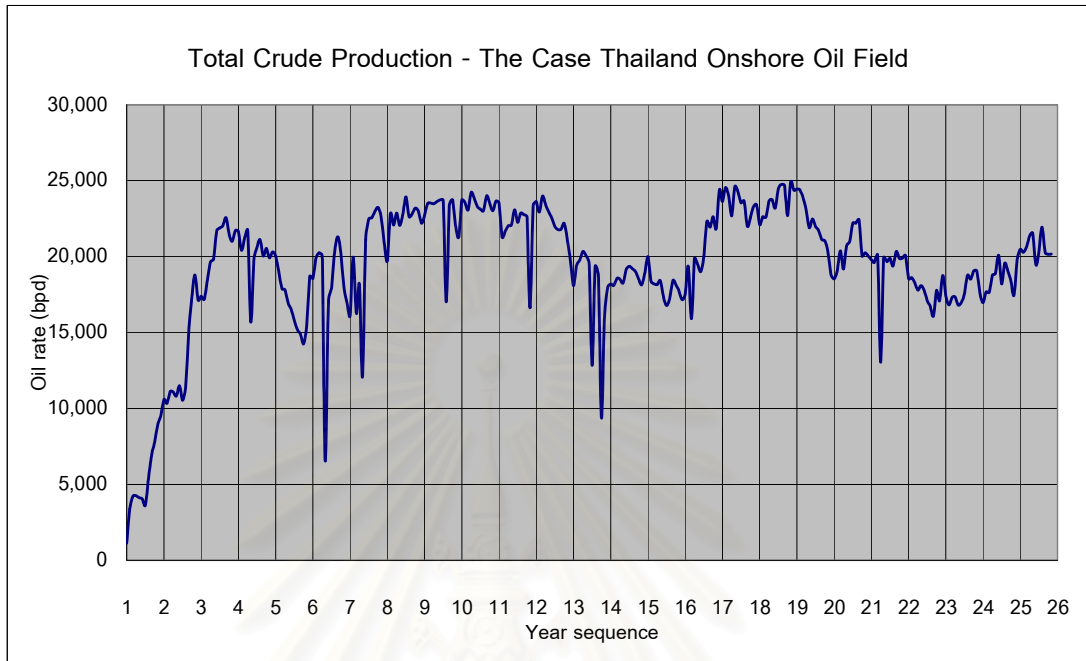


Figure 3-3 Oil production of Thailand onshore oil field case

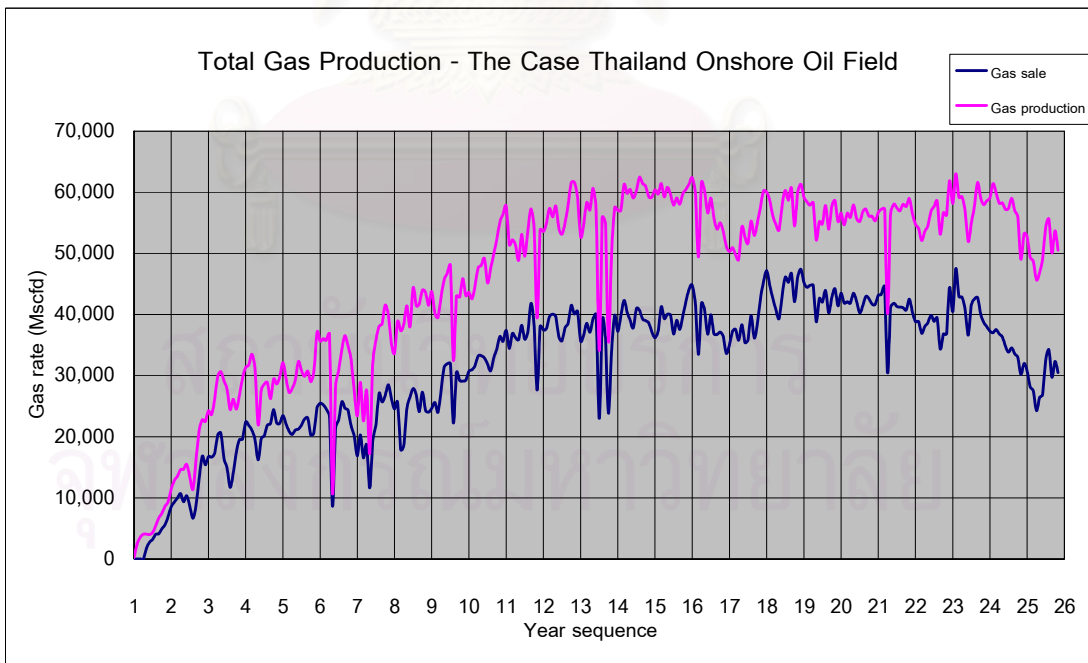


Figure 3-4 Gas production of Thailand onshore oil field case

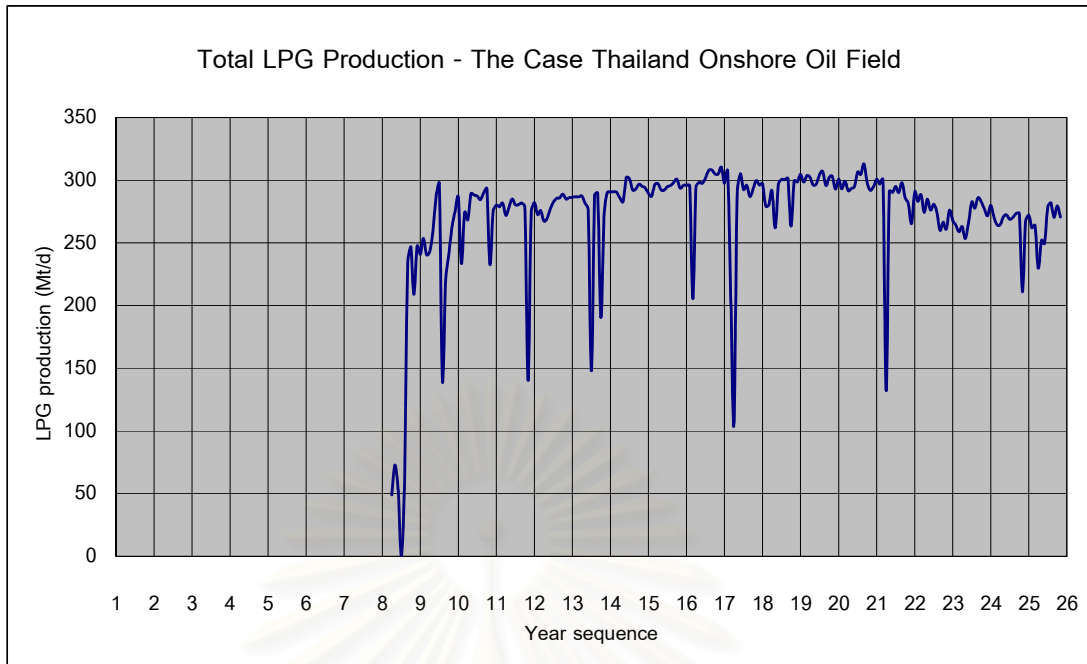


Figure 3-5 LPG production of Thailand onshore oil field case

### 3.3.2 Production Strategies

Crude oil and natural gas are petroleum products from Thailand onshore oil field case can be divided into 2 main groups, 1) main station production, and 2) site station production

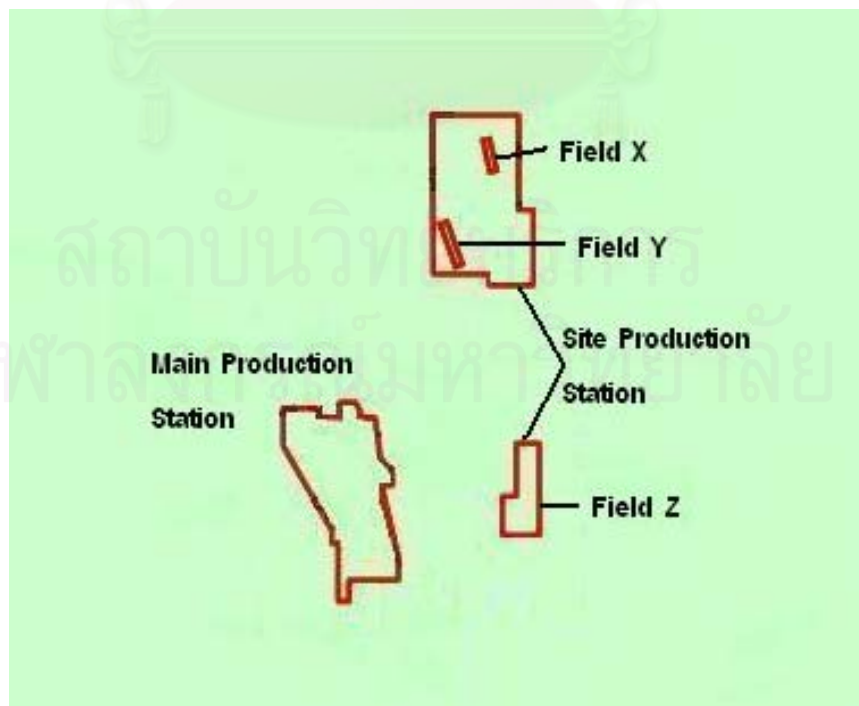


Figure 3-6 Production station layout

### 1) Main Station Petroleum Production

Petroleum products from main production area will be transferred via pipeline to the main production station to separate water and natural gas from crude oil, as seen in figure 3-7. The crude from main production station will be transported by 200 barrels trailer (100 barrels each) to the train station which is 55 km. of distance and then go to refinery in Bangkok and Chonburi. Since associated natural gas here is qualified for LPG, LPG plant was constructed and opened in January 1990 to sell their LPG product to the customer. The rest of natural gas is supplied to power plant which started in March 1983 and for gas lift process in crude oil production section. So the remaining gas from all previous processes has to be flared because the gas is low pressure gas, extremely used and cannot be used. The entire process is shown in Figure 3-7.

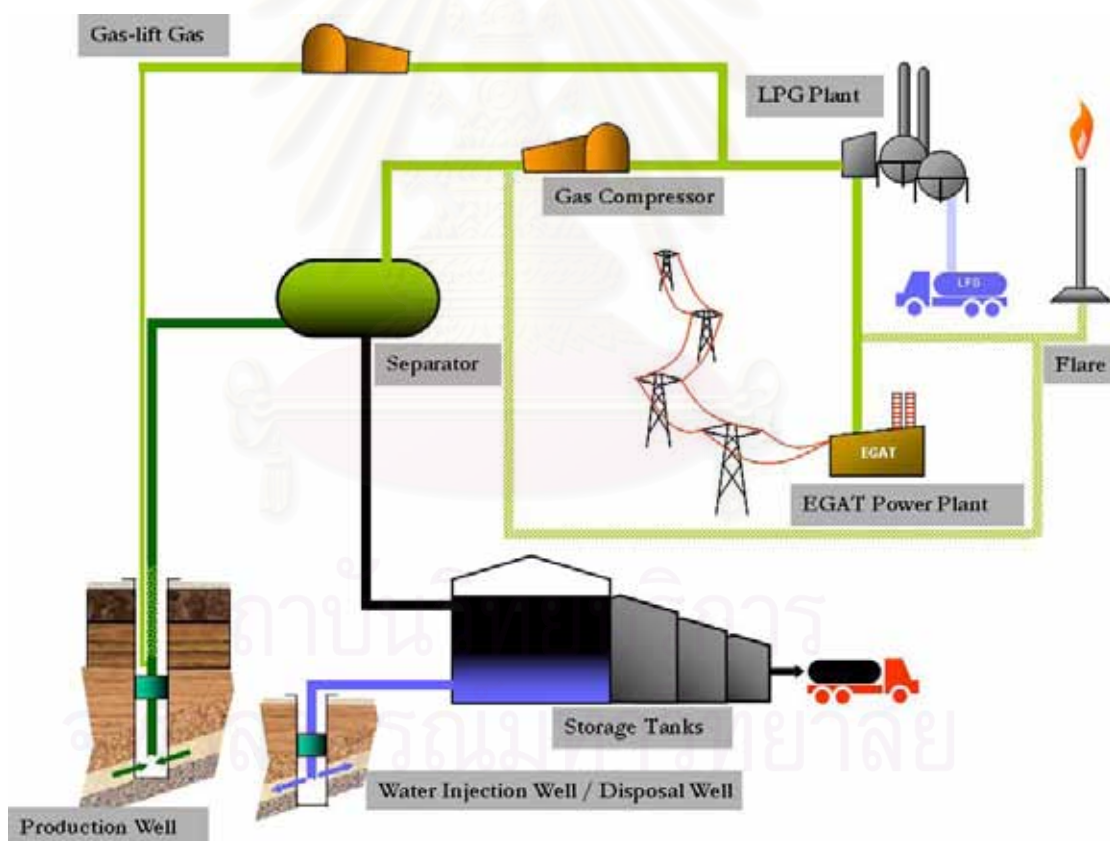


Figure 3-7 Main station petroleum production process

(Source: [www.eppo.go.th](http://www.eppo.go.th))

## 2) Site Station Petroleum Production

There are 3 fields of site production stations (field X, Y, and Z in site production station of Figure 3-6) in Thailand onshore oil field case. Because these 3 fields are located at a long distance from the main production station as seen in the layout in figure 3-6, pipeline connected to the main production station were uneconomical. However, necessary production equipment was installed to separate natural gas from crude oil and water. Then, the mixture of crude oil and water was transported by trailer to the main production station for separation process. Associated natural gas was used as fuel in site station but the rest has to be flared for safety. The entire process is shown in Figure 3-8. The difference from the previous figure is that the site process was ended at the separator and the associated gas is flared.

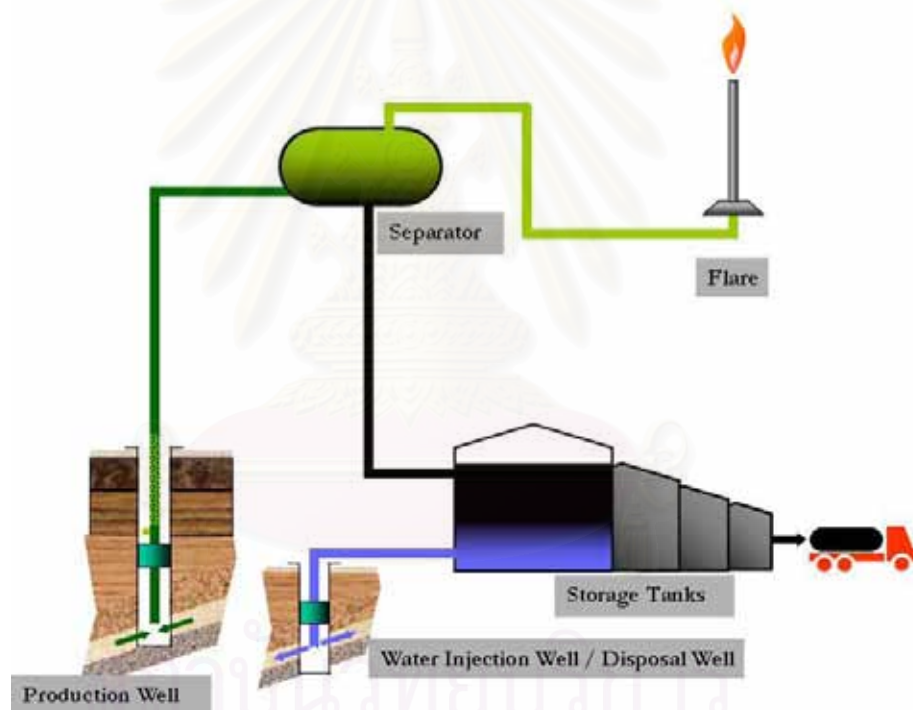


Figure 3-8 Site station petroleum production process

(Source: [www.eppo.go.th](http://www.eppo.go.th))

### 3.3.3 Associated Natural Gas Flared

Generally, associated gas has to be flared because of safety reason and low pressure gas. Refer to figure 3-4, the different between gas sale and gas production curve was not all flared. As seen in figure 3-7 and 3-8, some of produced gas was consumed by gas lift, site gas generator, and operation of LPG production. So there are flared in both main station and site station. Figure 3-9 – 3-12 show the amount of

associated natural gas flared in the main production station and site production stations in the 24<sup>th</sup> year.

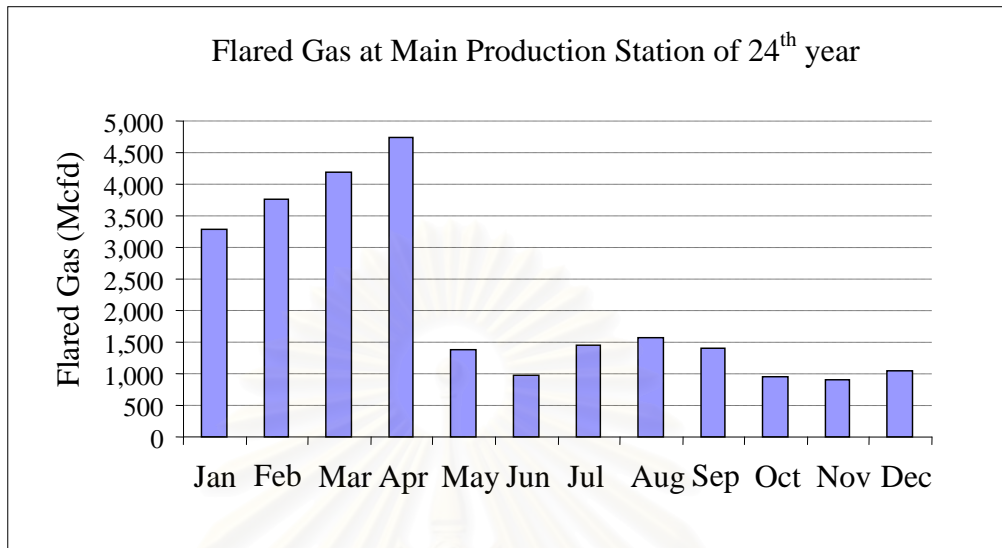


Figure 3-9 Amount of associated natural gas flared at the main production station of 24<sup>th</sup> year

Amount of natural gas flared at the main production station of the 24<sup>th</sup> year averaged 2.1 MMscfd or equivalent to 60,609 liters/day of diesel or 45 tons/day of LPG.

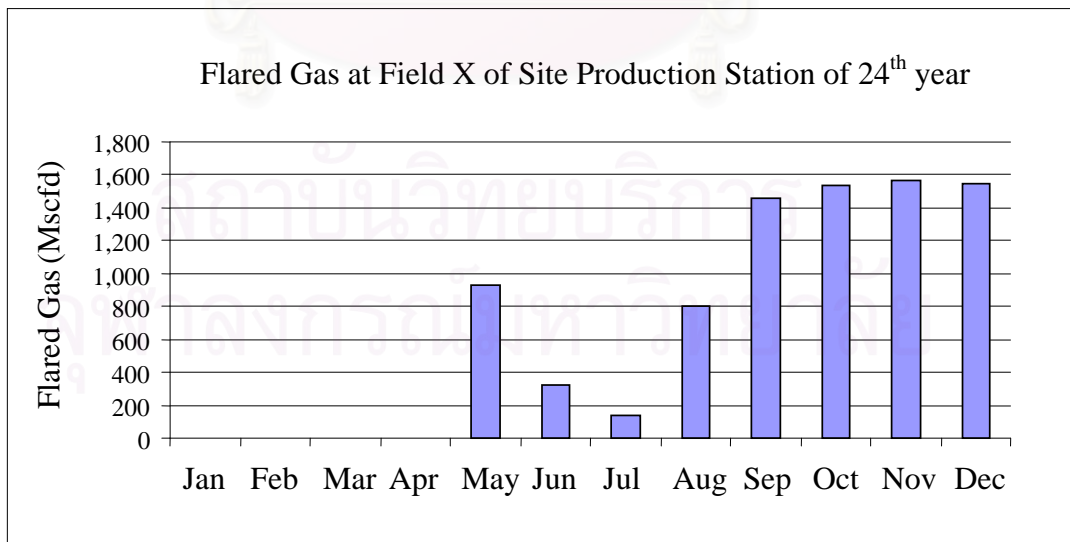


Figure 3-10 Amount of associated natural gas flared at field X of site production station of 24<sup>th</sup> year



The amount of natural gas flared at field X of site production station in the 24<sup>th</sup> year was 1.0 MMscfd (average) or equivalent to 29,464 liters/day of diesel or 22 tons/day of LPG.

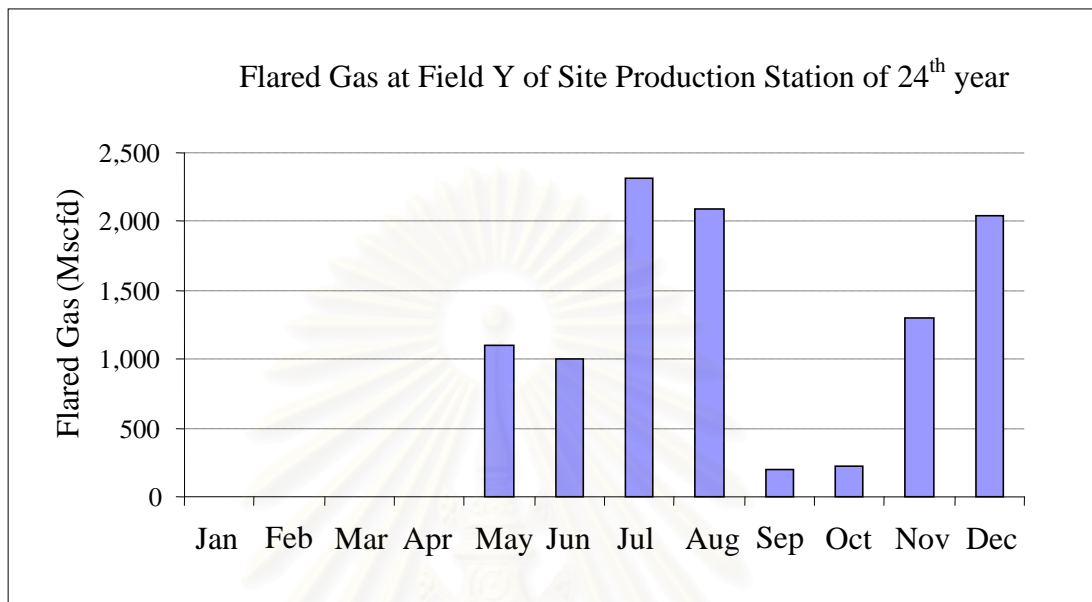


Figure 3-11 Amount of associated natural gas flared at field Y of site production station of 24<sup>th</sup> year

The average amount of natural gas flared at field Y of site production station of the 24<sup>th</sup> year was 1.2 MMscfd or equivalent to 36,481 liters/day of diesel or 27 tons/day of LPG.

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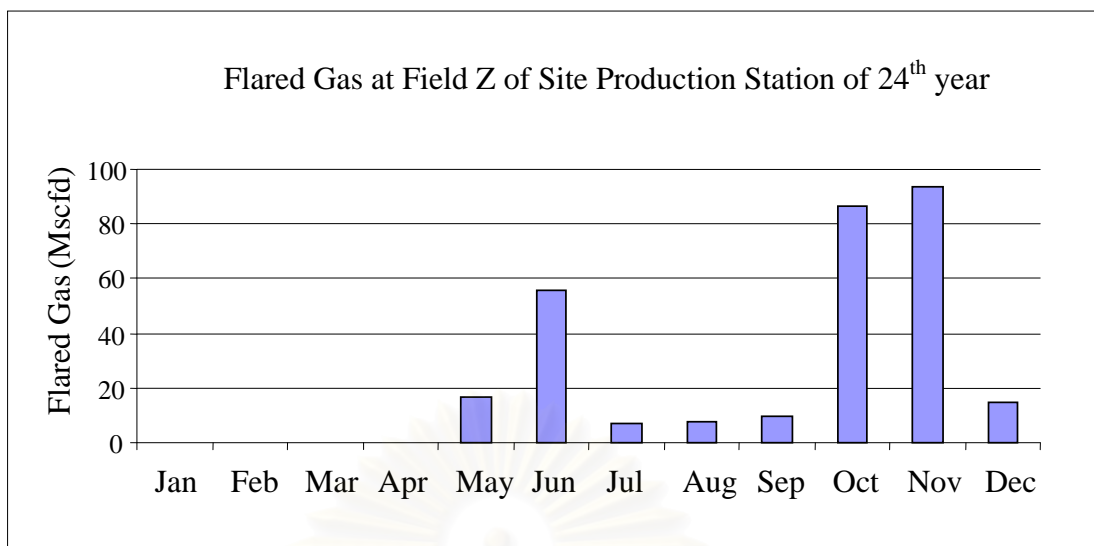


Figure 3-12 Amount of associated natural gas flared  
at field Z of site production station of 24<sup>th</sup> year

The average amount of natural gas flared at field Z of site production station of the 24<sup>th</sup> year averaged 0.02 MMscfd or equivalent to 419 liters/day of diesel or 0.3 tons/day of LPG.

Normally, the associated gas in Thailand onshore oil field case had to be flared for safety because that gas cannot be of primary use. Therefore, utilization of associated natural gas should be determined by the criteria established from the previous chapter especially the reserve and daily production criteria. The associated gas flared cannot be utilized by all 3 fields. The associated flared gas of the Thailand onshore oil field case was shown in figure 3-13.

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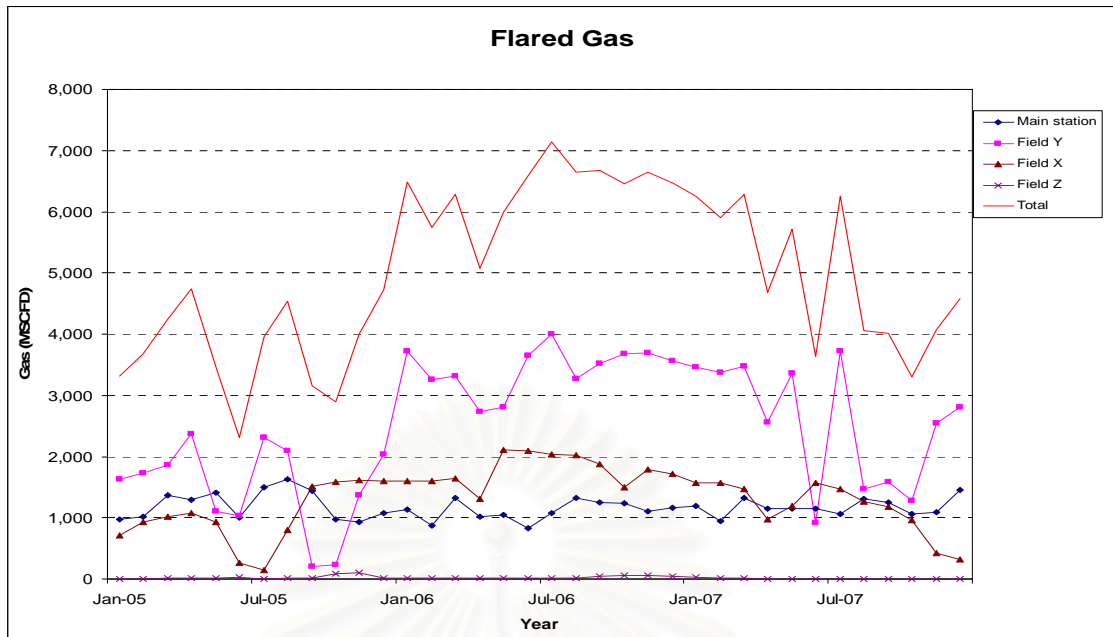


Figure 3-13 Associated flared gas of Thailand onshore oil field case

The most possible utilization fields are field X and Y because of their high amount of associated gas produced and flared. The production of field Z is too low for further utilize by current technology and associated gas from main station production has too low pressure to be utilized as previously described. So the associated gas utilization technologies studied in the previous chapter will be applied for the potential fields (X and Y) in the Thailand onshore oil field case.

# **CHAPTER IV**

## **ASSOCIATED GAS UTILIZATION**

### **OPPORTUNITIES IN THAILAND**

Since the objective of petroleum development in the past was to supply commercial industry. For instance, natural gas was used as fuel for power plant, or as raw material for natural gas plant while crude was used as raw material for oil refinery. Hence, marginal field especially gas field cannot be developed because it was uneconomical. The same applies to as marginal oil field, produced associated gas will be flared without any use.

This chapter describes the opportunities to develop small scale of gas utilization in Thailand onshore fields. Using associated gas in the local communities located in or near the area of Thailand onshore oil field case is the one of the opportunity. Substitution of conventional fuels by the associated gas can help reduce cost and environmental effects. This chapter discussed opportunities for associated gas utilization in Thailand.

#### **4.1 Associated Gas Utilization in Thailand: Small Scale Options in Thailand**

Due to advance in technology, a number of associated gas usage possibilities exist with requirements for different gas treatment and facilities. These usage options are primarily related to small-scale projects design to provide new energy options for households and small-scale industry. Such projects are local and are located within a short distance from the oil fields. The technologies to develop marginal field especially associated flared gas utilization as following:

1. 1 MW power generator fueled by associated gas.
2. LNG (Liquefied Natural Gas) and NGV (Natural Gas for Vehicle) car fuel production for transportation.
3. Associated natural gas for fuel which is directly pipelined to community (gas to community).
4. Utilization of LNG by-product.

## 4.2 Criteria for Associated Gas Utilization in Thailand

Associated gas utilization project in the Thailand onshore oil field case was examined by the selected criteria to determine the most efficient and economical gas utilization options. The main criteria for considerations are shown below:

1. Associated natural gas reserve

Reserve is the amount of petroleum be able to produced commercially at the evaluation date under economic constraints and existing production process. Therefore, utilization of associated flared gas project requires evaluation of associated gas reserve. The associated gas reserve must ensure that the gas production is enough for each project and return of the investment.

For example, 2 MW of gas power generation project needs at least 0.4 bcf of gas reserve or 0.5 MMscfd with at least 2 years of gas production. If this requirement can be met, the power generation project will be worth and can be proceed.

2. Associated gas daily production

Daily production of associated gas must be enough to supply the power generator or other equipment to be worth being processed. For example, 1 MW of gas power generator needs at least 0.2 MMscfd of natural gas.

3. Safety and environmental consideration

The developed project must be first considered in terms of safety. The project must not be dangerous for lives in that local community nor lead to environmental problems. If necessary, before project is developed, Environmental Impact Assessment (EIA) has to be studied and reported to the Office of Natural Resource and Environmental Policy and Planning. For instance, gas power generation project with higher than 10 MW capacities needs EIA report. On the other hand, the gas separation or transformation process of any capacity must report.

4. Supply the improvement of community enterprises

The associated natural gas is a natural local resource. The project can be focused on community use such as supplying natural gas to substitute the conventional fuel (LPG). Moreover, the associated gas utilization in local community aims to reduce cost of local products (One Tambon One Product: OTOP). The project needs to co-operate with the government sector and Local Administration Organization (i.e. Provincial Administration Organization and District Administration Organization) to allocate and select the suitable community enterprises for utilization

of gas project, in order to avoid the unfairness of resource allocation to only one individual. So the work process may be in the form of cooperation.

#### 5. Financial consideration

Even though, gas utilization projects are very beneficial for the local community, these projects need financial benefit, to, get the investment back at least. For private company's operation, the profit must be high enough for continuous operation otherwise the project fails.

### 4.3 Associated Gas Utilization Opportunities in Thailand

As previous described in section 4.1 Associated Gas Utilization in Thailand: Small Scale Options in Thailand, this part will describe in more detail of each options in the sense of theory and implementation.

#### 4.3.1 Power Generation

Power production from gas turbine fueled by natural gas has similar principle as steam turbine. While steam turbine is driven by steam, gas turbine is driven by hot gas generated from fuel combustion. Energy is obtained from mechanical process.

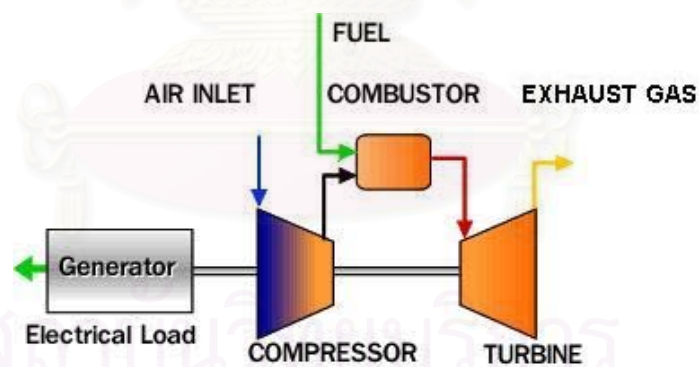


Figure 4-1 Gas turbine principle





Figure 4-2 Gas power generator

Basic components of both types of turbines include an air compressor, a combustor and a turbine. As shown in figure 4-1 for gas turbine, working gas (air) is compressed in a compressor and heated by combustion energy of fuel (natural gas or oil) in a combustor. The working gas now has high temperature and pressure. The engine then converts the energy of the heated working gas into energy to rotate the turbine generating electricity. The pressure of the working gas decreases after flowing through the turbine and the gas is vented to the atmosphere.

#### 4.3.2 Small-scale Liquefied Natural Gas (LNG)

LNG production is processed by Nitrogen Recycle System (NRS) technology where nitrogen is refrigerant as shown in figure 4-3. This technology is suitable for investment because of its simple and flexible production process. NRS is able to improve efficiency during processing so that it fits the production capacity of the natural gas field.

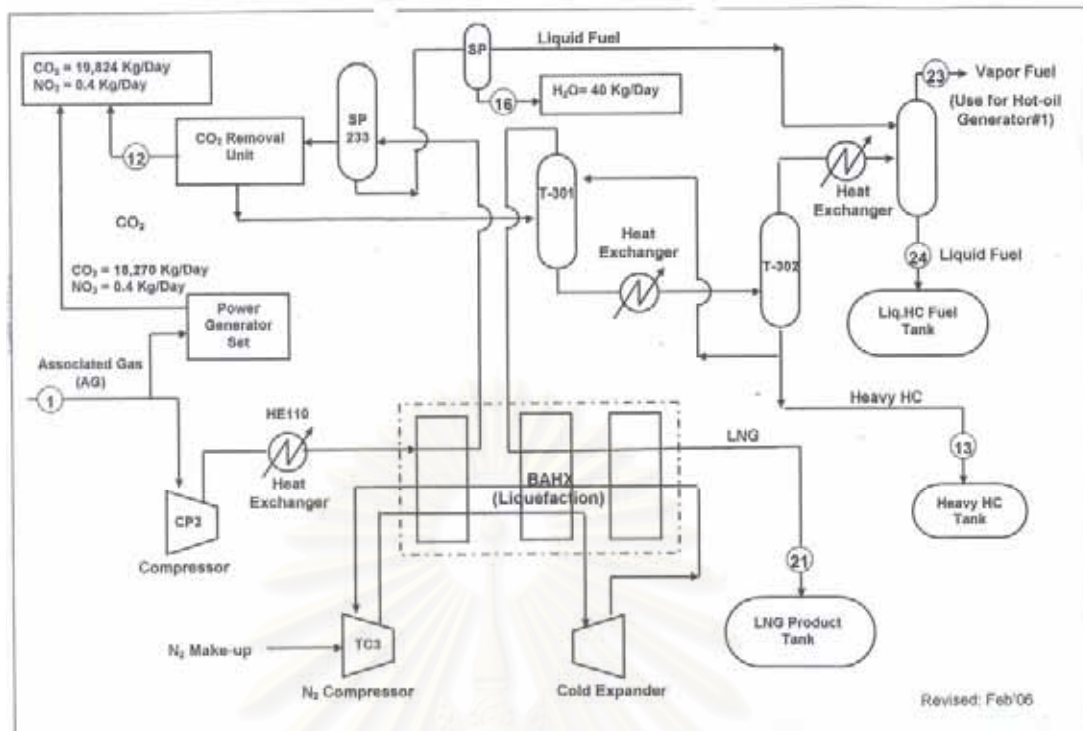


Figure 4-3 LNG production process (Witsarut *et al*, 2007)

In the LNG process, associated natural gas is fed through the compressor and cooled down by the heat exchanger. The gas then flows through the Blazed Aluminum Heat Exchanger (BAHX) to reduce the gas temperature. Light weight hydrocarbon components are liquefied by cold liquid nitrogen.

The outlet from BAHX flows to the separator where liquid mixture (water and liquefied hydrocarbon) are separated from the gas stream. The water and liquefied hydrocarbon are then separated in the knockout drum. The liquefied hydrocarbon is transferred to liquid hydrocarbon production system while the water disposed off.

The gas from the separator flows to the CO<sub>2</sub> removal unit to remove CO<sub>2</sub> and moisture is absorbed by molecular sieve. After that, the gas flows to the adsorption column to separate methane (CH<sub>4</sub>) from other hydrocarbon components (C<sub>2</sub>-C<sub>5+</sub>). The gas from the adsorption process has approximately 90% methane (CH<sub>4</sub>) and flow through BAHX unit where the condition of the gas is changed to -149 °C and 65 psi. This is LNG to be stored in LNG product tank. The LNG can be then transformed to be CNG for transportation fuel as shown in figure 4-4.

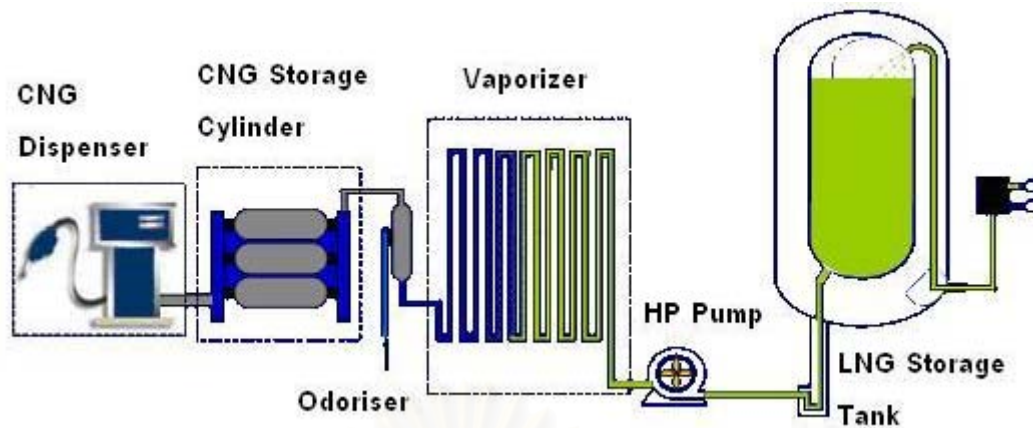


Figure 4-4 LCNG refueling station

(Source: www.pttplc.com)

The gas from the bottom part of the adsorption column flows through another heat exchanger to increase temperature. The heated gas flows to the stripping column to separate  $C_{2+}$  ( $C_2H_6$ ,  $C_3H_8$ ,  $C_4H_{10}$ ) and flow to the top of the column.  $C_{5+}$  or Natural Gas Liquid (NGL) flows to the bottom of the column. Some portion of the  $C_{5+}$  stream flows to the adsorption column to separate methane ( $CH_4$ ) from the others ( $C_2-C_{5+}$ ). This process is called reflux and the rest of the  $C_{5+}$  stream is stored for use.

The  $C_{2+}$  stream from the top of the stripping column flows through another heat exchanger and combines with liquid hydrocarbon from the knockout drum in the 2<sup>nd</sup> separator. The vapor phase of  $C_{2+}$  is then separated from liquid phase. This vapor is used for power generation and the liquid is stored in a 2-layer special storage since liquid  $C_{2+}$  is stable at 5 ° Celsius and 19 bars or 280 psi.

### 4.3.3 Pipeline

One of natural gas utilization technology is gas pipeline transporting gas for household usage. This is also called ‘City Gas or Town Gas’. It is very useful and famous in USA, Japan, China, and European countries. Natural gas is transferred from a gas field via pipeline to a gas distribution station to adjust pressure. The gas is then piped to community main pipe and then distributed to households, restaurants, hospitals, hotels and also industrial factories.

As shown in Figure 4-5, general pattern of natural gas pipeline begins with connecting split pipe (3) from the gas flared line (1) to a surge drum (4) for stabilization of temperature and pressure. The safety valve (2) between the flared line

and the surge drum controls the amount of gas in the drum by controlling pressure. If the pressure is high enough which means that the drum is full, the valve will close and the gas will be flared. On the other hand, too low pressure in the drum causes the valve to open and allow the gas to flow into the drum.

After the surge drum is pipeline (5). The length of the pipeline must not be too long because we have to control the expense and the pressure at the end of the flow line. The gas flows from the surge drum via pipeline to the tank (8). The blower (6) and gate valve (7) are installed to protect back flow and control proper pressure in the tank for uninterrupted delivery (9).

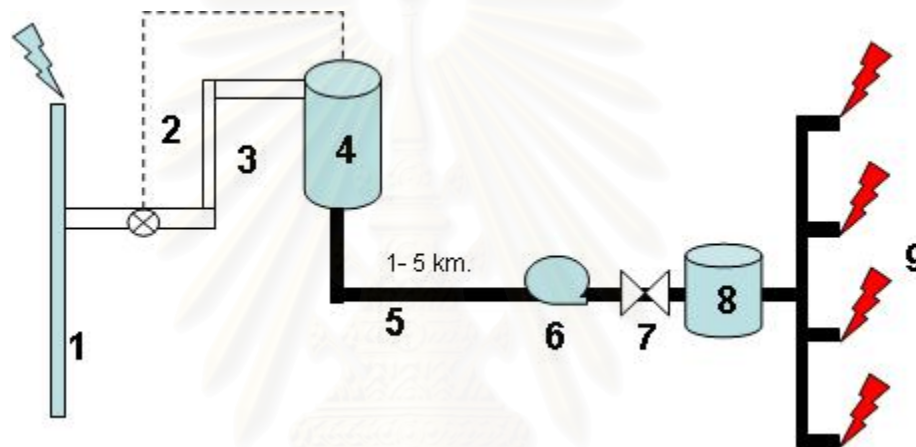


Figure 4-5 Schematic diagram of natural gas pipeline

#### 4.3.4 NGL Utilization from LNG By-product

As mentioned in previous section of LNG production process, there are 3 products from the process which are LNG,  $C_{2+}$ , and  $C_{5+}$  or NGL. All 3 products can be contained in a tank and transported to customers.

Actually, LNG and  $C_{2+}$  are in gaseous phase at ambient temperature ( $30^{\circ}\text{C}$  approximately) and atmospheric pressure. In order to transport these products in liquid phase, a special 2-layer tank (inner – stainless, outer – carbon steel) is needed for keeping low temperature and high pressure. To use LNG and  $C_{2+}$ , one need to vaporize the liquid back to gaseous phase using a vaporizer as shown in figure 4-6.



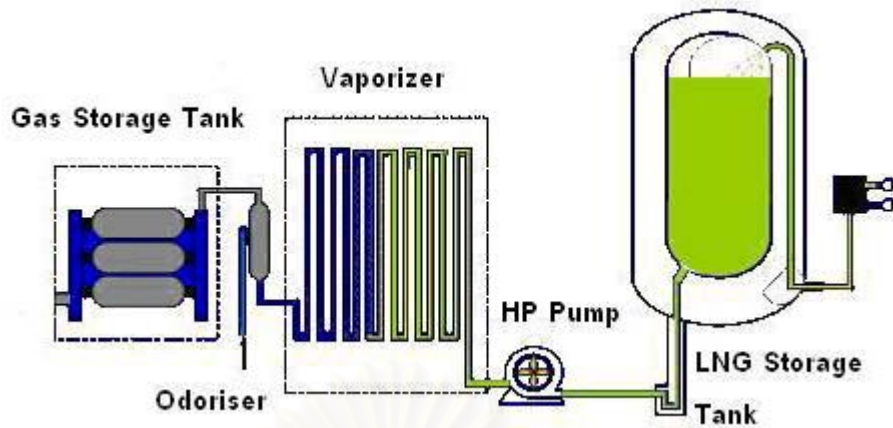


Figure 4-6 LNG re-gasification  
(Source: www.pttplc.com)

$C_{5+}$  or NGL is clear liquid at room temperature  $30\text{ }^{\circ}\text{C}$  and atmospheric pressure but immediately evaporate when opened to approximately  $32\text{-}33\text{ }^{\circ}\text{C}$ . NGL is inflammable at low vapor pressure so it can be stored in common metal vessel. But due to its volatile property it needs to be kept in closed vessel. In the tank, the product can be transported to the users easily and low investment for vessels is required.

Currently, there are burners that can be fueled by natural gas, LPG, or even diesel. Diesel burners can be modified to be fueled by NGL. Figure 4-7 shows a NGL prototype burner.

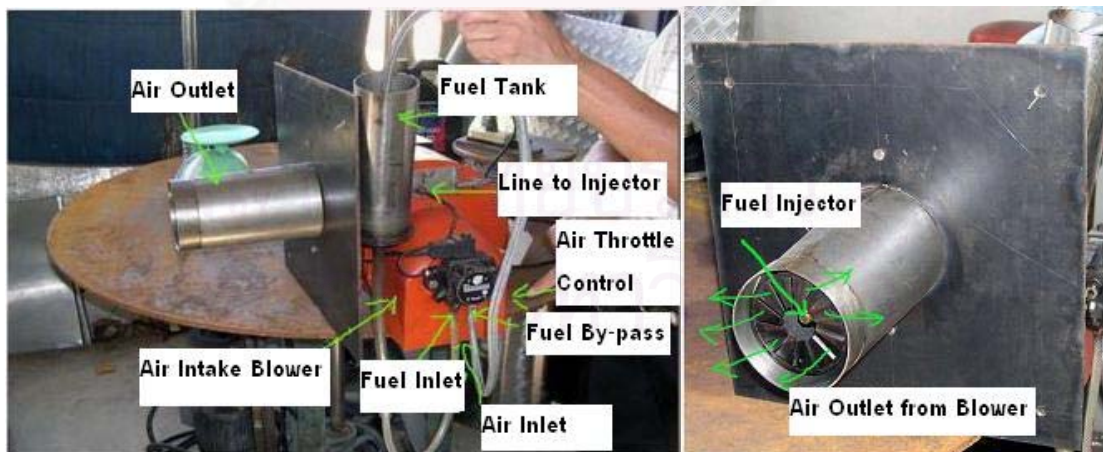


Figure 4-7 NGL prototype burner



Figure 4-7 NGL prototype burner (cont'd)

The NGL burner was designed to inject fuel liquid using a pump and to intake air using a blower. The main components of the NGL prototype burner include fuel (NGL) pump for injecting fuel, air intake blower, fuel injector for spraying the fuel, and burner tip to ignite the burner. The process starts by pumping NGL to the injector. Fuel is sprayed out to mix with the air from the air intake blower. Lastly the burner tip ignites fire. The level of heat and strength of fire can be adjusted by changing injector and blower volumes.

#### 4.4 Associated Gas Utilization in Community

Local community can be one of potential markets for an associated gas utilization project which can significantly help the local community to gain benefit from their local resource. The products of associated gas enhance development of community enterprises and reduce production cost. When fuel cost is decreased, community income increases. This also reduces the environmental problems cause



use of conventional fuels. In this study, the community enterprises chosen for gas utilization feasibility studies are a group making brass Buddha statues, and a group making food products from fruits and plants.

#### **4.4.1 Associated Natural Gas Utilization in Community Prospective Group**

##### **1. The group of making Buddha statues from brass**

Making Buddha statues from brass is handicraft that has been done for long time. This activity takes place in foundries. A brass foundry is considered an industrial factory as it requires factory registration. Presently (July 2006), there are 9 registered foundries. The main problem of the statue of Buddha foundries is the fuel used in process operations including brass melting and mold burning processes as shown in figure 4-8 – 4-9. The fuels used in the processes are used lubricant oil for brass melting and mold burning and firewood for mold burning.



Figure 4-8 Brass furnace by used lubricant oil



Figure 4-9 Brass melting by used lubricant oil fueled

Burning used lubricant oil in brass furnace causes environmental problems, Black smoke and dusts from the burning disturb nearby villagers. Furthermore, the dangerous components in lubricant oil such as mercury and sulfur compounds are released to the atmosphere causing air pollutions.

## 2. The group of making food products from fruits and plants

Five-star food products from fruits and plants (shown in figure 4-10) of the province are from more than 26 groups and 300 stoves. The main products are banana chips, taro chips, yam chips, and pumpkin chips. The conventional fuel used in the food production is only a 48-kg LPG for high daily usage. LPG is convenient and safe to use because LPG stoves are easy to adjust and control the heat, and the user is familiar with it as well. However, high consumption of gas leads to high expense and the increase of LPG price makes the expense higher. In addition, every house producing the products must have many LPG tanks so there are risks from explosion and fire.





Figure 4-10 Making food products from fruits and plants

#### 4.4.2 Criteria for Selecting Associated Gas Utilization in Prospective Community Groups

Specific criteria for selecting associated gas utilization in local community are considered for both of the aforementioned groups. There are many concerns such as fuel cost. The production cost increases because the LPG fuel price increases. For the Buddha statue making group, there is an environmental concern from smoke

generated by the use of lubricant oil as fuel. The food product making group needs to be considered for its safety when many LPG tanks stayed in households or accommodations. Therefore, the new fuel fashion should meet the criteria as follows:

1. The substitute fuel must be cheaper or at least not more expensive than the fuel currently used, especially LPG. Although substitution of used lubricant oil will cause higher expense, the group of making Buddha statue from brass will accept this point if the smoke and air pollution problems can be solved.

2. The substitute fuel must be user friendly that it is easy and convenient for the users. It is better if the using pattern does not change too much because these may cause the confusion and may damage the products.

3. The new fuel must provide realistic and continuous use, especially when new investment of equipment and long-term use are needed.

4. Safety criterion must also be met. Most users will be afraid and worried to use unfamiliar things, thus knowledge and understanding are needed to be taught.

#### **4.4.3 Opportunities for Associated Gas Utilization in Community**

By analyzing problem, opportunities, and possibilities, it can be concluded that the use of  $C_{5+}$ , which is by-product of LNG production to substitute LPG and used lubricant oil for the group of making Buddha statues from brass in the local community is possible.  $C_{5+}$  is a liquid hydrocarbon with low vapor pressure so it can be easily stored in LPG tank and have no danger for transporting to users. Furthermore, it is easy to use because the using pattern is quite similar to that of conventional fuels.

Another alternative is the possibility for the users near the gas production site. The users unified to be the group of making food product from fruits and plants, and built facility like a food production station. When the users unified as a group to build the food production station and have several gas burners, it is feasible to invest pipeline line to transport natural gas to the local community instead of using LPG.



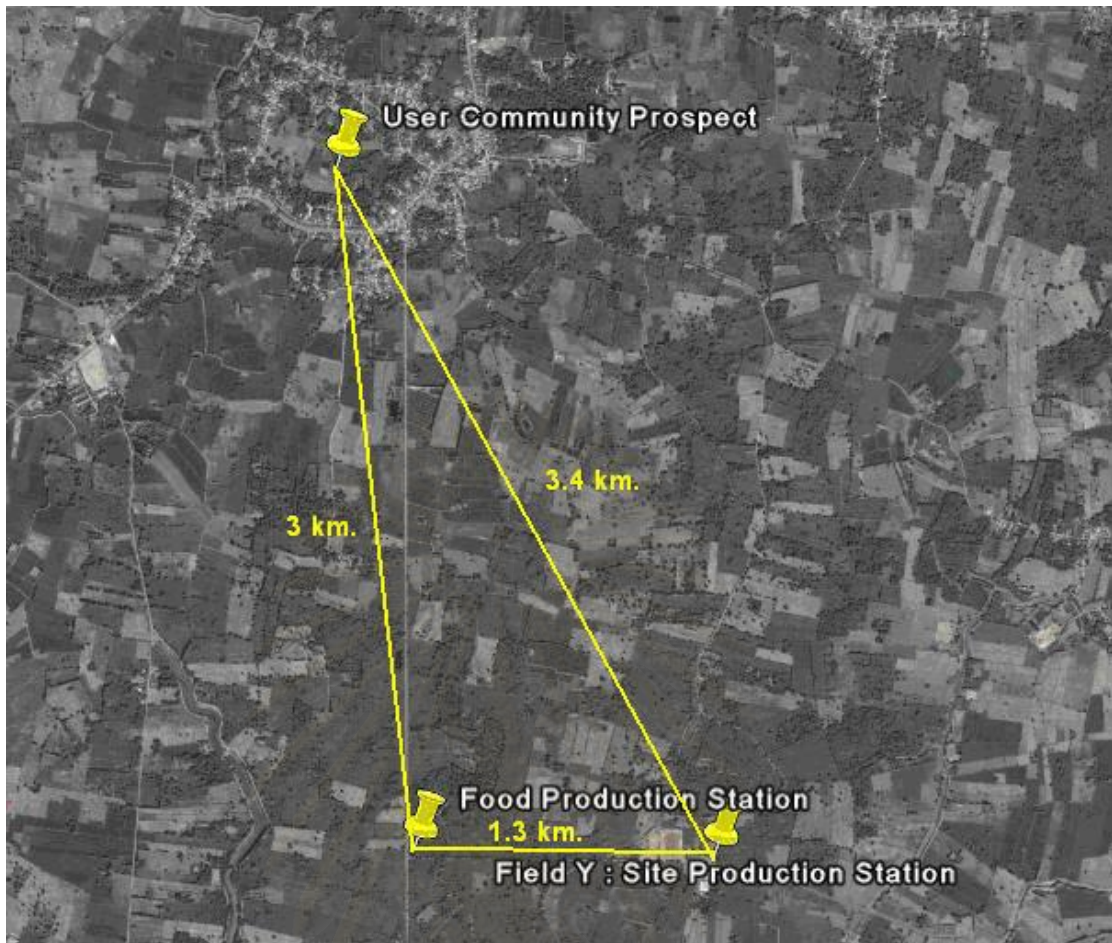


Figure 4-11 Location of the prospective user community and site production station of field Y

The above figure shows the example of location of gas pipeline to the food production station. The distance between the site production station and the location of the food production station should be in 3 km. range. The distance from site production station of field Y to the food production station is approximately 1.3 km. but from the site production station to the user community prospect is approximately 3.4 km.

# CHAPTER V

## ASSOCIATED GAS UTILIZATION

### FEASIBILITIES STUDY

Economic and financial analysis is the tools for the next stage of the study. We will investigate in detail on a site-specific basis. In this chapter, the qualitative field screening process is started. The candidates that pass this screening process will be further investigated in qualitative process to determine their associated gas reserves, and then screened by additional criteria. The production forecasts are also determined and financial analyses are performed. The social responsibilities evaluation is the last part of the chapter. The options of utilization of associated gas from the economic and financial analysis are also concluded. The overview of the chapter is shown as in figure 5-1.

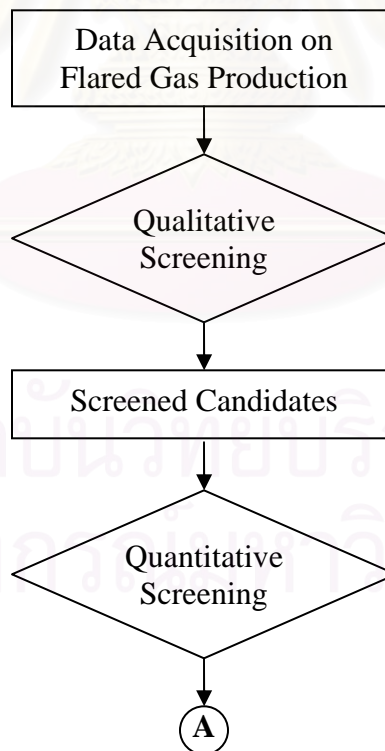


Figure 5-1 Feasibilities study overview



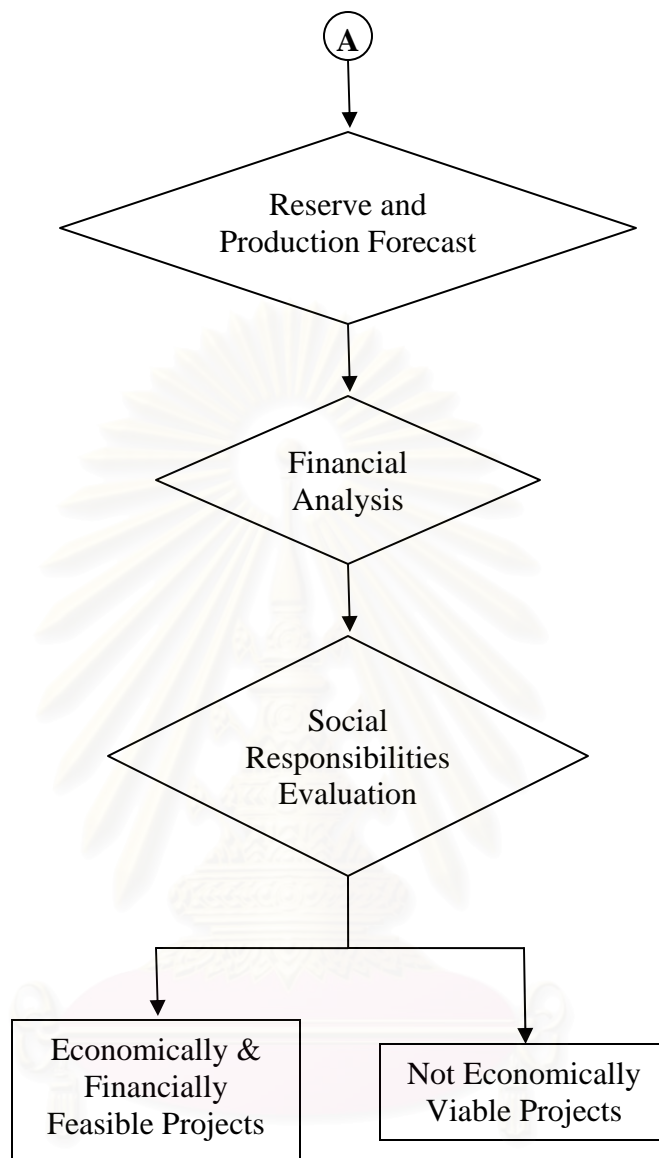


Figure 5-1 Feasibilities study overview (cont'd)

### 5.1 Qualitative Field Screening

Ideally, utilization of associated gas project from Thailand onshore oil field case would be evaluated one-by-one on a site-specific basis, assessing the costs and benefits of various utilization options against continuous flaring. However, since there are 14 fields in 189.6 sq. km. of total production area in Thailand onshore oil field case, this approach would entail a number of data acquisitions and detailed evaluations, which would be impractical.

Therefore, we have taken a structured screening approach in which we efficiently narrow down candidate fields to the most promising candidates for pilot utilization of associated gas projects by the set up criteria.

### **5.1.1 Qualitative Field Screening Criteria**

Qualitative screening sorts fields based on practical considerations such as:

- Volume of flaring
- Associated gas production volume
- Remaining associated gas reserves
- Whether associated gas production is already committed.

Furthermore, we approach fields of utilization of associated gas project as following:

1. All fields in Thailand onshore oil field case that do not show any gas productions are eliminated.
2. The remaining fields were identified in Thailand onshore oil field case. If they were connected to an existing gas pipeline, they were eliminated.
3. It was then assumed that all remaining fields, i.e. those with at least some gas production but not connected to gas pipelines, were flaring and that the amount of gas flared was equal to field production of associated gas since there was no reason for a field to flare non-associated gas. The total prospective field was then confirmed not to exceed the total gas production from these fields. This approach may over-estimate flaring at these fields because there is no way to identify possible use of this gas production from the available data.

### **5.1.2 Qualitative Screening of Candidate Fields by Pipeline Connected**

There are 304 production wells (September 2007) in 14 fields of Thailand onshore oil field cases. Some wells or fields will be screened out by above criteria for approaching the utilization prospects.

The first screening eliminates fields that were most likely connected to main production station by delivery pipelines. It was assumed that gas from these fields were

sold and not flared. Base on this criterion, 285 wells of 9 fields in the main production station area were eliminated. There are 19 wells remaining as shown in table 5-1.

Table 5-1 Remaining wells in Thailand onshore oil field case,  
pipeline connected screened out

No.	Well	Location
1	XX-01	Field X
2	YY-01	Field Y
3	YY-02	Field Y
4	YY-03	Field Y
5	YY-04	Field Y
6	YY-05	Field Y
7	YY-06	Field Y
8	YY-07	Field Y
9	YY-08	Field Y
10	YY-09	Field Y
11	YY-10	Field Y
12	YY-11	Field Y
13	ZZ-01	Field Z
14	ZZ-02	Field Z
15	ZZ-03	Field Z
16	ZZ-04	Field Z
17	ZZ-05	Field Z
18	ZZ-06	Field Z
19	ZZ-07	Field Z

## **5.2 Quantitative Field Screening**

Since amount of reserve and daily production of both oil and gas are 2 of the criteria to be considered and needed to be determined by this following step. At this stage, Decline Curve Analysis (DCA), Cumulative GOR vs.  $N_p$  diagnostic plot and probabilistic evaluation will be used for this purpose.

### **5.2.1 Methodology for Generating Production Forecast and Determining P2 Reserves**

Oil and gas production forecast of all remaining producing wells are planned to be considered. Then, all that wells will be considered for projects of associated gas utilization.

#### **5.2.1.1 Scope**

In this section, generating production forecast and determining P2 reserves will be performed at wellbore level by using Decline Curve Analysis (DCA), cumulative GOR vs.  $N_p$  diagnostic plots, and probabilistic evaluation using commercial software: Oil Field Manager (OFM) and @Risk.

Although this methodology could be applied for most of the existing wells, it is decided not to be applied for some cases as described below:

- New wells with insufficient information. For instance, wells have just completed drilling/workover operation and put on production for a month. In this case, production forecast and reserves of those particular wells will be taken from drilling/workover proposal.

- Wells that have already reached their limits (see 5.2.1.2 Assumptions). Although some of these wells are still producing from time to time, these wells are as considered nonproductive wells. This means that there is no production forecast to be generated from these wells.

### 5.2.1.2 Assumptions

To make the methodology more reliable, some assumptions have been made as described below:

#### Assumptions for Decline Curve Analysis (DCA) and Diagnostic Plots

1. All wells have their own boundaries without communication with other wells nearby. Opening/closing/adjusting choke size of each well will only have direct effect on that particular well.

- Production allocation at wellbore level is assumed to be reliable for the analysis. This assumption might not be valid in the case that split factor is highly inaccurate.

- Since the economic limit of the field in history is around 2 – 8 bpd range. Economic limit of oil production rate at wellbore level is set for low, mid, and high cumulative production cases are 8, 4, and 2 STB/D respectively as field practical used.

- Ending production time of the forecast is limited to be not over 31/12/2030 (end of production license is at 31/03/2031)

- Relationship between cumulative GOR and  $N_p$  is assumed to be a straight line over an entire range of the production forecast period. However, if the relationship from historical data shows negative slope, the slope to be used in the equation (see the calculation of Cumulative GOR vs.  $N_p$  diagnostic plot) will be assumed to be a zero. In other words, cumulative GOR at wellbore level will be assumed to be constant over the entire range of the forecast period. Furthermore, there is no limit of GOR to be applied at wellbore level.

#### Assumption for Probabilistic Evaluation

- Triangular distribution is assumed for reserves input into the Monte Carlo simulation.

### 5.2.1.3 Methodology

An overview of the methodology to generate the production forecast and determining P2 reserve is shown as follows:

Oil: Three cases (i.e. low, mid, and high) of oil production forecast at wellbore level are generated by extrapolating the curve fitted to selected historical data. The production history in this field mostly matches as exponential decline so low and mid

cases are generated by using exponential decline to determine reserve. The high case is generated by using harmonic decline because the harmonic decline can match to the production history and also generate more reserve than exponential decline. (Mohagheh, 2005)

Reserves of each case can be obtained from cumulative oil production since the starting time of production forecast until economic limit or production time limit depending on which limit is reached first. These reserves are then inputted into Monte Carlo simulation by using triangular distribution. After that, P2 reserves distribution will be generated. P2 reserves at 10<sup>th</sup> and 90<sup>th</sup> percentiles, and expectation, will be used for reporting purpose.

The expected value obtained from Monte Carlo simulation will be used for adjusting production forecast of the mid case. This means that monthly nominal decline rate of the mid case has to be adjusted in order to make the mid case reserves to be equal to the expected value.

Gas: Slope of diagnostic plot between cumulative GOR and Np is determined. The data used to create the plot have to be data from each well. With this slope and the last historical cumulative GOR of each well, gas production forecast can be generated at any point in time by using the equations for circulating Cumulative GOR vs. Np diagnostic plot. The parameters required in the equations can be obtained from the parts of historical data and oil production forecast. However, those values have to be the values at wellbore level.

The procedure to determine the production forecast and reserve of each well at the wellbore level is explained as follows:

1. Prepare basic information that is necessary for the analysis of well performance. This is the most important step for the analysis. Without good representative of historical data, the results from the analysis might be useless. This information consists of:

- 1) Production history
- 2) Wellhead information

2. Set up all necessary parameters in OFM software as follows.

- 1) Start Time should be set to “0 (zero) Month from End”
- 2) Start Rate should be set to “Last Historical Rate” or “Last Fit Rate”



3) End Time should be set to “Date 20301231”

4) End Rate to be set is already described in the assumptions. These options are needed to be set in order to make the analysis more consistent.

3. Plot  $Q_o$  (produced day) vs.  $N_p$  on normal scale. Generate production forecast and determine reserves of the low case by extrapolating from selected historical data to the economic limit or production time limit depending on which limit is reached first. Historical data to be selected will be in the period where the steepest decline is found. This will ensure that the reserves determined are the minimum reserves we could obtain from that well. The plots of results are shown in Appendix A-1.

4. Perform the same plot of  $Q_o$  (produced day) vs.  $N_p$  on normal scale, generate production forecast and determine reserves of the mid case by using the same procedure as the low case described in the previous step. At this time, however, historical data to be selected will be in the period where the overall decline of the current well performance is seen.

5. Construct the plot of  $Q_o$  (produced day) vs.  $N_p$  on semi-log scale. Generate production forecast and determine reserves of the high case by using the same procedure as mid case which is described in the previous step. Again, historical data to be selected will be in the period where overall decline of the current well performance is seen.

6. Input reserves determined from these three cases (i.e. low, mid, and high) into Monte Carlo simulation (@Risk software) by using triangular distribution. Run the simulation to obtain P2 reserves at 10<sup>th</sup>, and 90<sup>th</sup> percentiles, and the expected value. Before running the simulation, there are two parameters needed to be specified as follows:

1) Number of Iteration should be set to “1000”

2) Random Number Generator Seed should be set to “Fixed 1000”.

7. Adjust monthly nominal decline rate of the mid case until reserves are equal to P2 reserves at the expected value. This new monthly nominal decline rate and the starting average oil production rate of the mid case will be used for generating expectation profile of the production. And, this is the last step for oil production forecast at wellbore level. The detail adjusted nominal decline rate of mid case plots are presented in Appendix A-2.

8. Plot cumulative GOR vs.  $N_p$ , and then select historical data to determine slope of this relationship. It is recommended that the recent period of production should be selected

for determining the slope. This slope and the last historical cumulative GOR of each well will be used for generating gas production forecast by using equations described in the following section, Calculation of Cumulative GOR vs.  $N_p$  Diagnostic Plot. The detail plots of cumulative GOR vs.  $N_p$  from OFM software are available in Appendix A-3.

#### 5.2.1.4 Calculation of Cumulative GOR vs. $N_p$ Diagnostic Plot

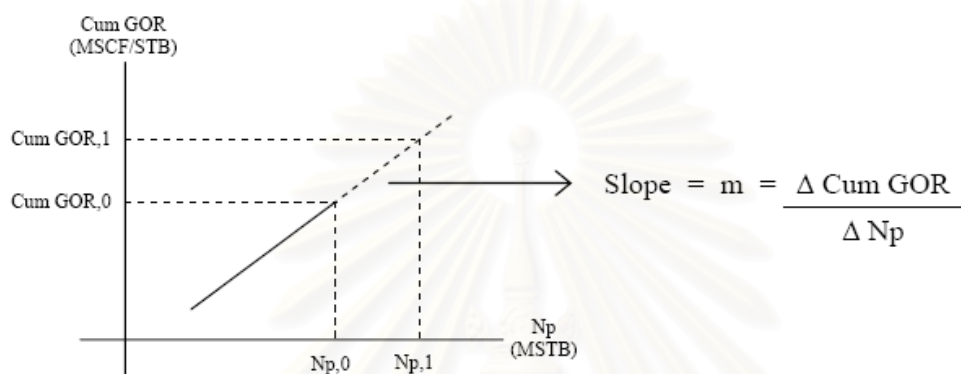


Figure 5-2 Cum GOR vs  $N_p$  relationship

$$m = \frac{\text{Cum GOR},1 - \text{Cum GOR},0}{N_{p,1} - N_{p,0}} \rightarrow \text{Cum GOR},1 = m (N_{p,1} - N_{p,0}) + \text{Cum GOR},0$$

$$\downarrow$$

$$\text{Cum GOR},t = m (N_{p,t} - N_{p,t-1}) + \text{Cum GOR},t-1 \quad (1)$$

$$\text{Cum GOR},1 = \frac{G_{p,1}}{N_{p,1}}$$

$$G_{p,1} = N_{p,1} \times \text{Cum GOR},1$$

↓

$$G_{p,t} = N_{p,t} \times \text{Cum GOR},t \dots\dots\dots (2)$$

$$Q_{g,1} = \left( \frac{G_{p,1} - G_{p,0}}{30.4} \right) \times 1,000$$

↓

$$Q_{g,t} = \left( \frac{G_{p,t} - G_{p,t-1}}{30.4} \right) \times 1,000 \dots\dots\dots (3)$$

Units;  $m$  : MSCF/STB/MSTB  
 Cum GOR : MSCF/STB  
 $G_p$  : MMSCF  
 $N_p$  : MSTB  
 $Q_g$  : MSCFD

As methodology described above, they can be concluded and presented as diagram in figure 5-3.

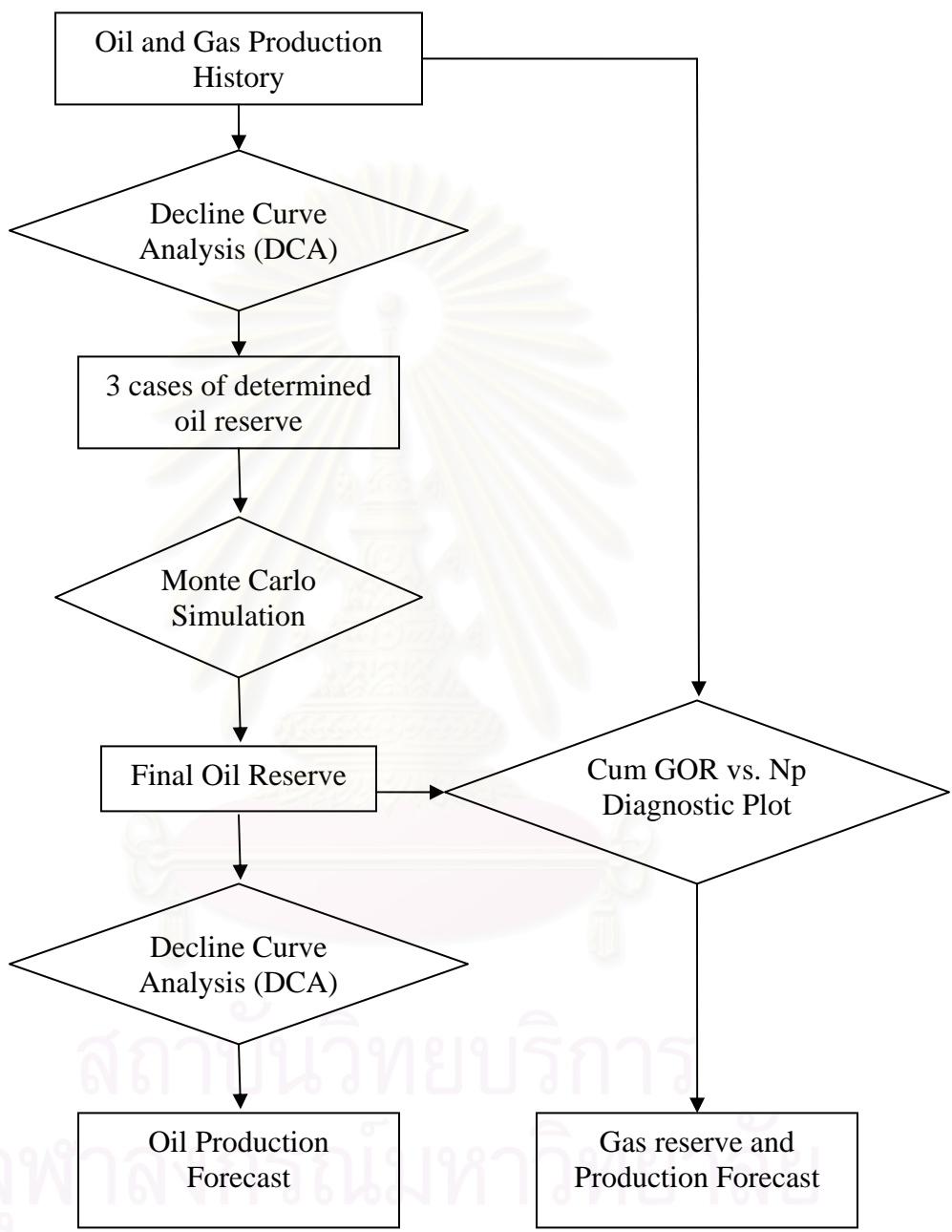


Figure 5-3 Oil and gas reserve and production forecast methodology overview

### 5.2.2 Reserve Results

The general results of 19 wells are shown in table 5-2 which consists of

- Reserves from all 3 cases (low, mid, and high)
- Monte Carlo Simulation (MCS) results
- Cumulative production and EUR
- Date reserve from adjusted mid case plots
- Slope and start cumulative GOR from cumulative GOR plots

Of the remaining 19 wells, additional 7 wells of field Z are eliminated due to their too small size, long distance from main production station, and split from the major part of the whole field as seen in figure 3-6. The crude oil and natural gas cannot be transferred from these wells via pipeline to the production station and it is uneconomic to invest gas transportation for this amount of reserves. Agree with the flared gas information in section 3.3.3, Associated Natural Gas Flared, daily flared gas is very small when compared with the other fields (X and Y). The average associated natural gas production is 20,000 cu. ft. per day. In addition, table 5-2 shows very small amount of oil reserve over the entire life of each well. Therefore, the associated natural gas is not enough to be developed using current technology of utilization alternatives.

There are now 12 wells in 2 oil fields (shown in table 5-3) to be considered as the candidates for associated gas utilization project.

Table 5-2 Reserve result of the remaining 21 wells, pipeline connected wells screened out

No.	Well	Location	OFM Result								MCS Result				
			Reserve (Oil)				Cum. Prod.	EUR	Date Reserve	Cumulative GOR		P2 Reserve (Oil)			
			Low Case	Mid Case	High Case	Average				Slope, m	Start Cum. GOR	Min.	Max.	Mean	Std Dev
			(MSTB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)	(MSCF/STB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)		
1	XX-01	Field X	692.80	692.80	1102.70	829.43	647.79	1523.32	12/31/2030	0.0052846	2.7667	723.33	1040.06	875.53	56.32
2	YY-01	Field Y	198.74	200.39	362.16	253.76	593.53	864.24	3/31/2015	0.0004859	1.46238	208.90	342.17	270.71	21.40
3	YY-02	Field Y	0.00	0.50	1.18	0.56	156.66	157.25	10/31/2007	0.0079251	1.18861	0.14	1.06	0.59	0.15
4	YY-03	Field Y	78.80	79.46	468.04	208.77	182.53	433.54	10/31/2014	0.0036565	1.16986	100.69	412.11	251.02	52.97
5	YY-04	Field Y	10.64	11.33	222.89	81.62	312.74	417.07	8/31/2019	0.0048422	0.906325	30.48	198.02	104.33	29.12
6	YY-05	Field Y	3.54	6.33	78.92	29.60	272.96	310.51	1/31/2013	0.001321	1.22788	11.51	70.12	37.55	10.34
7	YY-06	Field Y	44.55	45.35	196.83	95.58	603.43	715.81	10/31/2013	0.0030688	2.35698	47.60	176.10	112.38	21.08
8	YY-07	Field Y	18.41	20.24	121.78	53.48	169.00	234.25	2/28/2018	0.0238671	4.68371	27.23	109.82	65.25	14.26
9	YY-08	Field Y	10.79	11.22	85.66	35.89	17.79	61.56	10/31/2011	-0.064716	11.5281	15.71	79.11	43.78	10.47
10	YY-09	Field Y	2.28	2.40	25.31	9.99	15.45	27.95	7/31/2009	-0.058807	2.4503	3.88	23.32	12.50	3.15
11	YY-10	Field Y	1.32	1.45	73.56	25.44	38.73	72.71	10/31/2014	0.755543	7.41284	7.63	60.22	33.98	9.82
12	YY-11	Field Y	1.87	1.99	9.81	4.56	3.77	9.19	7/31/2008	0.677387	3.45189	2.42	8.81	5.42	1.10
13	ZZ-01	Field Z	0.39	0.39	20.33	7.04	42.10	51.30	6/30/2009	0.0003706	0.120016	2.19	18.07	9.20	2.68
14	ZZ-02	Field Z	3.74	4.52	53.78	20.68	22.58	48.69	1/31/2014	0.0024389	0.126972	7.90	48.03	26.11	6.58
15	ZZ-03	Field Z	0.00	0.00	0.36	0.12	9.69	9.85	8/31/2007	0.0009708	0.11612	0.02	0.31	0.16	0.05
16	ZZ-04	Field Z	0.83	1.44	64.11	22.13	225.34	254.50	8/31/2018	7.42E-06	0.105466	6.50	53.66	29.16	8.64
17	ZZ-05	Field Z	2.71	3.14	25.71	10.52	11.87	24.93	5/31/2010	0.003505	0.130638	4.40	22.64	13.07	3.07
18	ZZ-06	Field Z	0.25	0.57	4.20	1.67	2.44	4.48	5/31/2008	0.330492	0.705633	0.63	3.68	2.04	0.53
19	ZZ-07	Field Z	28.59	29.85	156.34	71.59	27.36	112.87	4/30/2016	-0.025629	0.270816	36.18	136.11	85.51	17.35

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Table 5-3 Oil and gas reserve of the remaining candidates

No.	Well	Location	OFM Result									MCS Result			
			Reserve (Oil)				Cum Prod.	EUR	Date Reserve	Cumulative GOR		P2 Reserve (Oil)			
			Low Case	Mid Case	High Case	Average				Slope, m	Start Cum. GOR	Min.	Max.	Mean	Std Dev
			(MSTB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)		(MSCF/STB)	(MSTB)	(MSTB)	(MSTB)	(MSTB)	
1	XX-01	Field X	692.80	692.80	1102.70	829.43	647.79	1523.32	12/31/2030	0.0052846	2.7667	723.33	1040.06	875.53	56.32
2	YY-01	Field Y	198.74	200.39	362.16	253.76	593.53	864.24	3/31/2015	0.0004859	1.46238	208.90	342.17	270.71	21.40
3	YY-02	Field Y	0.00	0.50	1.18	0.56	156.66	157.25	10/31/2007	0.0079251	1.18861	0.14	1.06	0.59	0.15
4	YY-03	Field Y	78.80	79.46	468.04	208.77	182.53	433.54	10/31/2014	0.0036565	1.16986	100.69	412.11	251.02	52.97
5	YY-04	Field Y	10.64	11.33	222.89	81.62	312.74	417.07	8/31/2019	0.0048422	0.906325	30.48	198.02	104.33	29.12
6	YY-05	Field Y	3.54	6.33	78.92	29.60	272.96	310.51	1/31/2013	0.001321	1.22788	11.51	70.12	37.55	10.34
7	YY-06	Field Y	44.55	45.35	196.83	95.58	603.43	715.81	10/31/2013	0.0030688	2.35698	47.60	176.10	112.38	21.08
8	YY-07	Field Y	18.41	20.24	121.78	53.48	169.00	234.25	2/28/2018	0.0238671	4.68371	27.23	109.82	65.25	14.26
9	YY-08	Field Y	10.79	11.22	85.66	35.89	17.79	61.56	10/31/2011	-0.064716	11.5281	15.71	79.11	43.78	10.47
10	YY-09	Field Y	2.28	2.40	25.31	9.99	15.45	27.95	7/31/2009	-0.058807	2.4503	3.88	23.32	12.50	3.15
11	YY-10	Field Y	1.32	1.45	73.56	25.44	38.73	72.71	10/31/2014	0.755543	7.41284	7.63	60.22	33.98	9.82
12	YY-11	Field Y	1.87	1.99	9.81	4.56	3.77	9.19	7/31/2008	0.677387	3.45189	2.42	8.81	5.42	1.10

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### 5.3 Production Forecast

The production forecasts are generated for the purpose of generating revenue in the financial analysis. In this study, three cases of production forecast will be considered:

- Case 1: Oil reserve from MCS with constant cumulative GOR
- Case 2: Oil reserve from MCS with increasing cumulative GOR
- Case 3: Oil reserve from harmonic decline with increasing cumulative GOR

The 3 cases of reserve and production forecast come from the considerations of risk. The 3 cases are looked at from 3 points of view, most optimistic, moderate, and most pessimistic.

In this stage, reserve and production forecast calculation will be shown in field level because the associated gas will be utilized field by field. Although the data are shown on field scale, background calculations are executed by well level. The detail calculations of all 3 cases are presented in Appendix A as previously described. The shown reserves are the reserve at the date of July 1, 2007 which is the 26<sup>th</sup> year of field development period.

#### 5.3.1 Result of Case 1: Oil Reserve from MCS with Constant Cumulative GOR

Table 5-4 shows the oil and gas reserve of case 1: oil reserve from MCS with constant cumulative GOR of the field X and field Y by individual wells. Figure 5-4 and 5-5 shows the production forecast of case 1: oil reserve from MCS with constant cumulative GOR of the field X and field Y respectively.

Table 5-4 Field X and field Y – Oil and gas reserve of case 1: Oil reserve from MCS with constant cumulative GOR

No.	Well	OFM Result											Calculation				
		Cum. Prod. (MSTB)	Cum. Date (Day = 0)	Qo,l (BPD)	EUR (MSTB)	Reserve Date (t)	Reserve (MCS) (MSTB)	GOR Plot			Qo,t (BPD)	Gp,l (MMSCF)	Qg,l (MSCFD)	Cum GOR,t (MSCF/STB)	Gp,t (MMSCF)	Gas Reserve (MMSCF)	Qg,avg (MSCFD)
								Slope, m	Cum GOR,l (MSCF/STB)								
1	XX-01	647.79	6/30/2007	290.78	1523.324	12/31/2030	875.534	0.0052846	2.7667	20.5495	1792.2406	1,573.22	2.7667	4,214.58	2,422.34	282.16	
2	YY-01	593.529	6/30/2007	462.88	864.2367	3/31/2015	270.7077	0.0004859	1.46238	3.81372	867.96494	1,782.32	1.4624	1,263.84	395.88	139.84	
3	YY-02	156.661	5/31/2007	7.55353	157.2485	10/31/2007	0.5875045	0.0079251	1.18861	3.58962	186.20883	52.05	1.1886	186.91	0.70	4.56	
4	YY-03	182.526	6/30/2007	449.075	433.5431	10/31/2014	251.0171	0.0036565	1.16986	3.878	213.52987	1,927.60	1.1699	507.1847	293.65	109.57	
5	YY-04	312.742	5/31/2007	71.928	417.0743	8/31/2019	104.3323	0.0048422	0.906325	3.93316	283.44589	184.1834	0.9063	378.0049	94.56	21.13	
6	YY-05	272.964	6/30/2007	51.6109	310.51149	1/31/2013	37.54749	0.001321	1.22788	3.93597	335.16704	38.883	1.2279	381.2708	46.10	22.58	
7	YY-06	603.43	6/30/2007	193.162	715.8069	10/31/2013	112.3769	0.0030688	2.35698	3.92253	1422.2724	917.4886	2.3570	1,687.14	264.87	114.41	
8	YY-07	169.002	6/30/2007	44.5215	234.25205	2/28/2018	65.25005	0.0238671	4.68371	3.96095	791.55636	483.5074	4.6837	1,097.17	305.61	78.44	
9	YY-08	17.7851	7/31/2006	91.1163	61.56318	10/31/2011	43.77808	-0.064716	11.5281	3.89639	205.02841	1391.172	11.5281	709.71	504.68	263.13	
10	YY-09	15.4508	5/31/2007	44.6	27.94765	7/31/2009	12.49685	-0.058807	2.4503	3.81573	37.859095	3.47	2.4503	68.48	30.62	38.66	
11	YY-10	38.7297	9/30/2004	29.2874	72.70686	10/31/2014	33.97716	0.755543	7.41284	3.98515	287.09707	-	7.4128	538.96	251.87	68.39	
12	YY-11	3.76977	6/30/2007	33.9397	9.187168	7/31/2008	5.417398	0.677387	3.45189	3.78306	13.012831	174.5148	3.4519	31.71	18.70	47.10	

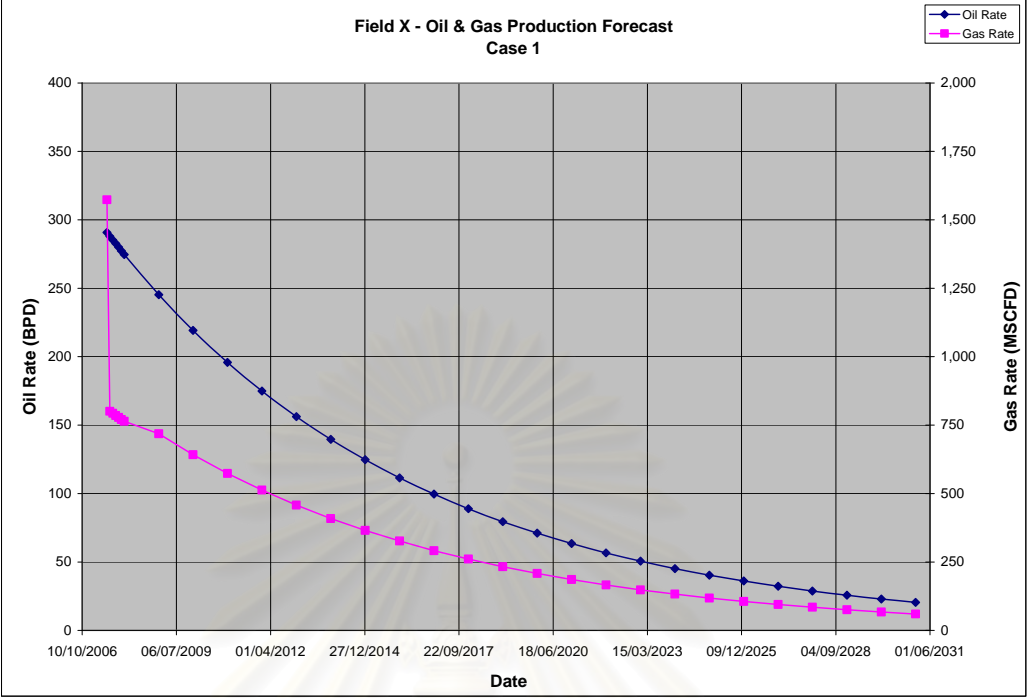


Figure 5-4 Oil and gas production forecast of field X, Case 1: Oil reserve from MCS with constant cumulative GOR

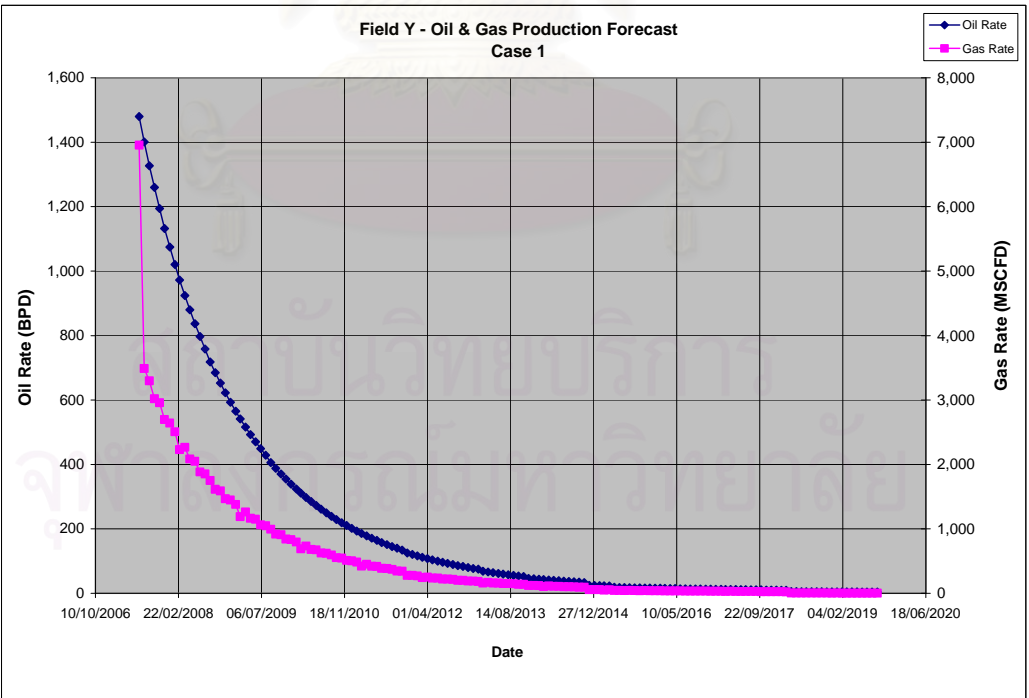


Figure 5-5 Oil and gas production forecast of field Y, Case 1: Oil reserve from MCS with constant cumulative GOR

### 5.3.2 Result of Case 2: Oil Reserve from MCS with Increasing Cumulative GOR

Table 5-5 shows the oil and gas reserve of case 2: oil reserve from MCS with increasing cumulative GOR of the field X and field Y by individual wells. Figure 5-6 and 5-7 are shown the production forecast of case 2: oil reserve from MCS with increasing cumulative GOR of the field X and field Y respectively.



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Table 5-5 Field X and field Y – Oil and gas reserve of case 2: Oil reserve from MCS with increasing cumulative GOR

No.	Well	OFM Result											Calculation				
		Cum. Prod. (MSTB)	Cum. Date (Day = 0)	Qo,l (BPD)	EUR (MSTB)	Reserve Date (t)	Reserve (MCS) (MSTB)	GOR Plot			Qo,t (BPD)	Gp,l (MMSCF)	Qg,l (MSCFD)	cumGOR,t (MSCF/STB)	Gp,t (MMSCF)	Gas Reserve (MMSCF)	Qg,avg (MSCFD)
								Slope, m	cumGOR,l (MSCF/STB)								
1	XX-01	647.79	6/30/2007	290.78	1523.324	12/31/2030	875.534	0.0052846	2.7667	20.5495	1792.2406	1,573.22	7.3935	11,262.70	9,470.46	1,103.14	
2	YY-01	593.529	6/30/2007	462.88	864.2367	3/31/2015	270.7077	0.0004859	1.46238	3.81372	867.96494	1,782.32	1.5939	1,377.52	509.56	179.99	
3	YY-02	156.661	5/31/2007	7.55353	157.2485	10/31/2007	0.5875045	0.0079251	1.18861	3.58962	186.20883	52.05	1.1933	187.64	1.43	9.35	
4	YY-03	182.526	6/30/2007	449.075	433.5431	10/31/2014	251.0171	0.0036565	1.16986	3.878	213.52987	1,927.60	2.0877	905.10532	691.58	258.05	
5	YY-04	312.742	5/31/2007	71.928	417.0743	8/31/2019	104.3323	0.0048422	0.906325	3.93316	283.44589	184.1834	1.4115	588.70904	305.26	68.22	
6	YY-05	272.964	6/30/2007	51.6109	310.51149	1/31/2013	37.54749	0.001321	1.22788	3.93597	335.16704	38.883	1.2775	396.67194	61.50	30.12	
7	YY-06	603.43	6/30/2007	193.162	715.8069	10/31/2013	112.3769	0.0030688	2.35698	3.92253	1422.2724	917.4886	2.7018	1,934.00	511.73	221.05	
8	YY-07	169.002	6/30/2007	44.5215	234.25205	2/28/2018	65.25005	0.0238671	4.68371	3.96095	791.55636	483.5074	6.2410	1,461.98	670.42	172.08	
9	YY-08	17.7851	7/31/2006	91.1163	61.56318	10/31/2011	43.77808	-0.064716	11.5281	3.89639	205.02841	1391.172	11.5281	709.71	504.68	263.13	
10	YY-09	15.4508	5/31/2007	44.6	27.94765	7/31/2009	12.49685	-0.058807	2.4503	3.81573	37.859095	3.47	2.4503	68.48	30.62	38.66	
11	YY-10	38.7297	9/30/2004	29.2874	72.70686	10/31/2014	33.97716	0.755543	7.41284	3.98515	287.09707	-	33.0840	2,405.44	2,118.34	575.17	
12	YY-11	3.76977	6/30/2007	33.9397	9.187168	7/31/2008	5.417398	0.677387	3.45189	3.78306	13.012831	174.5148	7.1216	65.43	52.41	132.03	



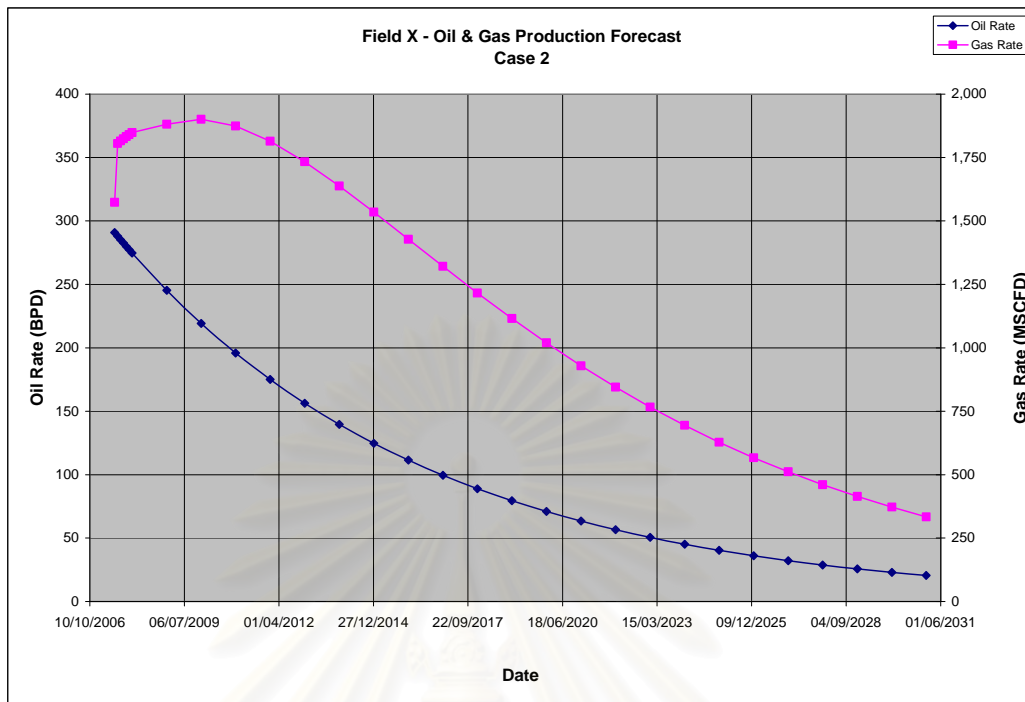


Figure 5-6 Oil and gas production forecast of field X,  
Case 2: Oil reserve from MCS with increasing cumulative GOR

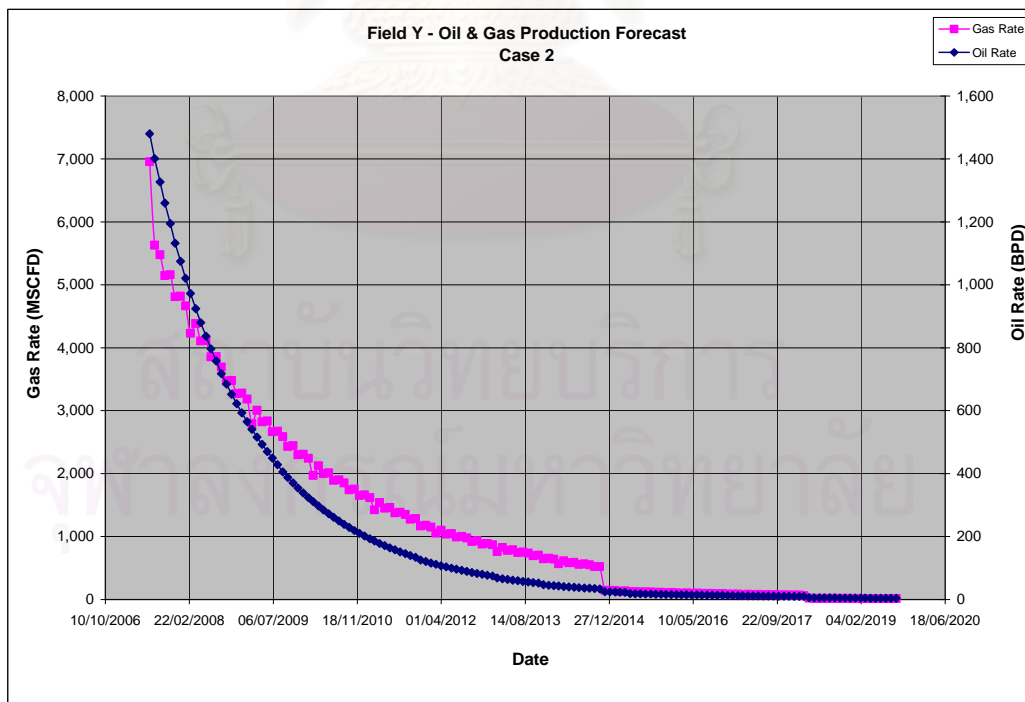


Figure 5-7 Oil and gas production forecast of field Y,  
Case 2: Oil reserve from MCS with increasing cumulative GOR

### 5.3.3 Result of Case 3: Oil Reserve from Harmonic Decline with Increasing Cumulative GOR

Table 5-6 is shown the oil and gas reserve of case 3: oil reserve from harmonic decline with increasing cumulative GOR of the field X and field Y by individual wells. Figure 5-8 and 5-9 shows the production forecast of case 3: oil reserve from harmonic decline with increasing cumulative GOR of the field X and field Y respectively.



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Table 5-6 Field X and field Y – Oil and gas reserve of case 3: Oil reserve from harmonic decline  
with increasing cumulative GOR

No.	Well	OFM Result											Calculation						
		Cum. Prod.	Cum. Date	Qo,l	EUR	Reserve Date	Reserve (MCS)	GOR Plot			Qo,t	Gp,l	Qg,l	cumGOR,t	Gp,t	Gas			
								Slope, m	cumGOR,l	Qo,t						Gp,t	Qg,t	Reserve	Qg,avg
(MSTB)	(Day = 0)	(BPD)	(MSTB)	(t)	(MSTB)							(MSCF/STB)	(MMSCF)	(MMSCF)	(MSCFD)				
1	XX-01	647.79	6/30/2007	290.78	1750.49	12/31/2030	1102.7	0.0052846	2.7667	67.5543	1792.2406	1,573.22	8.5940	15,043.66	13,251.42	1,543.56			
2	YY-01	593.529	6/30/2007	462.88	955.685	12/31/2030	362.156	0.0004859	1.46238	11.0166	867.96494	1,782.32	1.6384	1,565.75	697.78	81.28			
3	YY-02	156.661	5/31/2007	7.55353	157.84334	5/31/2008	1.18234	0.0079251	1.18861	1.91356	186.20883	52.05	1.1980	189.09	2.88	7.88			
4	YY-03	182.526	6/30/2007	449.075	650.566	12/31/2030	468.04	0.0036565	1.16986	15.6846	213.52987	1,927.60	2.8812	1874.43	1,660.90	193.47			
5	YY-04	312.742	5/31/2007	71.928	535.636	12/31/2030	222.894	0.0048422	0.906325	12.1244	283.44589	184.1834	1.9856	1063.5684	780.12	90.55			
6	YY-05	272.964	6/30/2007	102.806	351.8864	12/31/2030	78.9224	0.001321	1.22788	2.38662	335.16704	38.883	1.3321	468.75988	133.59	15.56			
7	YY-06	603.43	6/30/2007	193.162	800.261	12/31/2030	196.831	0.0030688	2.35698	6.54372	1422.2724	917.4886	2.9610	2,369.59	947.32	110.35			
8	YY-07	169.002	6/30/2007	44.5215	290.782	12/31/2030	121.78	0.0238671	4.68371	6.18988	791.55636	483.5074	7.5902	2,207.11	1,415.55	164.89			
9	YY-08	17.7851	7/31/2006	63.4631	103.443	12/31/2030	85.6579	-0.064716	11.5281	3.16054	205.02841	1391.172	11.5281	1,192.50	987.47	110.72			
10	YY-09	15.4508	5/31/2007	44.6	40.756	2/28/2018	25.3052	-0.058807	2.4503	1.99766	37.859095	3.47	2.4503	99.86	62.01	15.79			
11	YY-10	38.7297	9/30/2004	29.2874	112.2849	12/31/2030	73.5552	0.755543	7.41284	3.57723	287.09707	-	62.9870	7,072.48	6,785.39	707.70			
12	YY-11	3.76977	6/30/2007	33.9397	13.58432	12/31/2011	9.81455	0.677387	3.45189	1.97608	13.012831	174.5148	10.1001	137.20	124.19	75.50			

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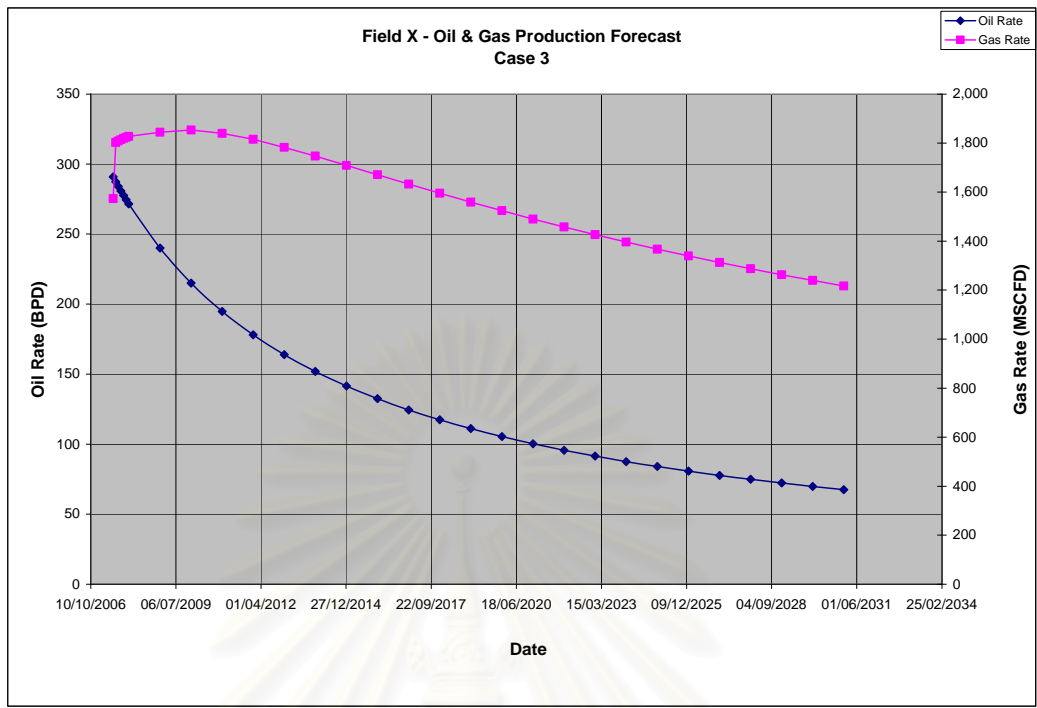


Figure 5-8 Oil and gas production forecast of field X, Case 3: Oil reserve from harmonic decline with increasing cumulative GOR

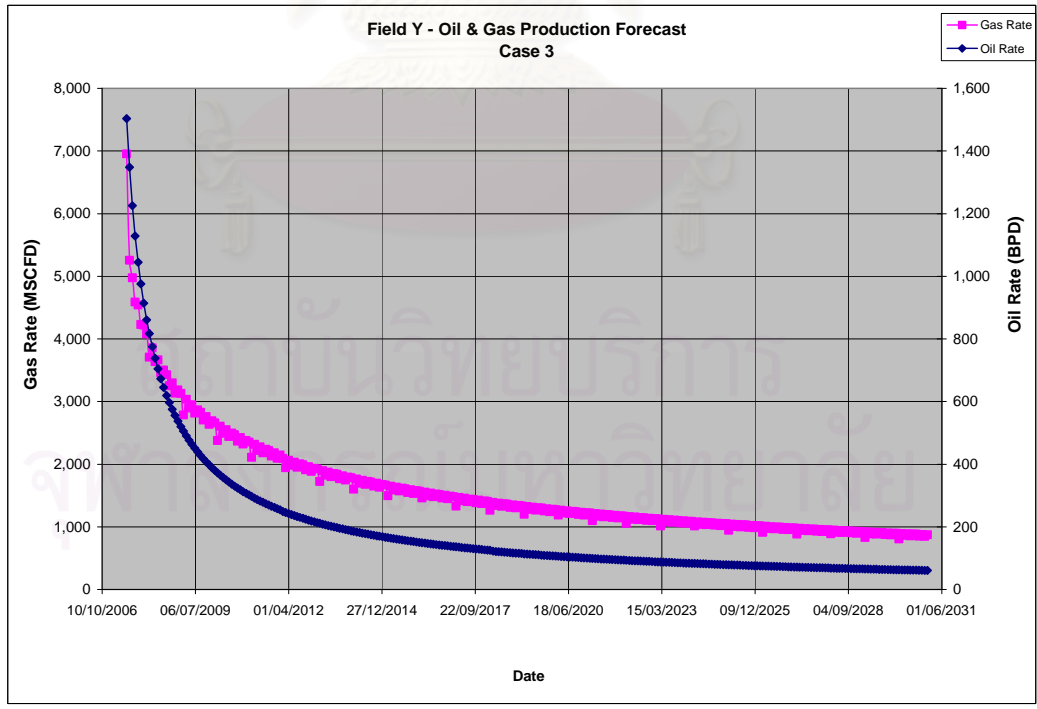


Figure 5-9 Oil and gas production forecast of field Y, Case 2: Oil reserve from harmonic decline with increasing cumulative GOR

Reserve and production forecast from harmonic decline in Case 3 show higher reserve than exponential decline in case 1 and 2 for both field. The production forecasts maintain at higher rate with longer period as follow the characteristic of harmonic decline. The field X shows higher reserve and daily production forecast than field Y which is consistent with production histories as shown in figures in Appendix A-1.

Hence, field X should give a better result of financial analysis than field Y for the option that needs a large amount of LNG. When small amount of gas is needed, the options of using gas for power generation and gas to local community should give close results of financial analysis for both fields.

#### **5.4 Financial Analysis**

The financial analysis is run for both 2 fields, X and Y, for all 3 cases of reserve and production forecast. In addition, sensitivity analysis of gas sale price and second product sale price are determined except for power price because of the fixed price from the buyer, Energy Policy and Planning Office (EPPO). The financial analysis is divided into 2 sections based on type of operator as:

- Single operator where gas owners operate each option's operations and business on their own. So the cash flow analysis is based on petroleum business. For the cash flow analysis of associated gas utilization of gas to the community, this option is assumed to be single-operator option.

- Separate between gas seller and option or business operator. So the cash flow analysis is based on petroleum business for gas seller, but the cash flow analysis of the option or business operator is based on ordinary juristic person. The operation period between two side of gas producer and gas buyer are related and considered. If the gas buyer stops producing the second product of associated gas, that means the gas seller cannot sell the associated gas too. Consequently, if the gas seller stops the associated gas production, the gas buyer has no raw material to supply, then the second production stopped too.

So the analysis will be presented into 3 scenarios:

- 1) Petroleum business basis which consists of all 3 options of 3 cases from both fields by single operator.



2) Power generation which consisted of all 3 cases from both fields by gas seller and power producer.

3) LNG which consisted of all 3 cases from both fields by gas seller and LNG producer.

Moreover, the power generation option may still show a large amount of gas flared. So we try to maximize the associated gas utilization by power generation option and minimize flared gas. The result will include the optimum power capacity generated from gas available from each field from Case 3: harmonic decline with increasing cumulative GOR.

#### 5.4.1 Assumptions

To make the analysis more reliable, some assumptions have been made as described below:

##### Power generation option

- Capital expenses are 10 million baht for pipeline, and 62 million baht for power generation facility for 2 power generator sets as of field practice.
- Operation and maintenance expense are assumed to be constant, and are 0.5 million baht per year as of field practice. Although being run at less than full the capacity, they are still needed to maintenance.
- Gas consumption of power generator is 200 Mscfd per each set of 1 MW generator.
- Stop 1 set of power generator when daily gas supply does not reach 0.2 MMscfd of each 1 MW
- Gas price 26 baht/MMBTU (Source: [www.egat.co.th](http://www.egat.co.th), March 17,2008)
- Power price 2.11 baht/kW (Source: [www.egat.co.th](http://www.egat.co.th), March 17,2008)
- Working day 365 days/year
- Depreciation: Straight line 10% for petroleum business basis and straight line over project life for the others.

### LNG option

- Capital expenses are 10 million baht for pipeline, 240 million baht for whole LNG production facility as of field practice.
- Transport O&M + insurance as % of capital cost: 10% (Source: GGFR, World Bank Group, 2006)
- Liquefaction O&M as % of capital cost: 3% (Source: GGFR, World Bank Group, 2006)
- 1 MMscfd of gas feed to LNG production gives 10 tons/day of LNG, 6 tons/day of C<sub>2+</sub>, and 425 kg/day of NGL as of field practice. Proportion can be applied.
- Production capacity as 20 tons/day of LNG, 12 tons/day of C<sub>2+</sub>, and 850 kg/day of NGL as of field practice
- LNG price 10.34 baht/kg (Witsarut *et al*, 2007)
- C<sub>2+</sub> price 15 baht/kg to competitive with LPG @ 18.33 baht/kg: LPG price of LPG as of Jan 30, 2008
- NGL price 15 baht/lit to be competitive with bunker oil @ 15.5162 baht/lit
- Working day 350 days/year
- Density of NGL 0.645 kg/lit @ 60 °F (Source: www.adnankhawaja.com)
- Depreciation: Straight line 10 % for petroleum business basis, but straight line over project life for the others

### Gas to community option

- Capital expense is 58 million baht for pipeline and facilities as of field practice
- Operation expense is 0.045 million baht per year of field practice
- Heating value of LPG 44,000 BTU/kg
- LPG price as of Jan 30, 2008: 48-kg cylinder of LPG is 880 baht, 18.33 baht/kg. So LPG price is 416.67 baht/MMBTU
- Gas sale price is half of LPG price
- Gas price 208.33 baht/MMBTU from half of LPG price
- Overall heating value required 105.75 MMBTU/day (Calculated from LPG used as conventional fuel)
- Associated gas heating value 1,340.83 BTU/cu. ft. (Witsarut *et al*, 2007)

- Associated gas required 78,868.1 scfd @ 60% stove daily usage
- Working day of 261 days/year as office working day
- Area of the factory making food products from fruits and plants is 19,200 m<sup>2</sup> with 240 stoves
- Although gas daily production < daily gas use, annual gas available > annual gas sale because annual gas available are from 365 days but annual gas sales are from 261 working days.
- Depreciation: Straight line 10 % for petroleum business basis, but straight line over project life for the others

The discounting rate for projects in emerging economies is country specific and is normally given by the local planning agency or Ministry of Finance. The Bank generally estimates the discounting rate at between 10 and 12 percent per year in emerging economies. A discounting rate of 10 percent per year has been used for this study (GGFR, World Bank Group, 2004). The period of facility construction is assumed to be 1 year for every option (GGFR, World Bank Group, 2006)

## **5.4.2 Financial Analysis Result**

The results of financial analysis are shown by each scenario with field and option in the plots of cumulative net cash flow and sensitivity analysis of product sale price. Each plot shows 3 cases of production forecast. Cumulative net cash flow plots present the payback period at the time interception and slopes of the plot imply the annual net cash flow. While sensitivity plots present the product sale price that makes the project economical. In addition, the plots also present the optimum associated gas supply capacity of the power generation for the combined cases. The detail calculations of financial analysis are available in Appendix B.

### **5.4.2.1 Petroleum business basis scenario**

The plots of petroleum business basis scenario by 3 options, power generation, LNG, and gas to community option relatively are shown. The power generation option is shown in figure 5-10 – 5-11. The LNG option is shown in figure 5-12 – 5-15. The gas to community option is shown in figure 5-16 – 5-21.

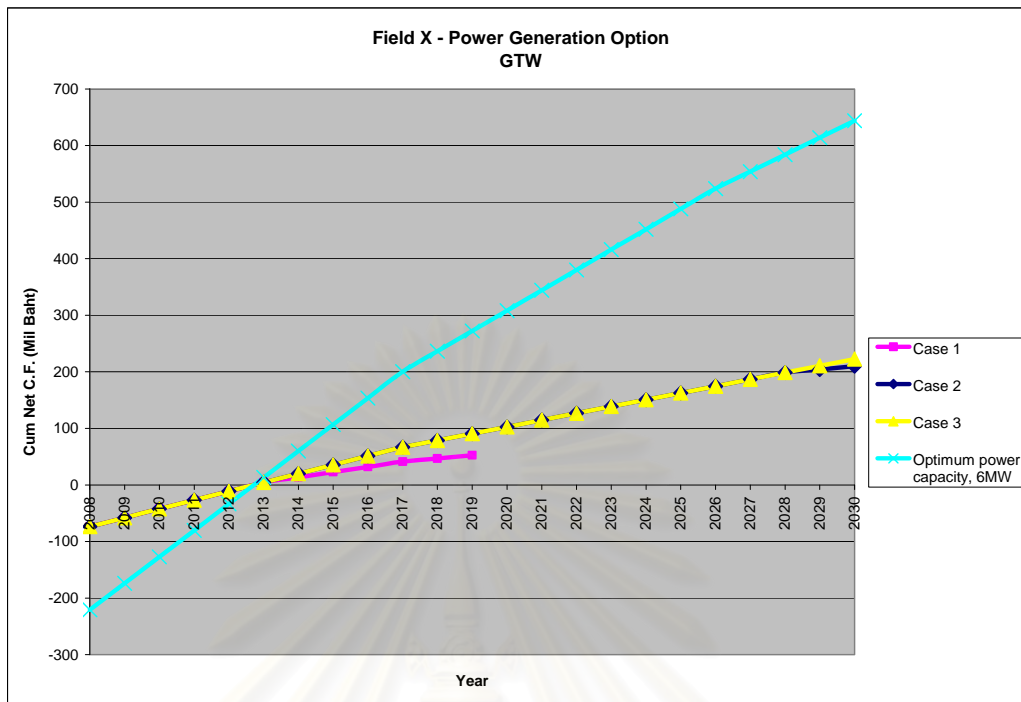


Figure 5-10 Cumulative net cash flow of power generation option of field X:  
Single operator (GTW)

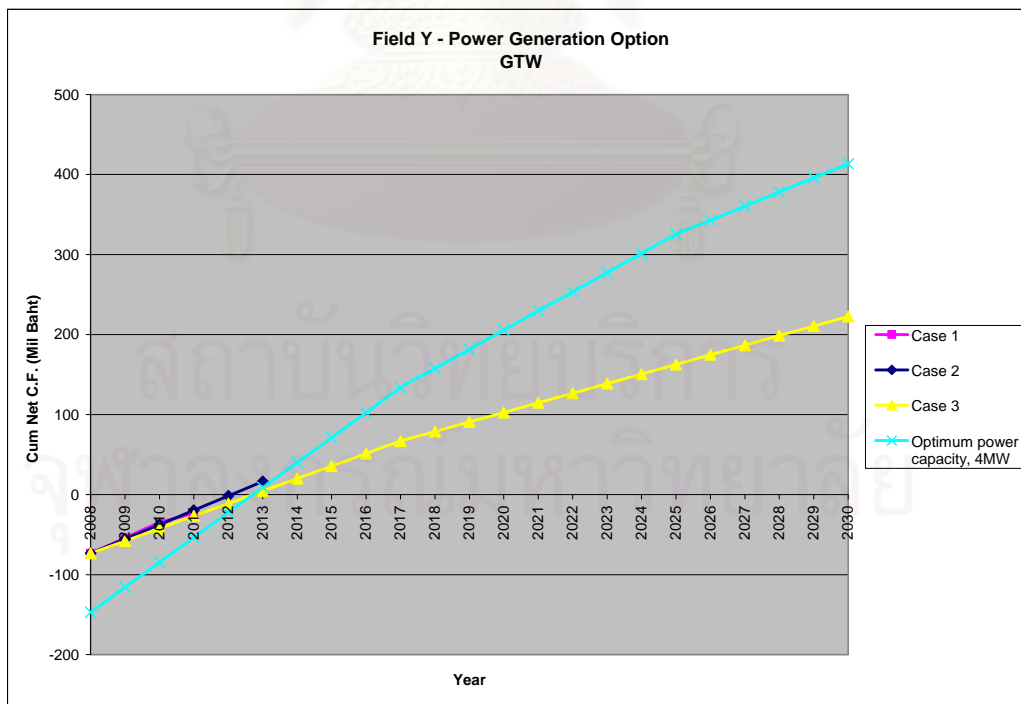


Figure 5-11 Cumulative net cash flow of power generation option of field Y:  
Single operator (GTW)

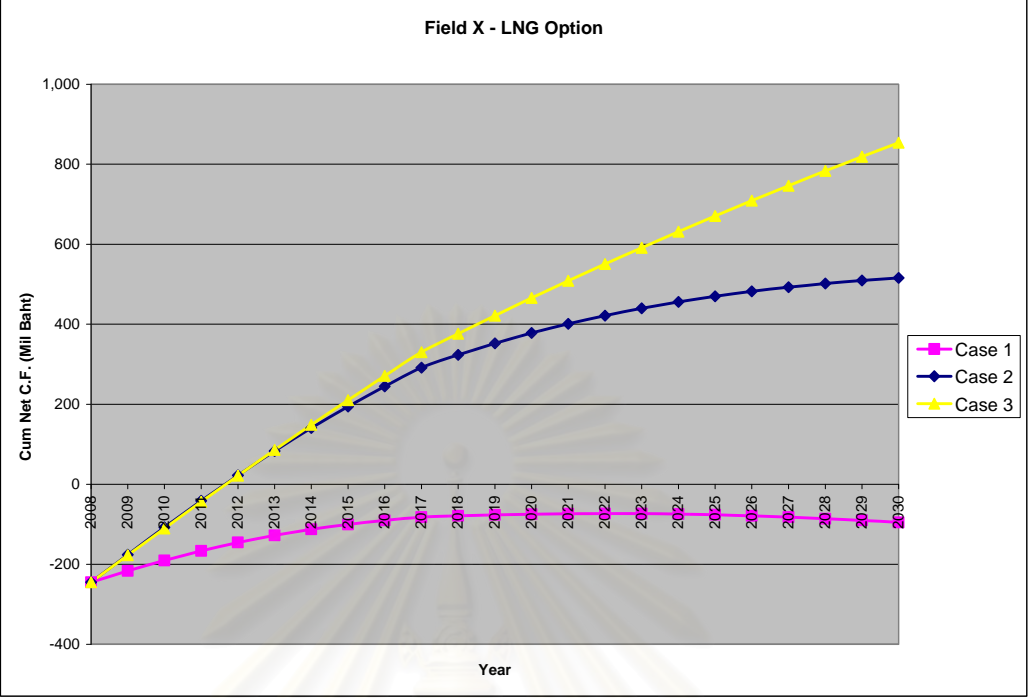


Figure 5-12 Cumulative net cash flow of LNG option of field X:  
Single operator (LNG project)

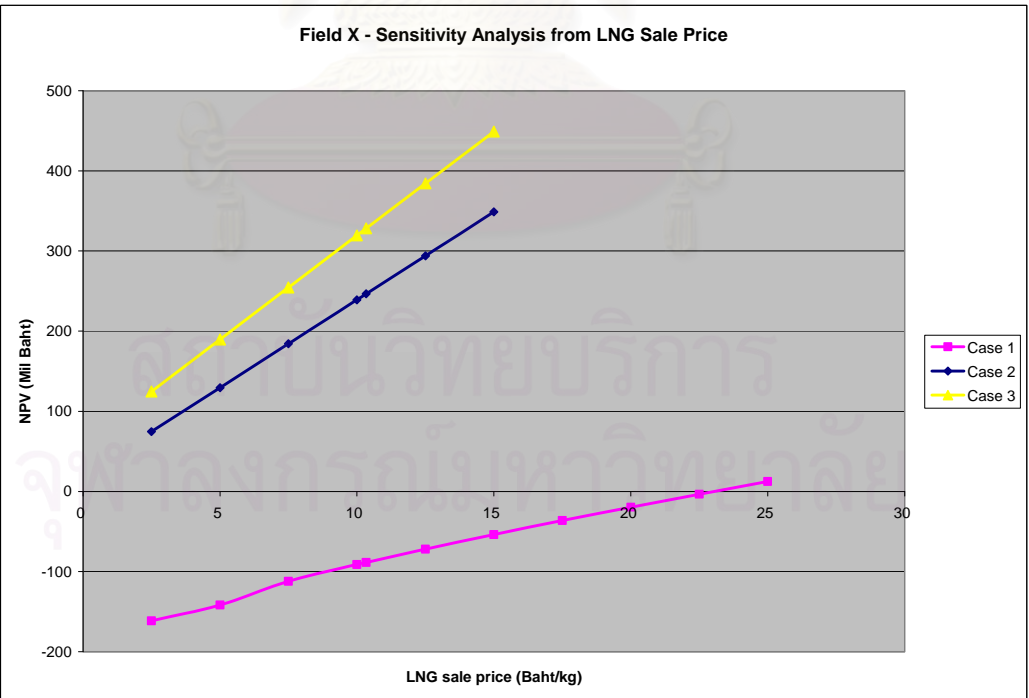


Figure 5-13 Sensitivity of LNG sale price of LNG option of field X:  
Single operator (LNG project)



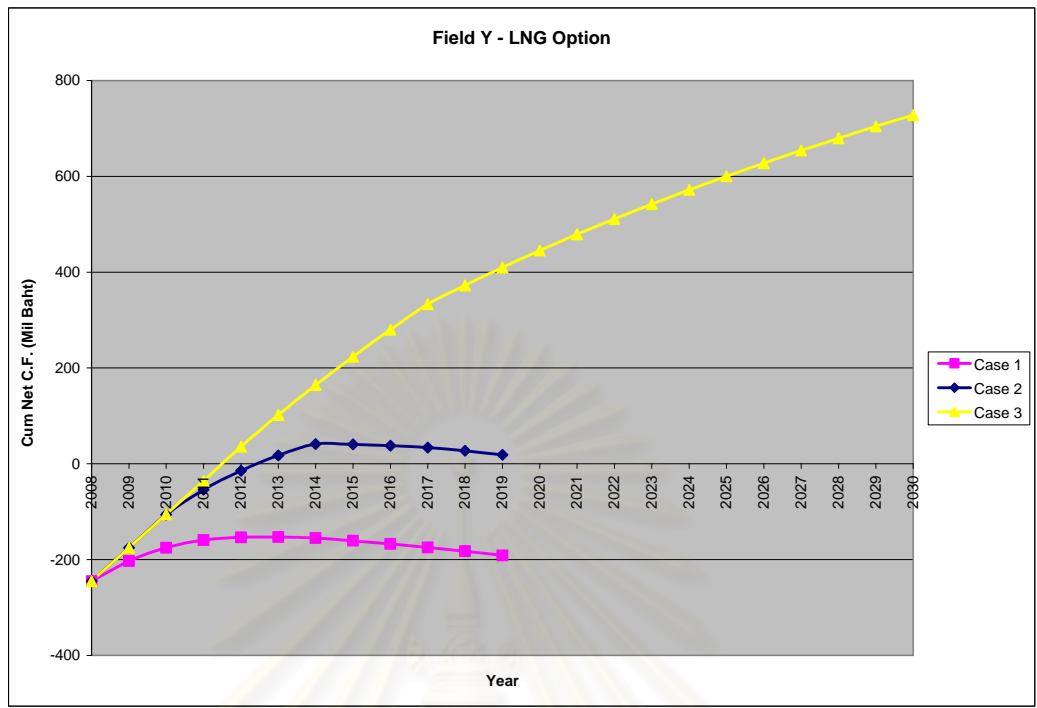


Figure 5-14 Cumulative net cash flow of LNG option of field Y:  
Single operator (LNG project)

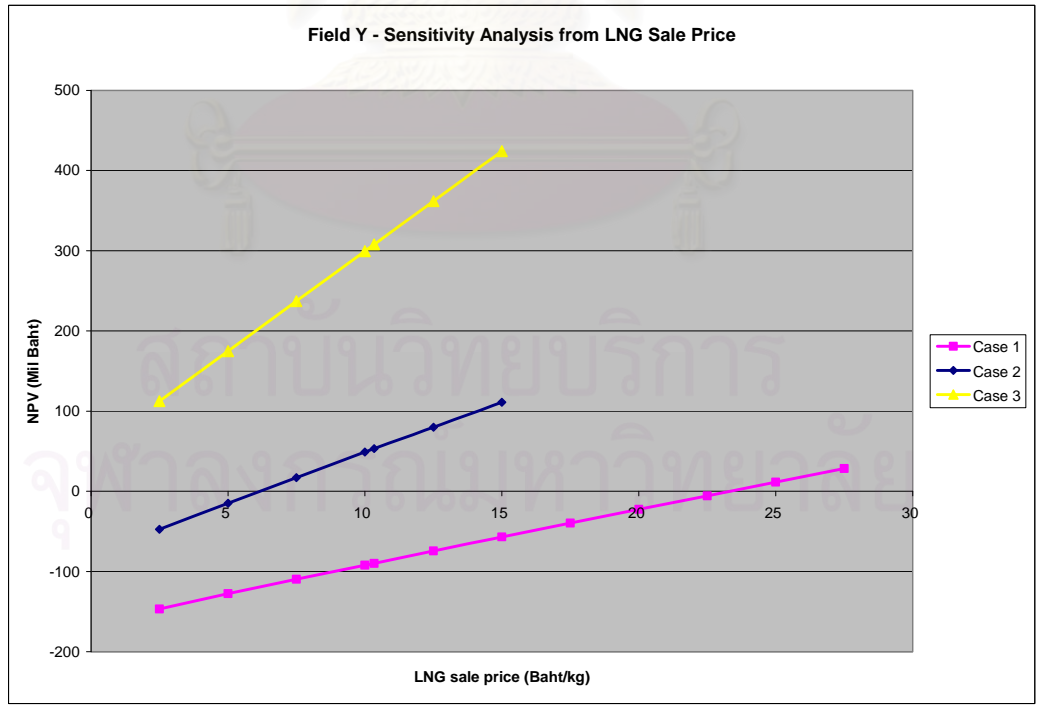


Figure 5-15 Sensitivity of LNG sale price of LNG option of field Y:  
Single operator (LNG project)

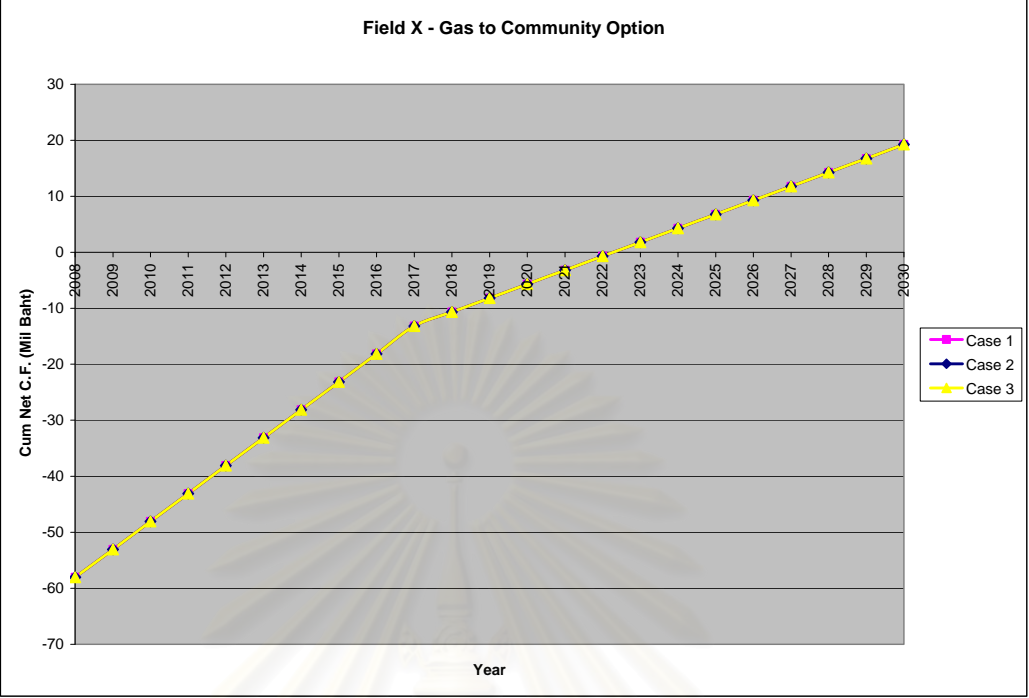


Figure 5-16 Cumulative net cash flow of gas to community option of field X

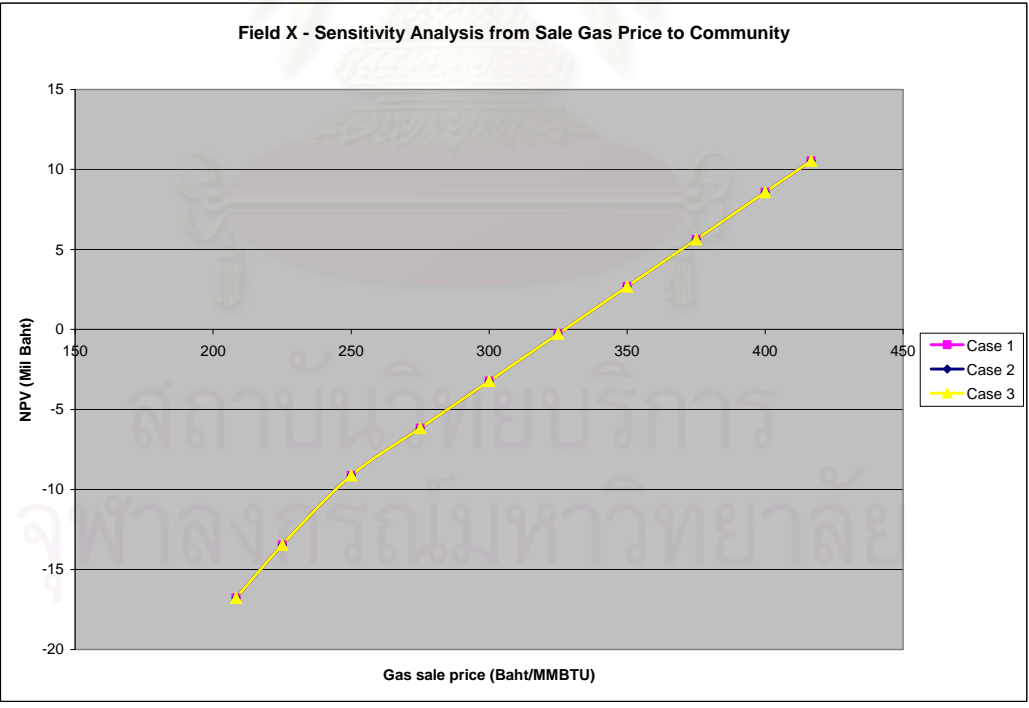


Figure 5-17 Sensitivity of gas sale price of gas to community option of field X

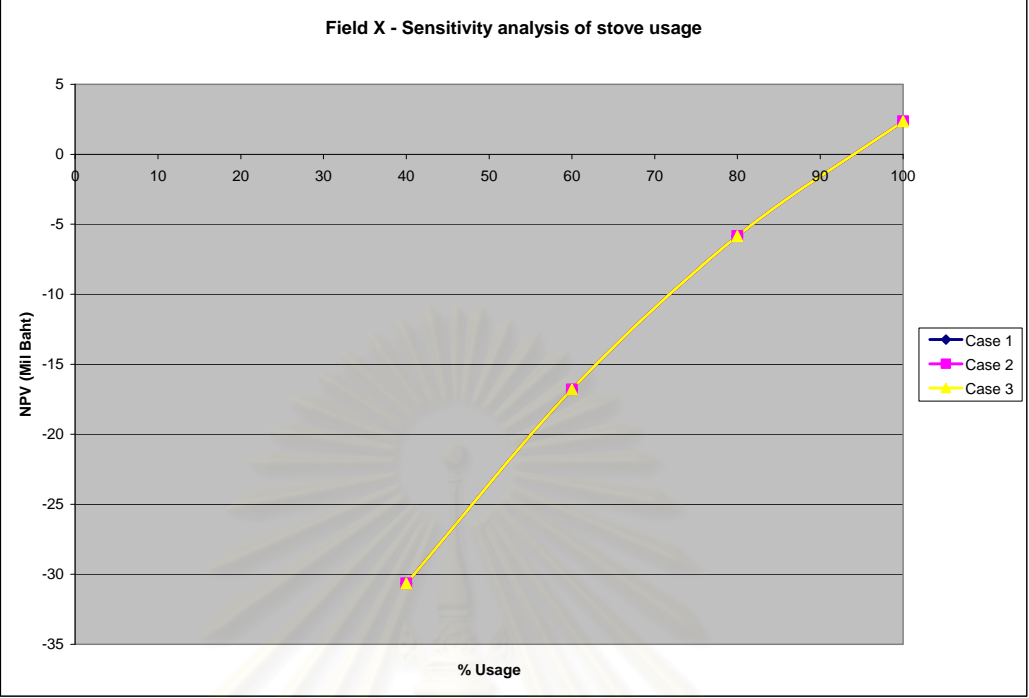


Figure 5-18 Sensitivity of percentage of gas usage of gas to community option of field X

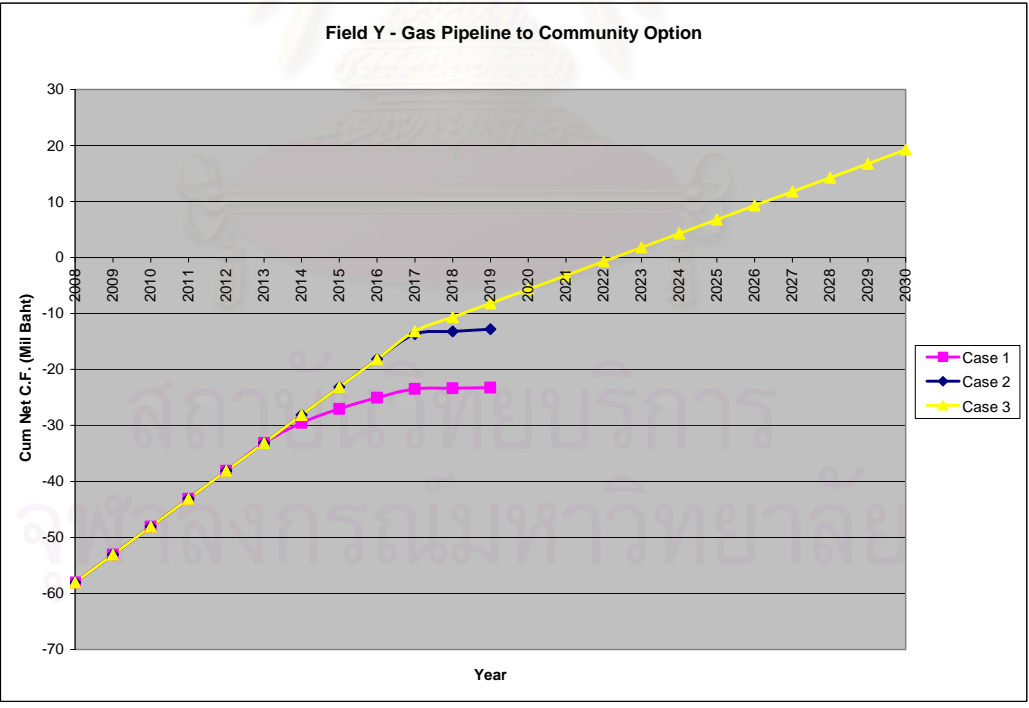


Figure 5-19 Cumulative net cash flow of gas to community option of field Y

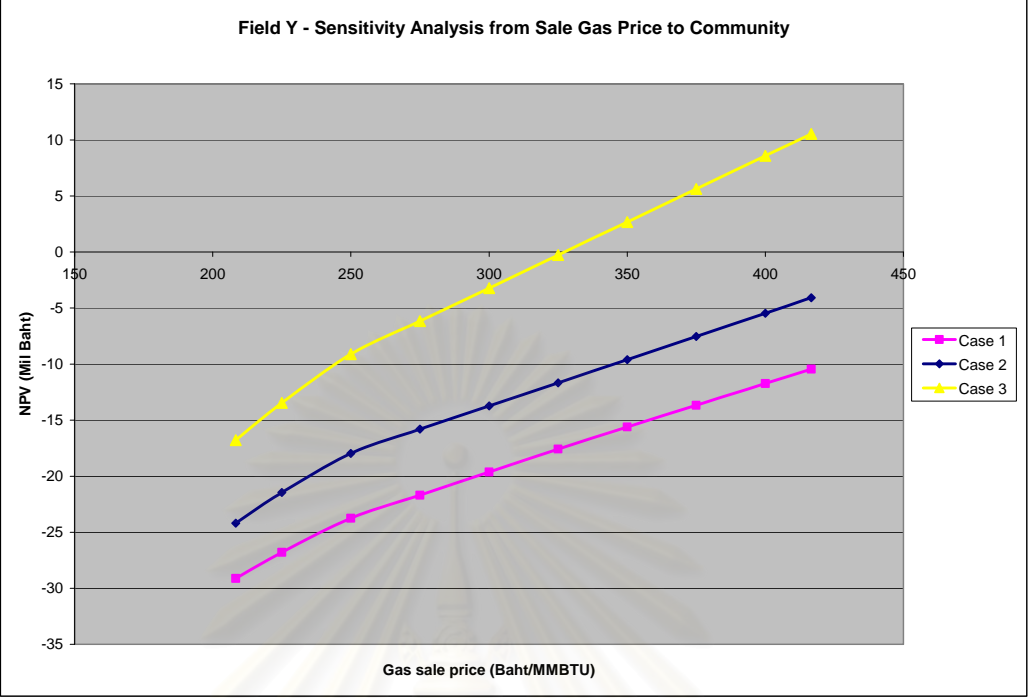


Figure 5-20 Sensitivity of gas sale price of gas to community option of field Y

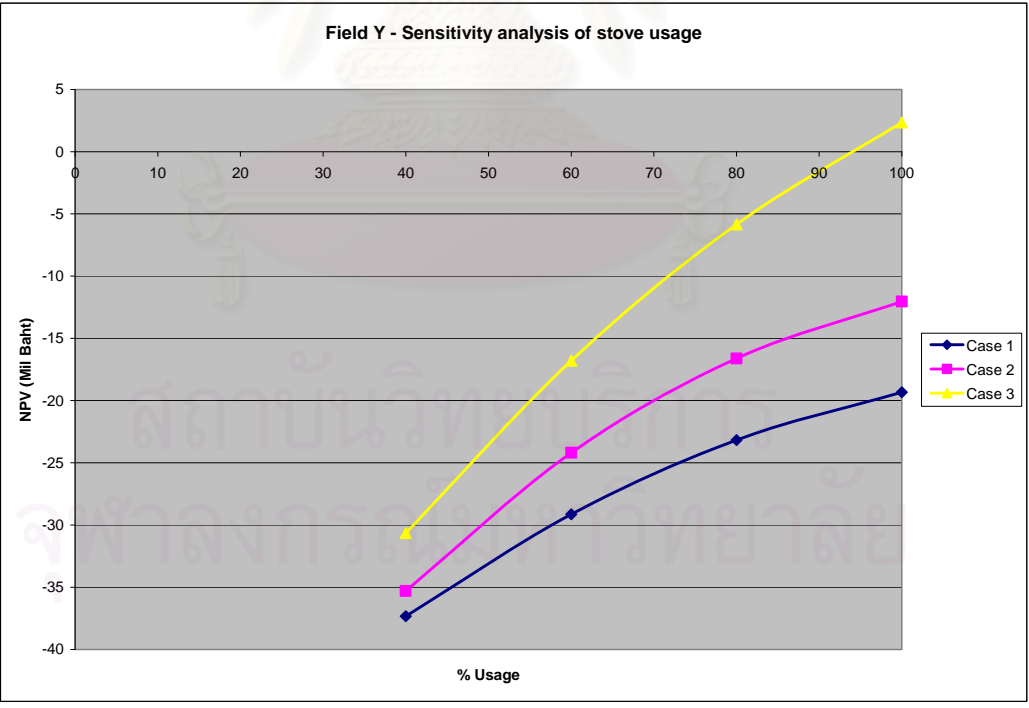


Figure 5-21 Sensitivity of percentage of gas usage of gas to community option of field Y

### 5.4.2.2 Power generation scenario

The cumulative net cash flow plots of field X are shown by figure 5-22 - 5-24 when the cumulative net cash flow plots of field Y are shown by figure 5-25 - 5-27.

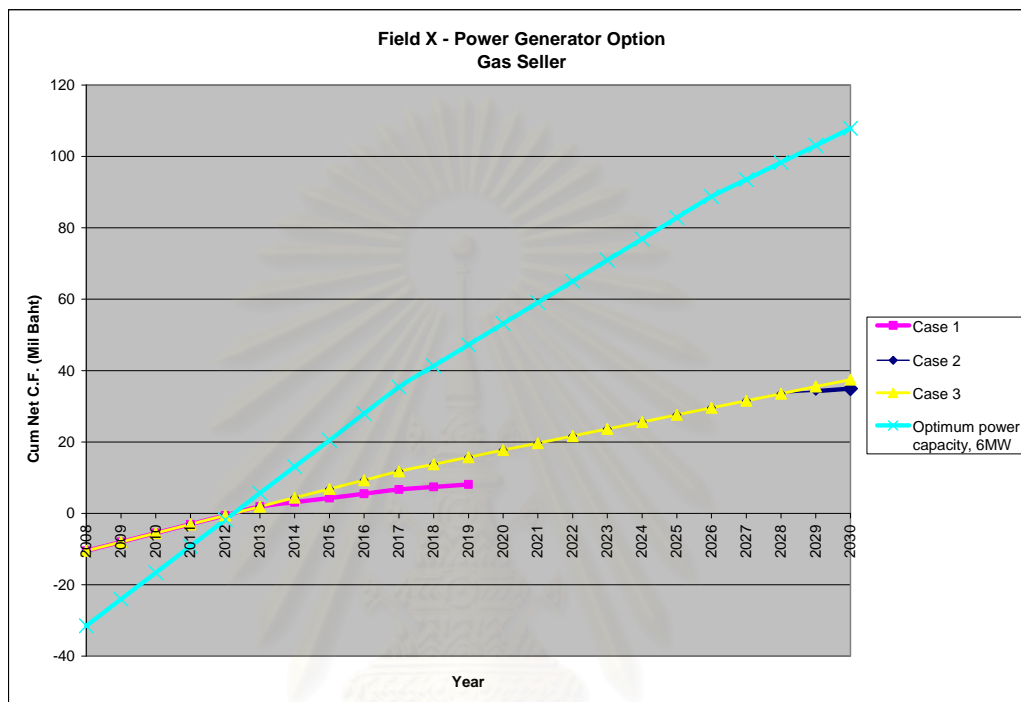


Figure 5-22 Cumulative net cash flow of power generation option of field X:  
Gas seller



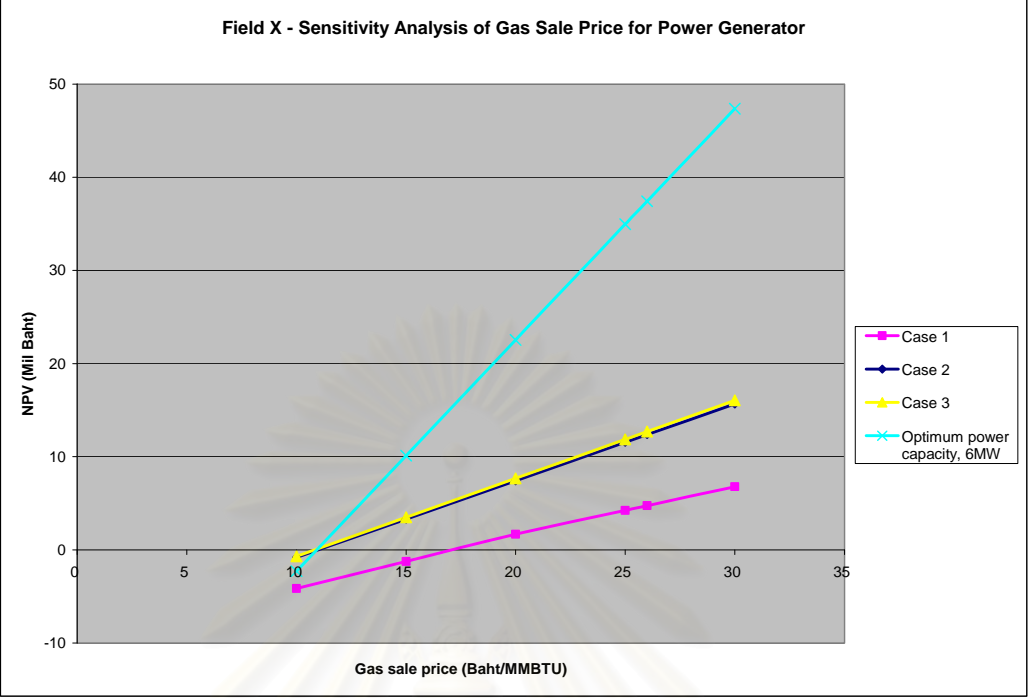


Figure 5-23 Sensitivity of gas sale price of power generation option of field X:  
Gas seller

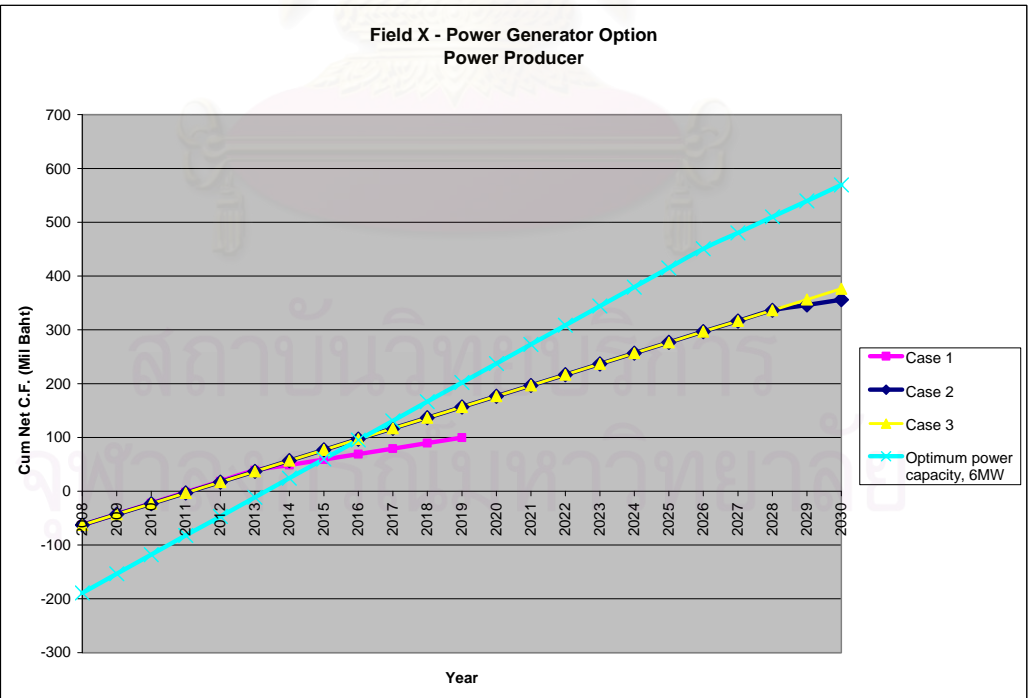


Figure 5-24 Cumulative net cash flow of power generation option of field X:  
Power producer

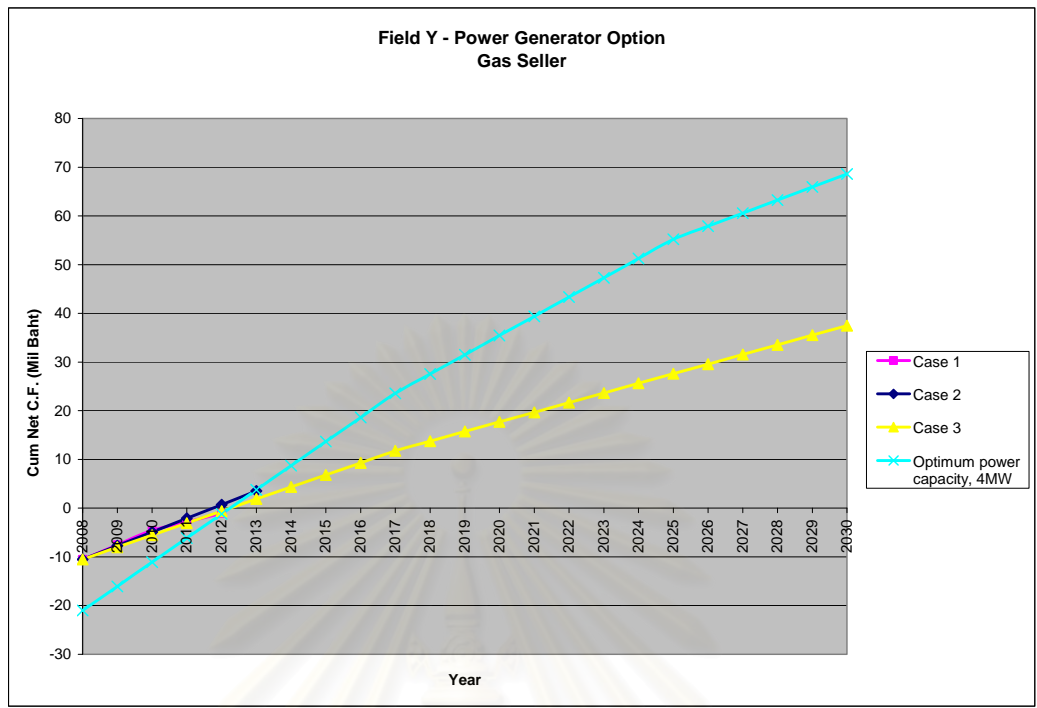


Figure 5-25 Cumulative net cash flow of power generation option of field Y:  
Gas seller

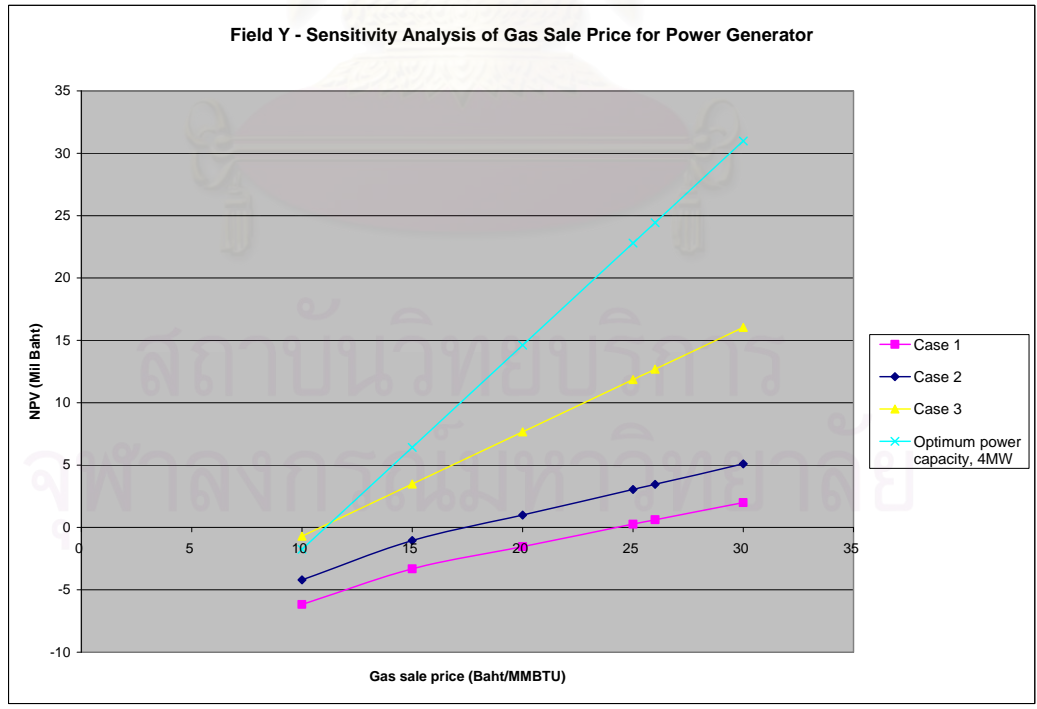


Figure 5-26 Sensitivity of gas sale price of power generation option of field Y:  
Gas seller

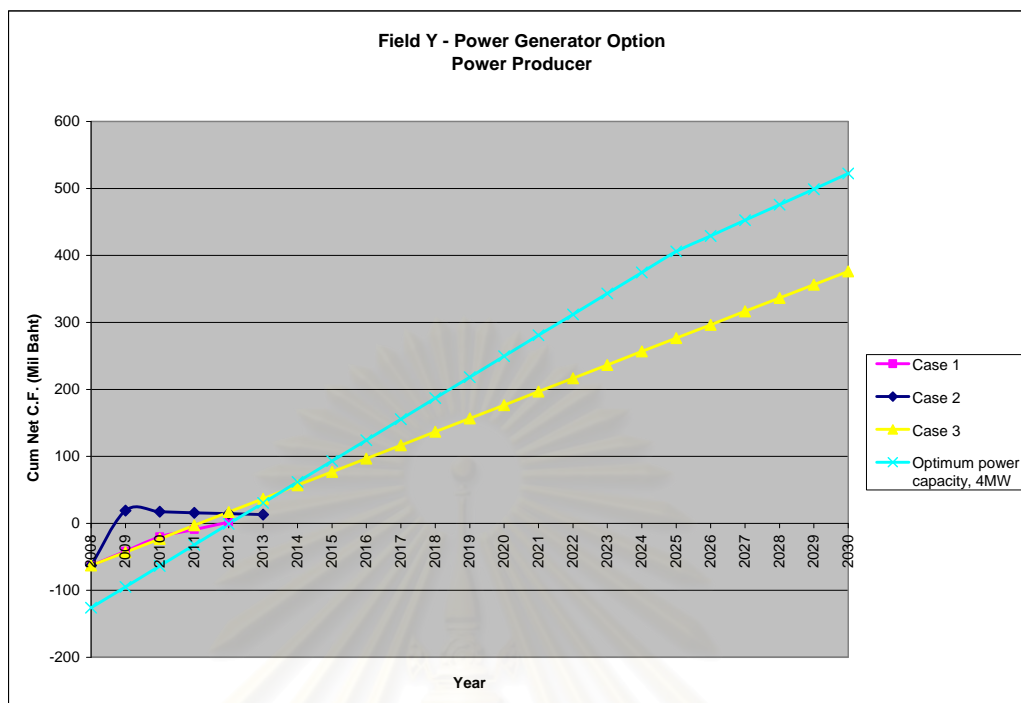


Figure 5-27 Cumulative net cash flow of power generation option of field Y:  
Power producer

#### 5.4.2.3 LNG scenario

The cumulative net cash flow plots of field X are shown by figure 5-28 - 5-31 when the cumulative net cash flow plots of field Y are shown by figure 5-32 - 5-35.

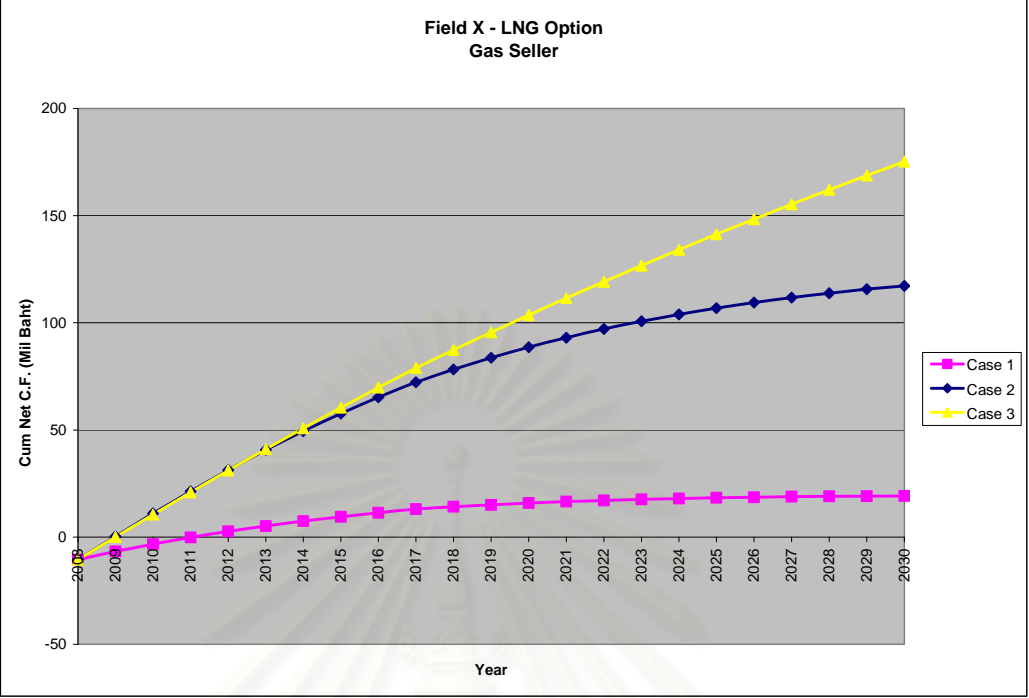


Figure 5-28 Cumulative net cash flow of LNG option of field X:  
Gas seller

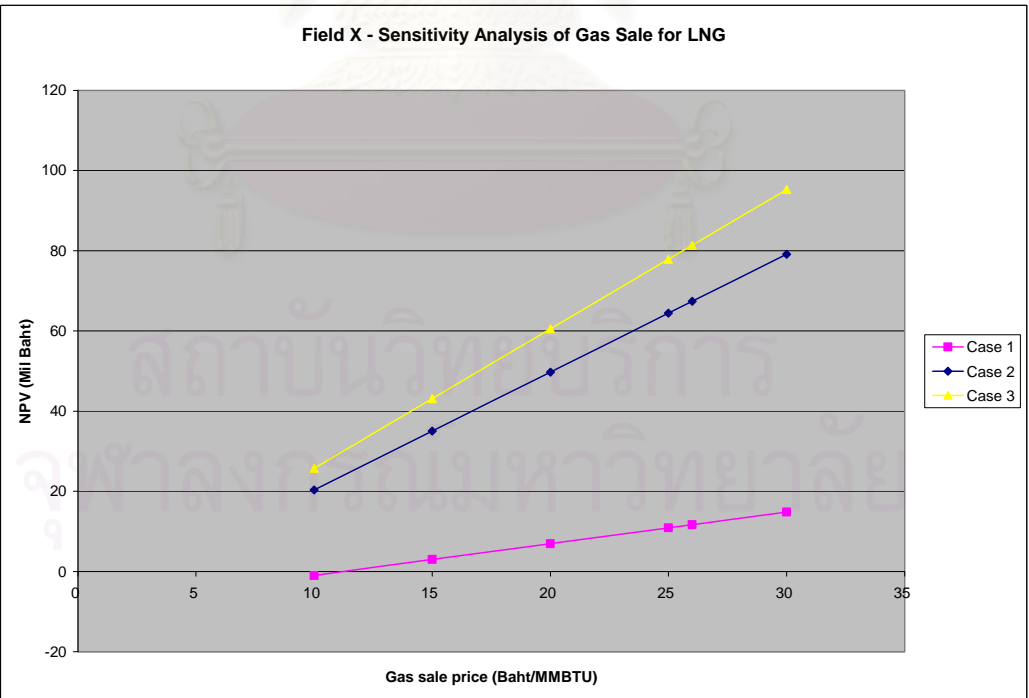


Figure 5-29 Sensitivity of gas sale price of LNG option of field X:  
Gas seller

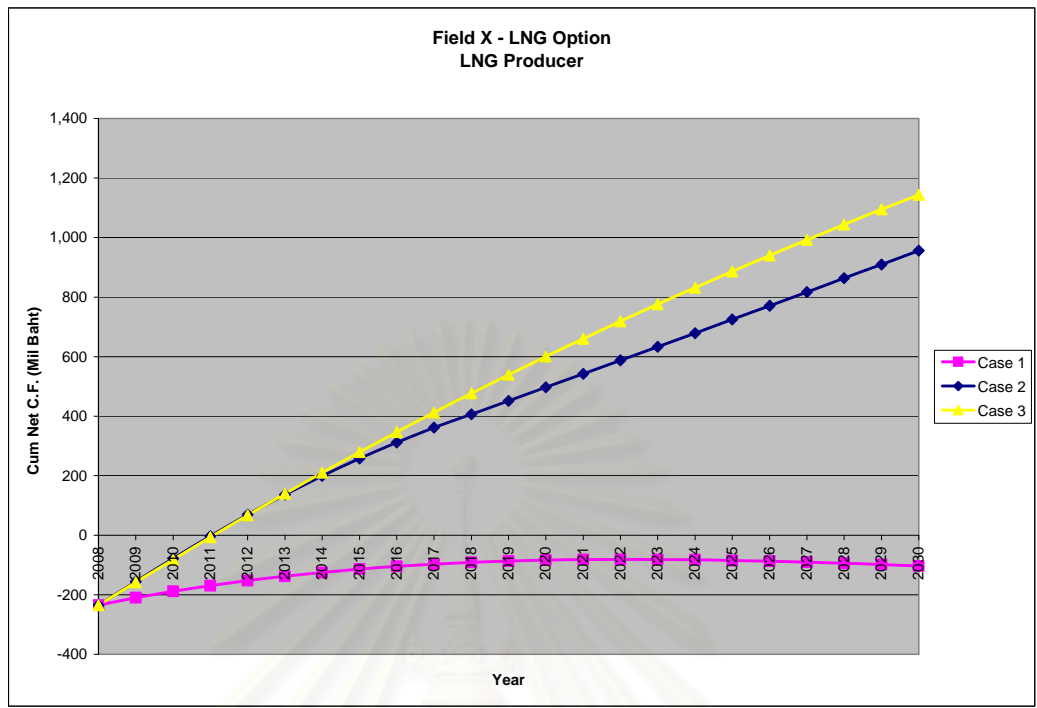


Figure 5-30 Cumulative net cash flow of LNG option of field X:  
LNG producer

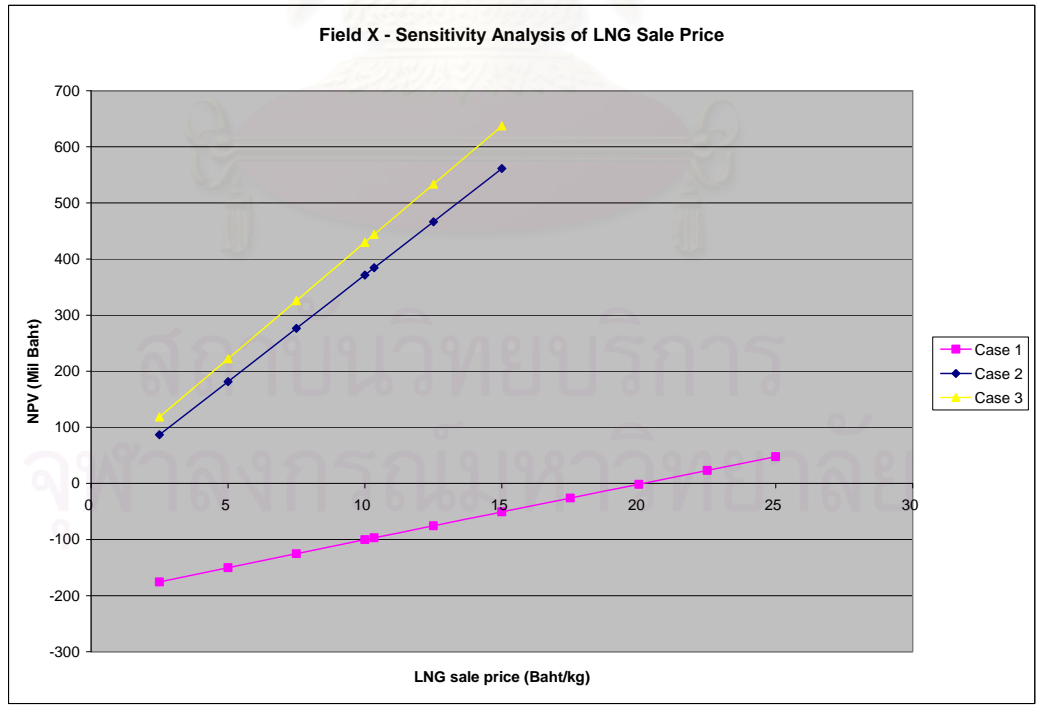


Figure 5-31 Sensitivity of LNG sale price of LNG option of field X:  
LNG producer



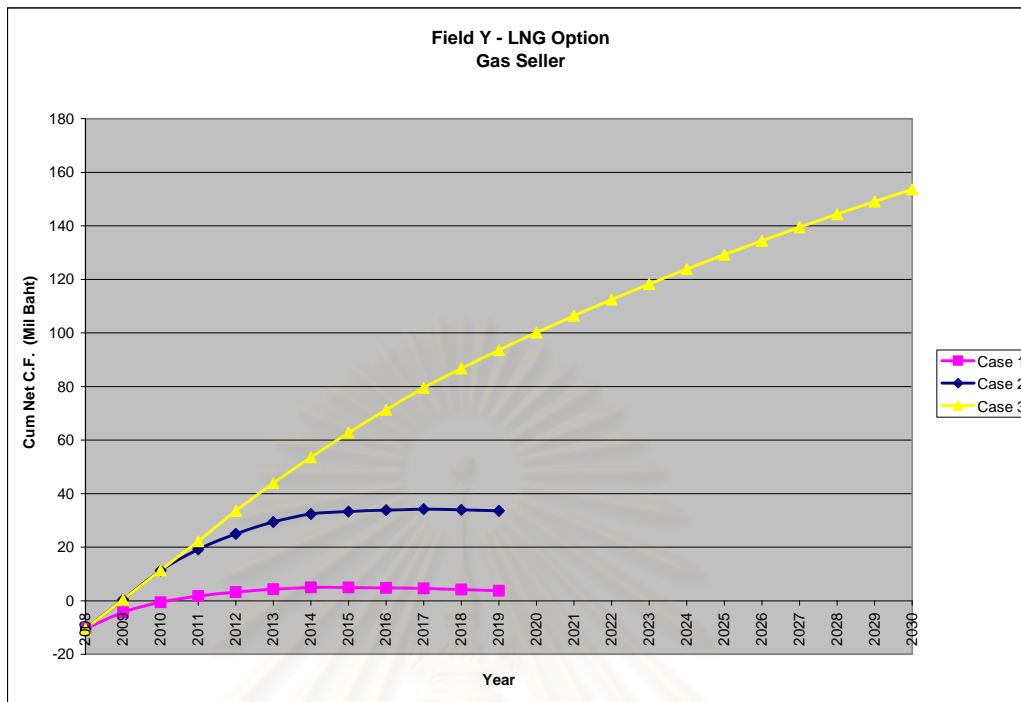


Figure 5-32 Cumulative net cash flow of LNG option of field Y:  
Gas seller

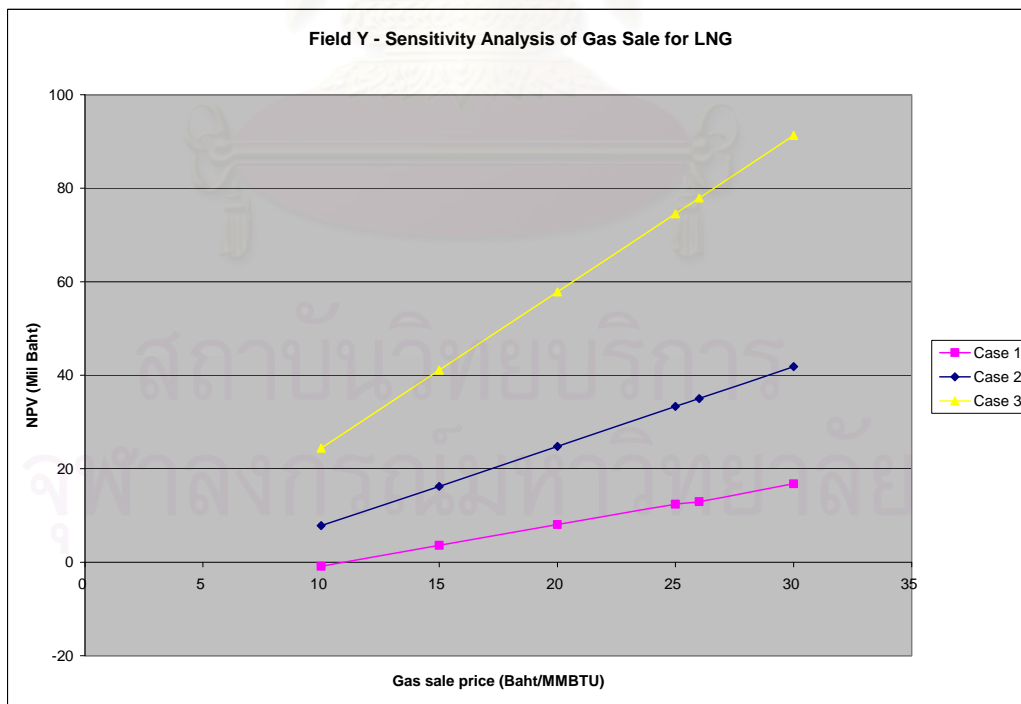


Figure 5-33 Sensitivity of gas sale price of LNG option of field Y:  
Gas seller

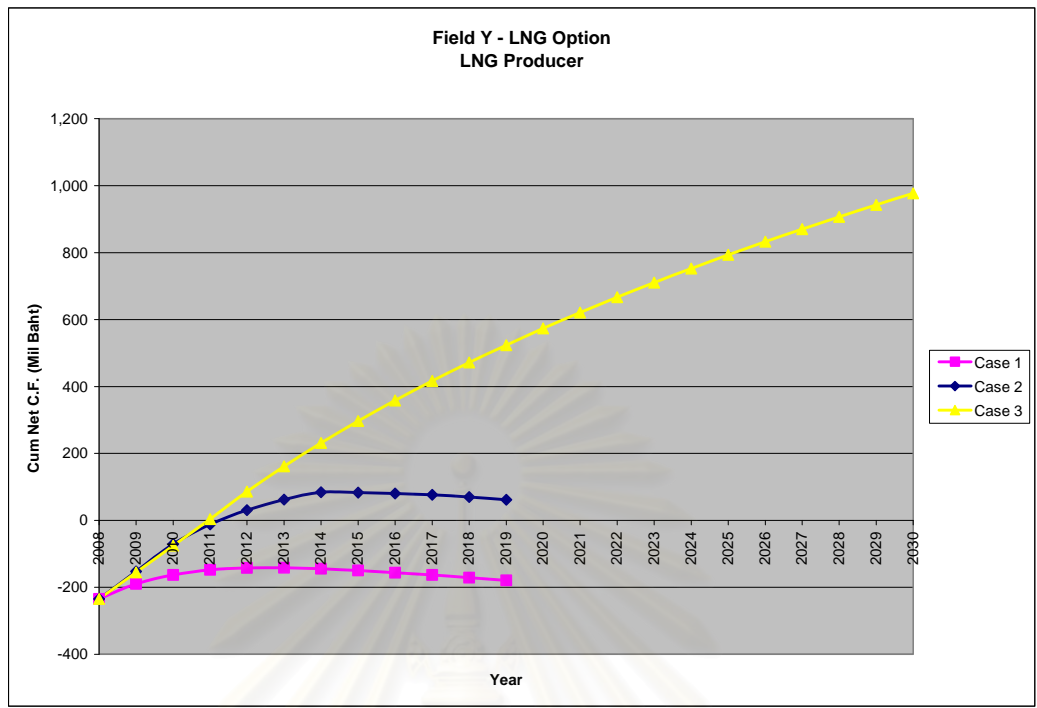


Figure 5-34 Cumulative net cash flow of LNG option of field Y:  
LNG producer

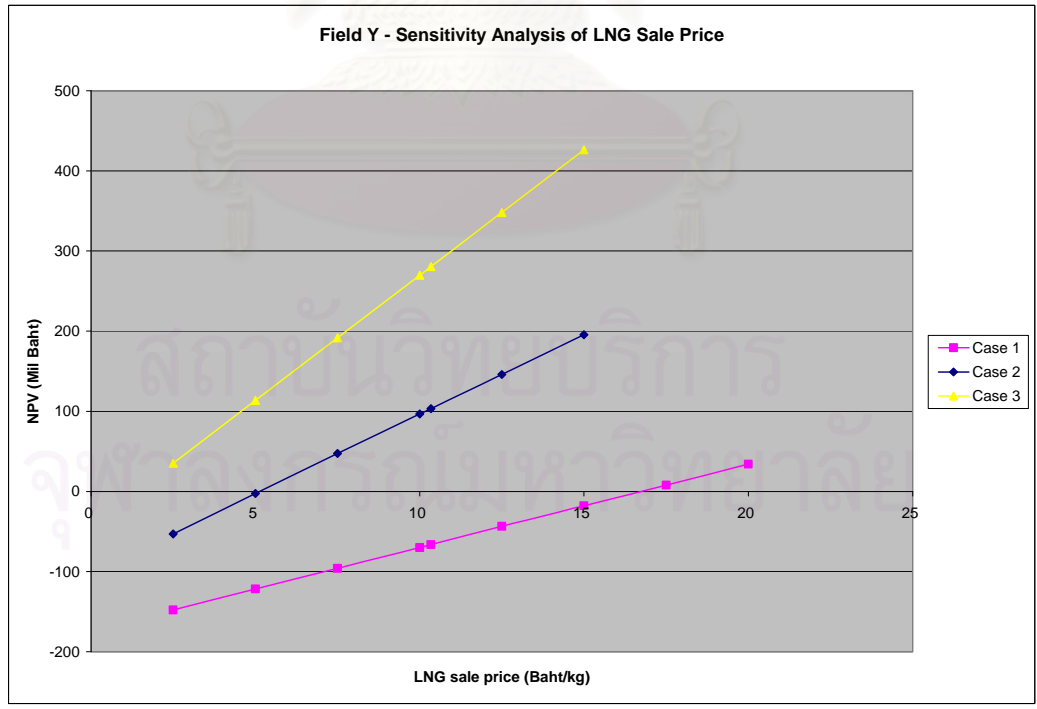


Figure 5-35 Sensitivity of LNG sale price of LNG option of field Y:  
LNG producer

Table 5-7 Cash flow result summary

Field		Field X									Field Y								
Option		Power (6 MW optimization)			LNG			Gas to community			Power (4 MW optimization)			LNG			Gas to community		
Scenario	Economic factor	NPV	IRR	PO	NPV	IRR	PO	NPV	IRR	PO	NPV	IRR	PO	NPV	IRR	PO	NPV	IRR	PO
Petroleum business basis	cumGOR const.	7.86	12.74%	5 <sup>th</sup>	-131.57	-7.25%	n/a	-21.82	3.23%	15 <sup>th</sup>	-31.76	-18.68%	n/a	-183.99	n/a	n/a	-34.16	-10.71%	n/a
	cumGOR increase	50.73	19.88%	5 <sup>th</sup>	169.12	23.24%	4 <sup>th</sup>	-21.82	3.23%	15 <sup>th</sup>	-5.32	7.13%	5 <sup>th</sup>	-33.95	5.67%	5 <sup>th</sup>	-29.22	-4.65%	15 <sup>th</sup>
	Harmonic decline	52.37	19.96%	5 <sup>th</sup>	251.98	25.37%	4 <sup>th</sup>	-21.82	3.23%	15 <sup>th</sup>	52.37	19.96%	5 <sup>th</sup>	229.50	23.14%	4 <sup>th</sup>	-21.82	3.23%	15 <sup>th</sup>
	Optimize of harmonic decline	153.70	19.89%	5 <sup>th</sup>							134.14	26.68%	5 <sup>th</sup>						
Power generator	Gas seller	cumGOR const.	1.78	14.52%	5 <sup>th</sup>							-2.86	-13.40%	n/a					
		cumGOR increase	9.39	22.54%	5 <sup>th</sup>							0.15	10.57%	4 <sup>th</sup>					
		Harmonic decline	9.72	22.62%	5 <sup>th</sup>							9.72	22.62%	5 <sup>th</sup>					
		Optimize of harmonic decline	28.50	22.56%	5 <sup>th</sup>							18.48	22.48%	5 <sup>th</sup>					
	Power producer	cumGOR const.	41.52	25.89%	4 <sup>th</sup>							-10.02	1.36%	4 <sup>th</sup>					
		cumGOR increase	109.56	31.60%	4 <sup>th</sup>							17.06	20.11%	3 <sup>rd</sup>					
		Harmonic decline	112.19	31.63%	4 <sup>th</sup>							112.19	31.63%	4 <sup>th</sup>					
		Optimize of harmonic decline	119.37	18.26%	6 <sup>th</sup>							142.46	24.53%	5 <sup>th</sup>					
LNG	Gas seller	cumGOR const.				7.32	25.75%	4 <sup>th</sup>						1.53	18.54%	3 <sup>rd</sup>			
		cumGOR increase				56.12	100.49%	1 <sup>st</sup>						23.37	90.96%	1 <sup>st</sup>			
		Harmonic decline				70.33	99.50%	1 <sup>st</sup>						66.48	103.62%	1 <sup>st</sup>			
	LNG producer	cumGOR const.				-136.93	-7.77%	n/a						-172.15	n/a	n/a			
		cumGOR increase				297.71	29.53%	4 <sup>th</sup>						3.99	12.31%	4 <sup>th</sup>			
		Harmonic decline				358.80	31.01%	4 <sup>th</sup>						329.00	31.68%	3 <sup>rd</sup>			

(Unit: Million Baht)

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1) Single operator is based on petroleum business basis calculation. The results from all 3 options (power generation, LNG, and gas to community) with 3 cases of reserve and production forecast on both fields are shown in table 5-7. The gas to community option is only available here as described above.

2) Power generation option with 3 cases of reserve and production forecast is splitted into gas seller for power producer and the power producer as shown in table 5-7. The cash flows of the gas seller are calculated on the petroleum business basis while the power producer is calculated on a 15% tax of ordinary juristic person basis for SPP (Small Power Producer) of EPPO (Energy Policy and Planning Office) and no royalty. The optimization power generation of field X is 6 MW capacity, and field Y is 4 MW capacity.

3) LNG option with 3 cases of reserve and production forecast is splitted into gas seller for LNG producer and the LNG producer as shown in table 5-7. The cash flows of gas seller are calculated by 30% tax of ordinary juristic person basis without royalty.

The combined option is the combination of power generation and gas to community option. The main reason for the combined option is to make the gas to community option viable. By combining 2 options, the positive cumulative net cash flow option will help the negative option to be positive and makes a viable combined option. Again, for the optimization of case 3 (harmonic decline with increasing cumulative GOR), power generation option combined with gas to community option are shown. By decreasing the power generation capacity of field X to 5 MW and field Y to 3 MW. The results are shown in figure 5-36 and 5-37.

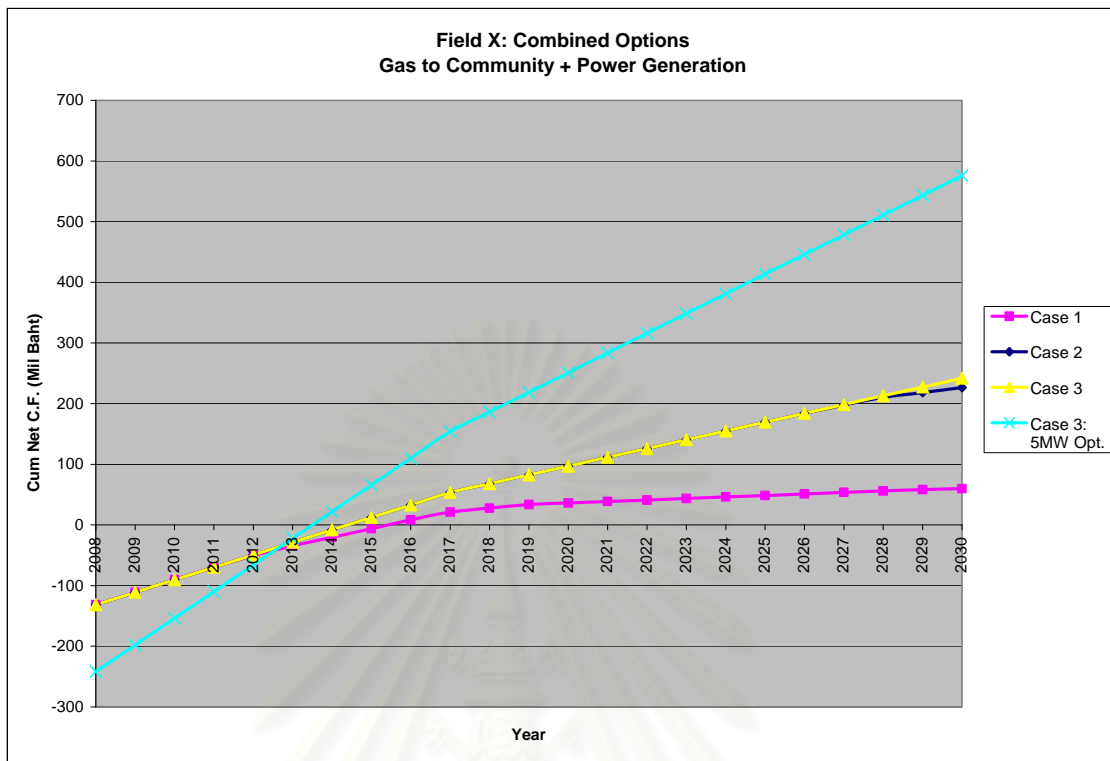


Figure 5-36 Field X: Combined options plot

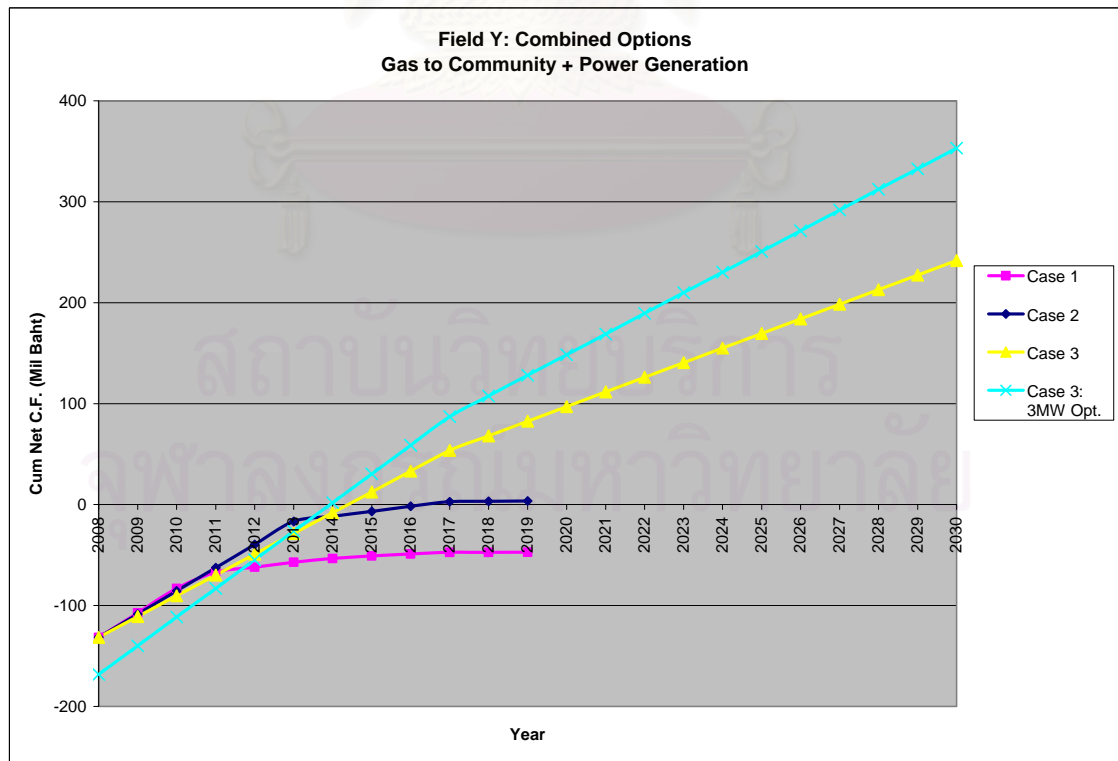


Figure 5-37 Field Y: Combined options plot

### 5.4.3 Financial Analysis Discussion

From the financial analysis results, field X presents a better overall result than field Y. Every scenario of field Y shows lesser or equal cumulative net cash flow and IRR than field X. The results are from higher reserve and productions maintained for a long period in field X. Same as result among 3 cases, the case 3 (harmonic decline of oil reserve with increasing cumulative GOR) shows the largest reserve and production forecast. Their results show the highest cumulative net cash flow.

Comparing between 3 scenarios, power generation scenario always shows positive cumulative net cash flow of both fields in all cases of reserve including gas seller and power producer. The reason is the lowest investment. LNG scenario shows positive outcome when the reserve and production are large. The gas seller is still gets the positive cumulative net cash flow in all cases. Similar to the petroleum business scenario, the case with high reserve and production will give positive outcome.

Comparing between 3 options, the power generation option show the best cumulative net cash flow among the others, the LNG option is the second, and the gas to community option is the worst option. This is because the power generation option needed low investment, but LNG option needed high investment, and the revenue from gas to community option is quite low.

Comparing between gas seller and the producer of power or LNG, the gas seller gets positive cumulative net cash flow from all cases of reserve due to low investment and low risk. The producer of power and LNG will get a better outcome when high reserve and production are present. Since LNG option needed expensive investment and has high risk.

The gas to community option always shows negative outcome. The gas sale price which is based on half of the LPG price is cheap and has low percentage of usage as in the assumptions. However, the sensitivity plots show that it can be positive by increasing percentage of usage up to 95% or increasing the sale gas price.

The optimization of associated gas utilization by power generation option of both fields in 2 scenarios (petroleum business basis and power generation) always gives high positive value of cumulative net cash flow. Since it is higher investment, the power producer presents the longer payback period.



Most cases of combined options present the positive outcome. Although the gas to community option is negative, the higher positive outcome of power generation option can cover the negativity. Therefore, the combined options can be viable. In some cases, the associated produced gas is inadequate to supply, the combined outcomes are still negative. Furthermore, the gas to community option shows the larger negative because of inadequate gas supply.

Comparing between one whole single operator and the combination of gas seller and second product producer, the total cumulative net cash flow of the combined operators is better than the single operator. This can be explained that the single is always based on petroleum business basis which has high tax deduction. The single one has two scenarios of tax deductions: small tax deduction for the small revenue of gas seller on petroleum basis and low rate of tax deduction for the large revenue of second product producer.

## 5.5 Environmental and Social Responsibilities

Since this study is focused on associated flared gas, the environment and social responsibilities of the project is determined from the amount of associated gas used. All 3 utilization options are calculated for the whole project life. The detail calculations of this section are available in Appendix C.

### 5.5.1 Assumptions

Gas heating value	1,340.83	BTU/ft <sup>3</sup>
NO <sub>x</sub> % mol by volume	1.498	
Uncontrolled Emission factor		
CO <sub>2</sub>	110	lb/MMBTU
NO <sub>x</sub>	0.138	lb/MMBTU of general burning

(Source: Emission Inventory Improvement Program (EIIP) VolumeII : Preferred and Alternative Methods for Estimating Air Emission from Oil and Gas Field Production and Processing Operation. September, 1999)

NO<sub>x</sub> 0.847 lb/MMBTU of 4-Stoke lean burn engines

(Source: Compilation of Air Pollution Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources)

### 5.5.2 Green House Gas Reduction

Table 5-8 presents the summary of green house gas reduction calculations from both 2 fields with 3 cases of reserve. In addition, there was an optimize gas utilization in some case of reserve so their calculations are included. The discussion of green house gas reduction is presented in this section.

Table 5-8 Green house gas reduction summary

	Field X						
	Options	Power		LNG		Gas to community	
	Case	B.L.	Flared	B.L.	Flared	B.L.	Flared
CO <sub>2</sub> Emission	Harmonic decline	864,372	639,719	864,372	0	864,372	832,698
	6 MW Power Optimization	864,372	209,947				
NO <sub>x</sub> Emission	Harmonic decline	3,794	1,202	1,624	0	1,624	1,565
	6 MW Power Optimization	7,943	395				
	Field Y						
	Options	Power		LNG		Gas to community	
	Case	B.L.	Flared	B.L.	Flared	B.L.	Flared
CO <sub>2</sub> Emission	Harmonic decline	853,120	628,466	853,120	81,849	853,120	821,446
	4 MW Power Optimization	853,120	428,232				
NO <sub>x</sub> Emission	Harmonic decline	3,772	1,181	1,741	154	1,603	1,544
	4 MW Power Optimization	5,706	805				

Unit: tons

### 1) Power Generation Option

The power generator unit mainly consists of internal combustion engine fueled by gas. So this engine generates emission from its operation. Although power generation option cannot significantly reduce the emission, this combustion utilizes useful product as electrical power instead of waste flaring. Furthermore, using associated flared gas to be the fuel of power generation, it can reduce the consuming of others fuels such as bunker oil, natural gas, coal, or even diesel and gasoline.

### 2) LNG Option

The LNG option can reduce the emission of all amount of gas utilized because the gas is transformed to new product without burning or flaring. Moreover, the by-product from LNG production as  $C_{5+}$  can be used in the heat requiring activity. For example, using  $C_{5+}$  instead of bunker oil or used lubricant oil in the group of making Buddha statues from brass in brass melting activity. This utilization will help to reduce the environmental pollution from using used lubricant oil as described in previous chapter.

### 3) Gas to Community Option

The gas to community option is taking associated gas to be flared to use in community. The option is similar to power generation option in the sense of burning gas, so the gas to community option cannot significantly reduce the emission. However, the gas utilization in community generates the useful product as fuel for community which doesn't flare by waste. The further advantage of gas to community option is to reduce the using of LPG in the making food products activity.

## 5.5.3 Energy Efficiency

This utilization of associated gas project is focused on utilizing the flared gas so it is exactly to get the benefit. Although the gas is still burned in the power generation and gas to community option, the gas burning gives benefit and is not wasted by being flared. For the LNG option, it can fully reduce the emission by its capacity.

However, associated gas cannot be utilized all of their production in some options and/or sometimes. Such as in the early life of project, there is larger amount of gas production than utilize capacity. So there is emission impact to the environmental but the associated gas utilization project helps to reduce the pollution.

Another important thing of the project is economic consideration. We will look in the sense of alternative energy source to save that existing conventional energy, reduce energy importing, help the local community to use low price fuel, and etc. At this stage, we will determine the amount of conventional energy substituted by using the associated flared gas or their products.

- Power generation option

Actually, the electrical power from hydrocarbon generated from coal, natural gas or bunker oil. This part will focus to use instead of bunker oil no. 6 which often use for power generation.

- LNG option

The option of LNG production will give LNG as main product and by-products as  $C_{2+}$  and  $C_{5+}$  by 20 tons, 12 tons, and 850 kg respectively with 2 MMscfd of associated gas feed. LNG can be use as transportation fuel by transformed to be LCNG (Liquefied Compressed Natural Gas) or substitute for diesel,  $C_{2+}$  and  $C_{5+}$  can be used instead of LPG and bunker oil respectively. So this part will focus to substitution for conventional fuel as previously described.

- Gas to community option

As earlier described, gas to community option is purposed to substitute the use of LPG. So the following determination shows the substitution of LPG usage as previous two options.

The following tables show the energy efficiency summary. The table 5-9 shows the amount of energies saved by the associated gas utilization project for each option. The table 5-10 shows the cost saved by the associated gas utilization project for each option.

Table 5-9 Energy efficiency summary by conventional energies

		Field X		Field Y	
		Harmonic decline	6 MW Power Optimization	Harmonic decline	4 MW Power Optimization
Power	Fuel Saved (Mil Lit.)	123.62	360.12	123.62	233.81
LNG	Diesel Saved (Mil Lit.)	112.85		126.48	
	LPG Saved (Mil kg.)	10.50		11.76	
	Fuel Saved (Mil Lit.)	6.12		6.85	
Gas to Community	LPG Saved (Mil kg.)	14.43		14.43	

Table 5-10 Energy efficiency summary by cost of conventional energies

		Market Product Price (Bath)	Field X		Field Y	
			Harmonic decline	6 MW Power Optimization	Harmonic decline	4 MW Power Optimization
Power	Fuel Saved (Mil Bath)	15.52	1,918.11	5,587.69	1,918.11	3,627.84
LNG	Diesel Saved (Mil Bath)	30.00	3,385.57		3,794.25	
	LPG Saved (Mil Bath)	18.33	192.41		215.63	
	Fuel Saved (Mil Bath)	15.52	94.90		106.36	
Gas to Community	LPG Saved (Mil Bath)	18.33	264.55		264.55	

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#### 5.5.4 Environmental and Social Responsibilities Discussion

As shown in this section, the associated gas utilization can significantly substitute the convention energy. The gas utilization project can save a lot of money necessary to buy the energy in whichever options. Not only save the energy, but the project responds to the environment also. The project mainly reduces the flared gas but associated gas is also utilized to substitute some energy sources to reduce the pollution in gas to community option. So this associated gas utilization project is interesting and has potential to implement in the sense of environmental and social responsibilities.



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# **CHAPTER VI**

## **CONCLUSIONS AND RECOMMENDATIONS**

Associated gas utilization project have the same concept of field development which the project feasibility study is performed. In this study, gas utilization options were studied to list the options including their constraints by current technology and gas to community option. The onshore oil fields in Thailand are previewed and, then studied in the detail. After that, a particular Thailand onshore oil field case was chosen. The possible options for small scale gas utilization are also selected for the particular field case. The field criteria to considerations are studied. The associated gas reserve and future production are the important factors for this study, and they depend on reserve and future production of crude oil. The associated gas reserve and production forecast was set to be 3 different cases of outcome, (i) gas reserve from oil exponential decline with constant cumulative GOR, (ii) gas reserve from oil exponential decline with increasing cumulative GOR, and (iii) gas reserve from oil harmonic decline with increasing GOR. The group of wells in Thailand onshore oil field case are screened by setting up criteria to get 2 candidate fields. The financial analysis is a tool to determine whether the project will be feasible or not.

We found that gas to community can be one of the options to utilize the gas as seen from the financial analysis result. The financial study in 2 fields with 3 options by 3 cases of reserve and production forecast gives both positive and negative outcomes. The results showed that field X presents the better result because it is the larger field. The future production maintains at high production rate and this is the same reason when comparing among 3 cases of reserve. Comparing among 3 utilization options, we found that the power generation option is the best way because of its lowest investment. The LNG option needs the highest investment, and the gas to community option gets the lowest revenue. For different 3 scenarios (petroleum business basis, power generation, and LNG), the power generation option presents the highest benefit by the same previous reason. Consideration between the gas seller and the producer of electrical power and LNG, the result of the gas seller always presents positive NPV while the second

producers present high positive value at high reserve and production rate in the case 3 (Oil reserve from harmonic decline with increasing cumulative GOR). The gas to community option is useful and helpful for the local community, and feasible when combined with power generation option. Furthermore, from the environmental and social responsibilities, the project can significantly reduce the flared gas and green house gas as CO<sub>2</sub> and NO<sub>x</sub>. The associated gas utilization generates various products from different option so it can also save the conventional energy as LPG, bunker oil, and diesel.

Several remarks on studying utilization of associated gas from onshore oil field production of Thailand are presented as follows:

1. The available gas utilization options and their constraints can be changed when the new technology presented including criteria to consideration. That means the current small eliminated wells can be feasible for new technology.
2. Reserve and production forecast are the necessary factor in both field screening methodology and financial analysis, which should be carefully determined. All 3 cases of reserve and production forecast present the uncertainty of the reserve and production profile of the fields.
3. Financial analysis is the important tool to help the investor in making a decision. It presents the result that which field is suitable for which option, or which role should be for the investor, i.e. gas seller, second product producer, or whole single investor.
4. Regarding to the local community it helps to get more options of associated gas utilization. Furthermore, the several benefits will be received by the local community.

The following points are recommended for future study:

1. The reserve in this study is determined by well level using decline curve analysis via OFM software. The picked points to calculate will differ by individual evaluator and cause different results. Reserve determination should

be obtained by other methods to confirm each other and to get accurate reserve and production forecast.

2. The costs of investment in the cash flow calculation are obtained from the correlation of the gas utilization study in others countries. This estimated cost can be reasonably used for rough estimations and reliable for this study. If there is any accuracy about financial analysis, it must be at this point. For the reality project study, the quoted costs from the supplier are needed to use to get accurate and reliable result.
3. This study can be the pilot project and can be applied for another field in Thailand including others countries. When new technology presented, this study can also be applied. Some negative outcomes may give positive result when new technology applied. Nevertheless, this study can be further continued by additional CDM (Clean Development Mechanism) evaluation which focuses on the reduction of greenhouse gas (GHG) and Certified Emission Reduction (CERs) trading.

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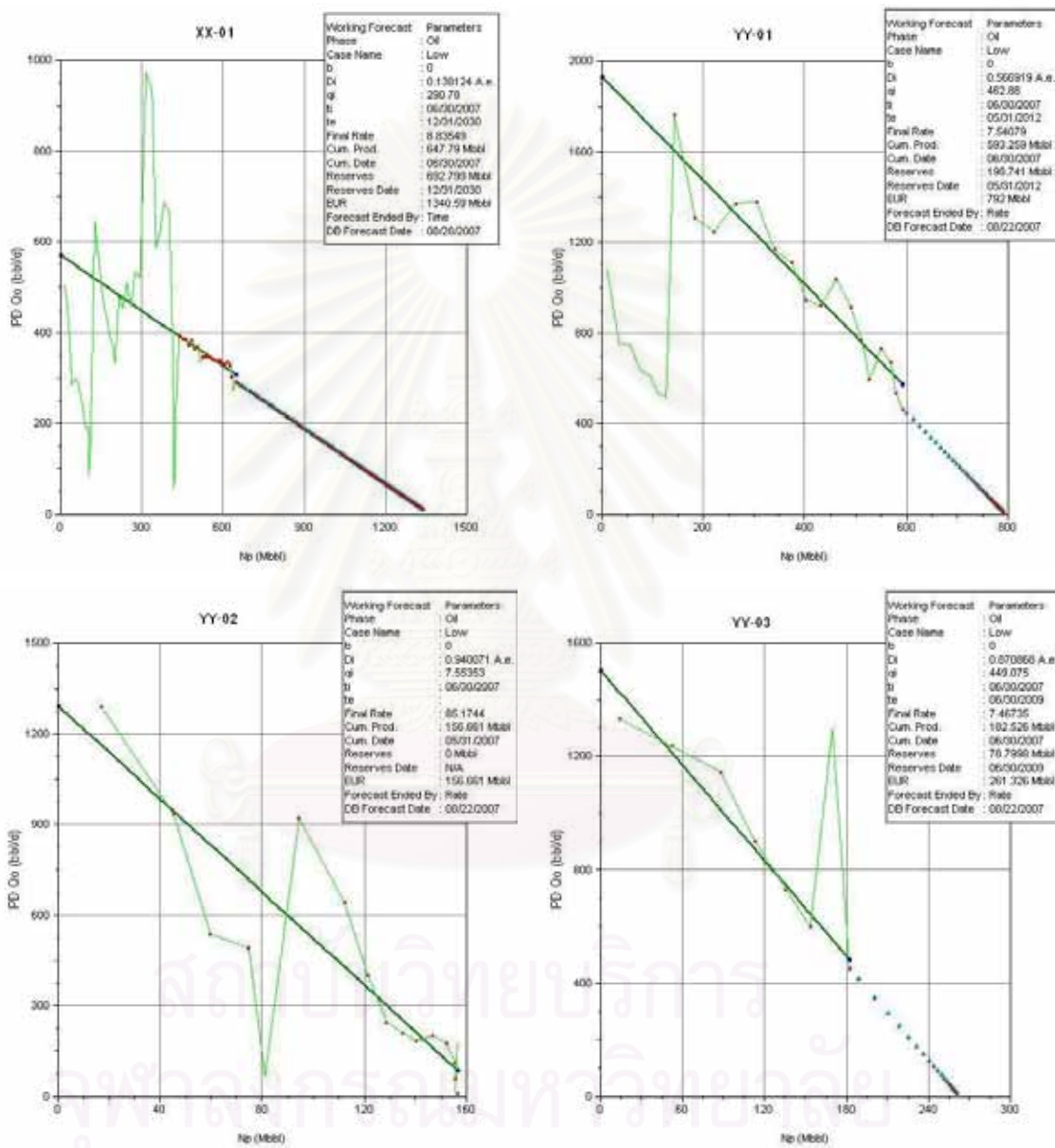
**APPENDICES**

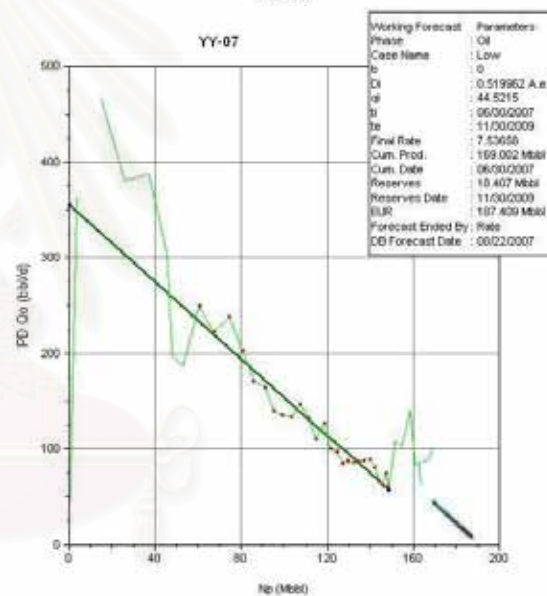
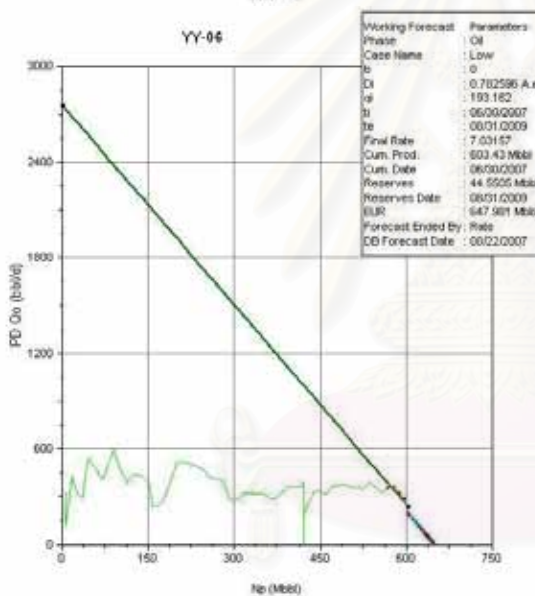
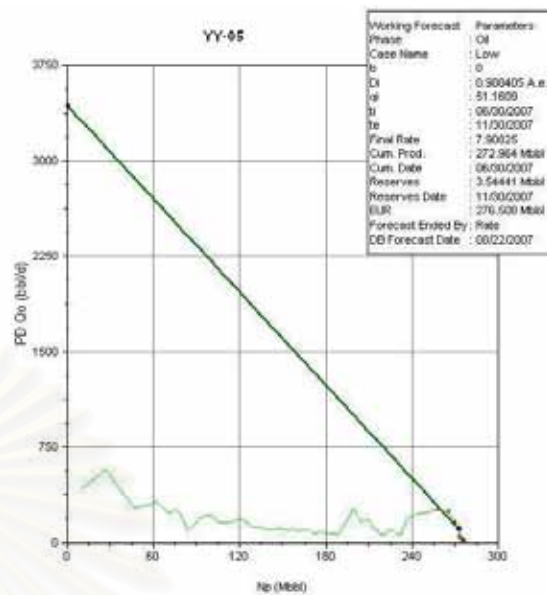
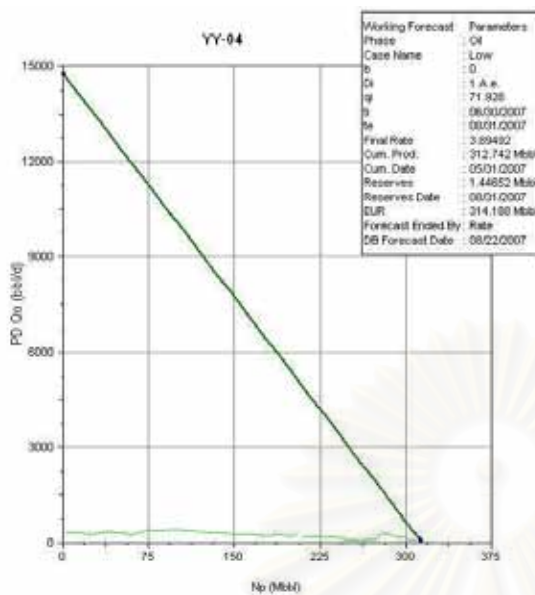
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## APPENDIX A

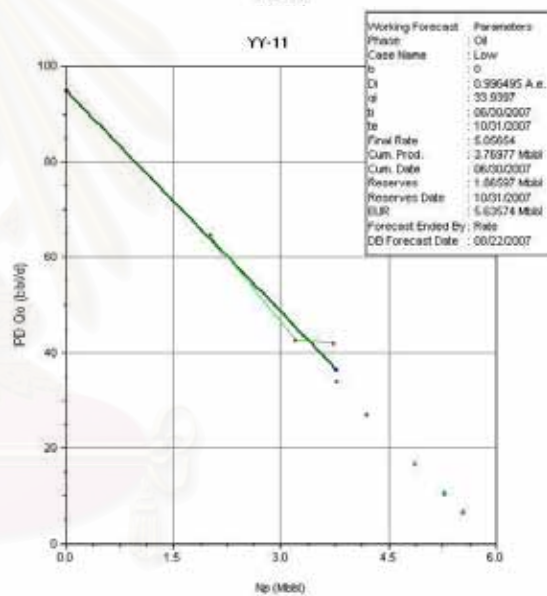
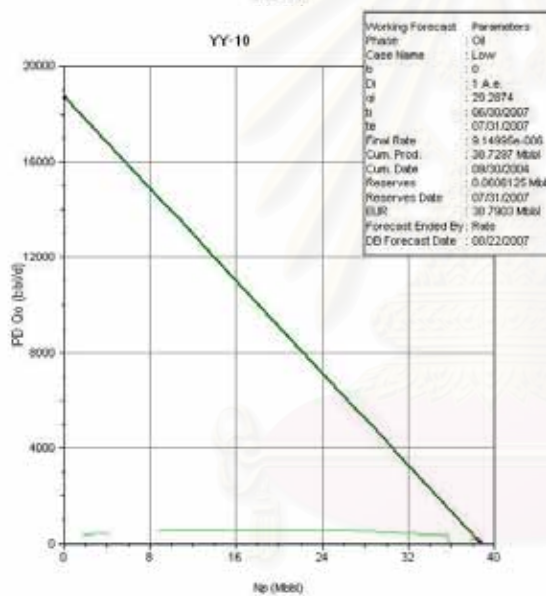
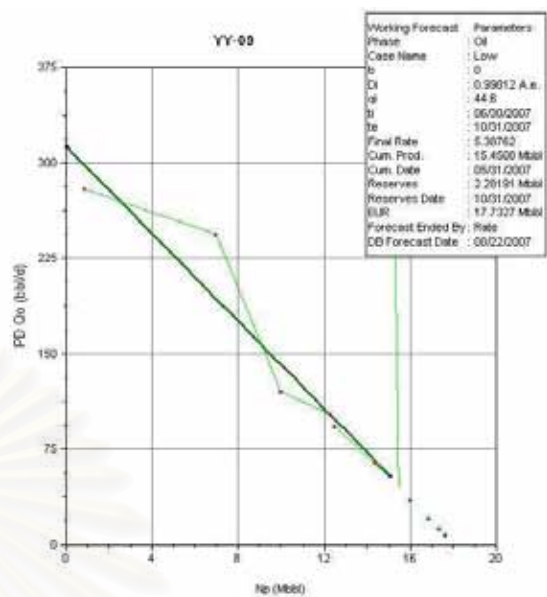
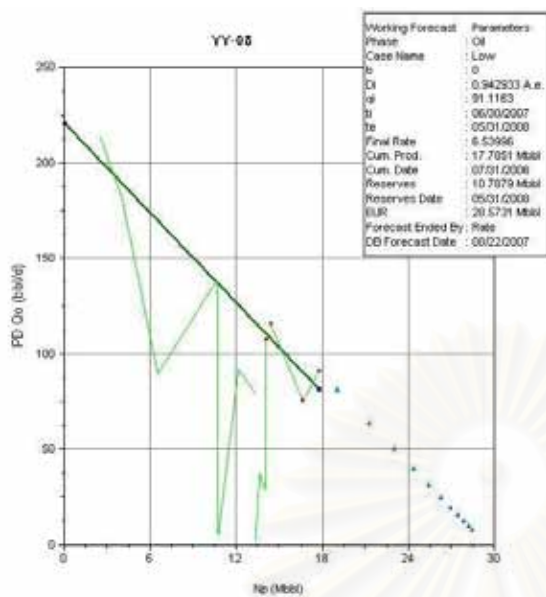
## A-1) Reserve and production forecast plot

- Low production case



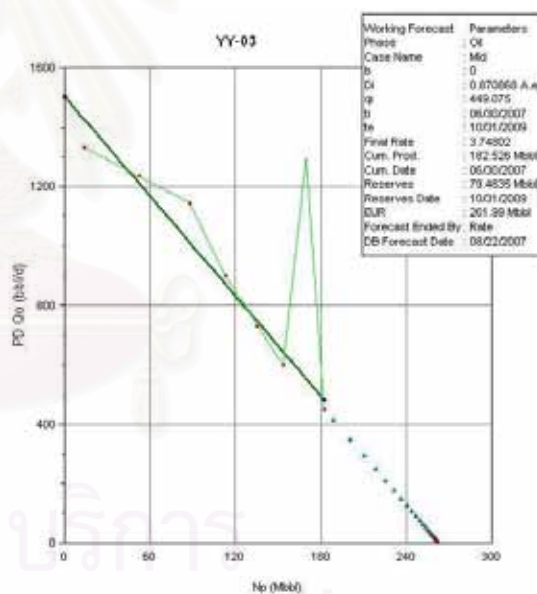
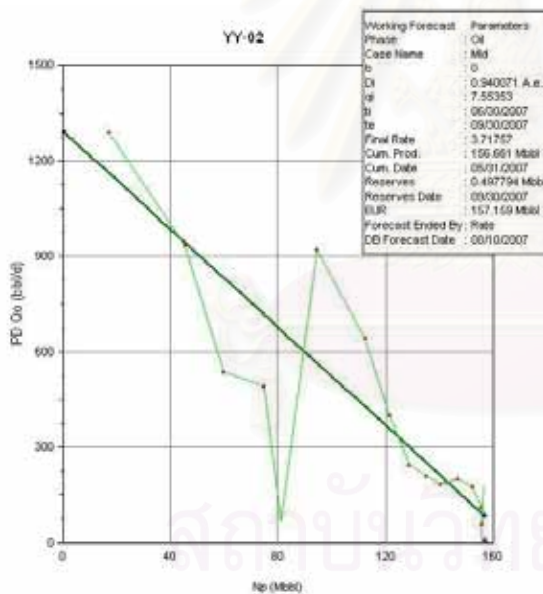
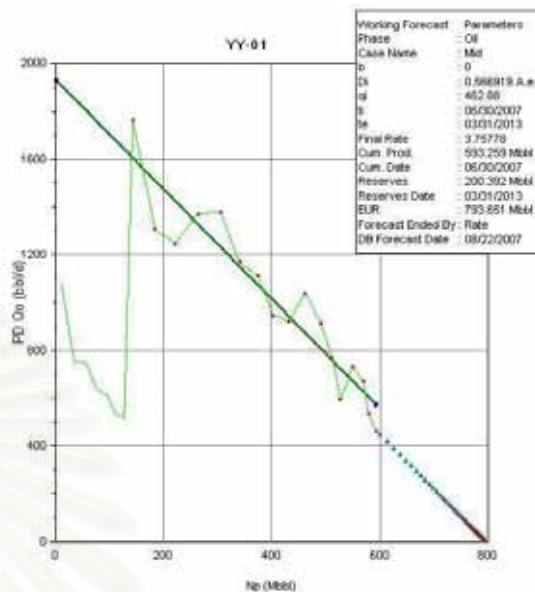
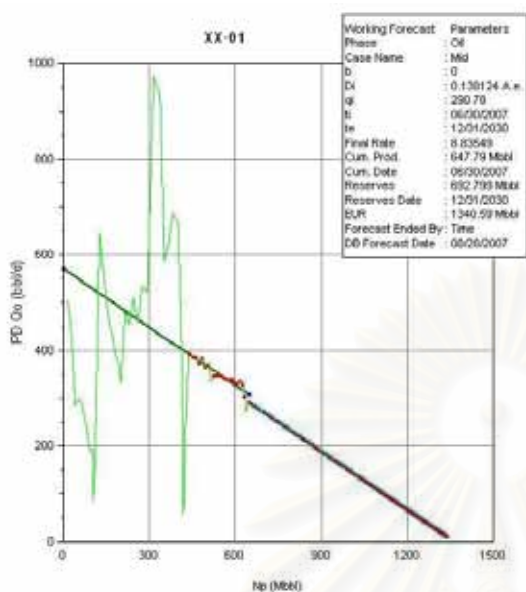


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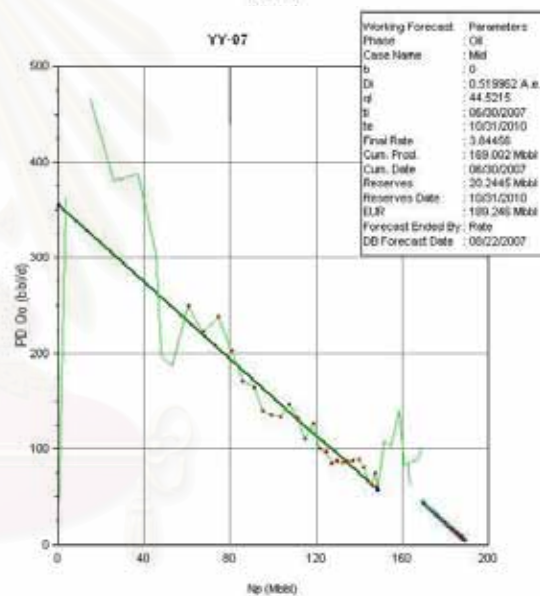
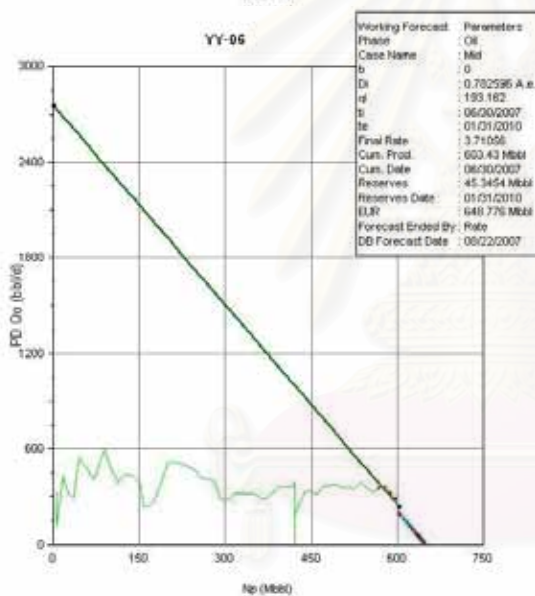
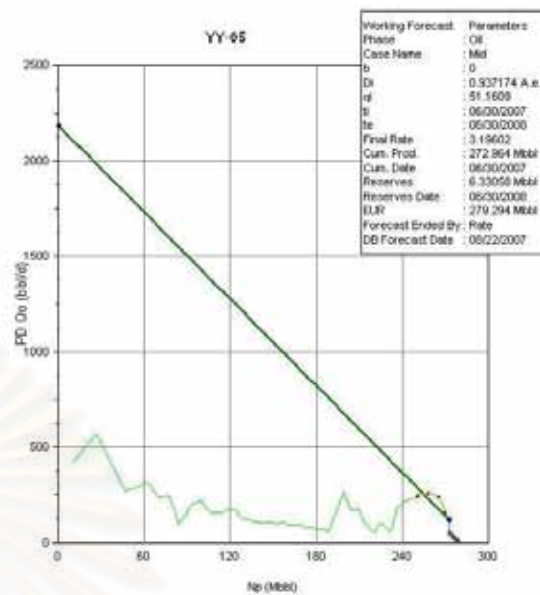
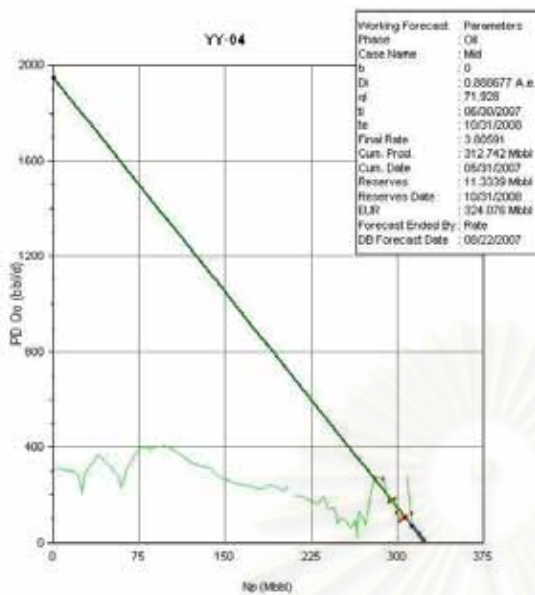
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- Mid production case

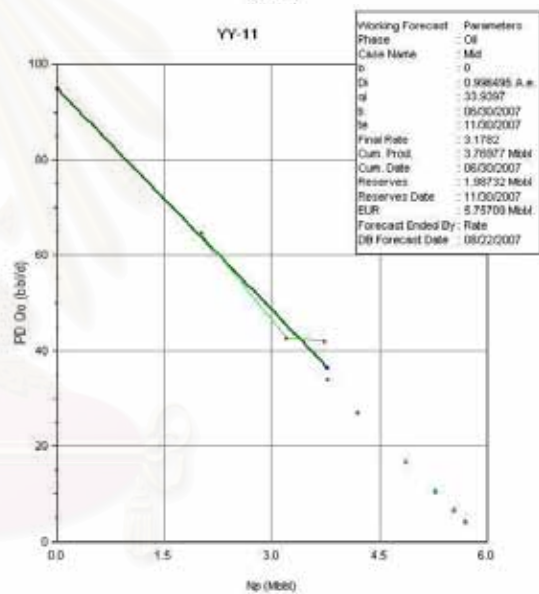
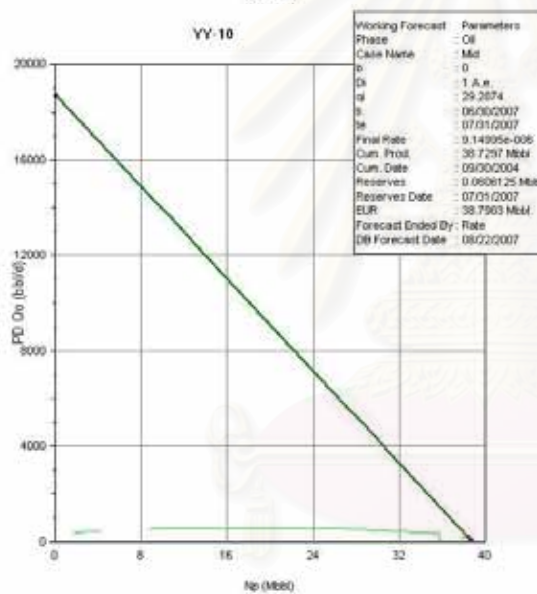
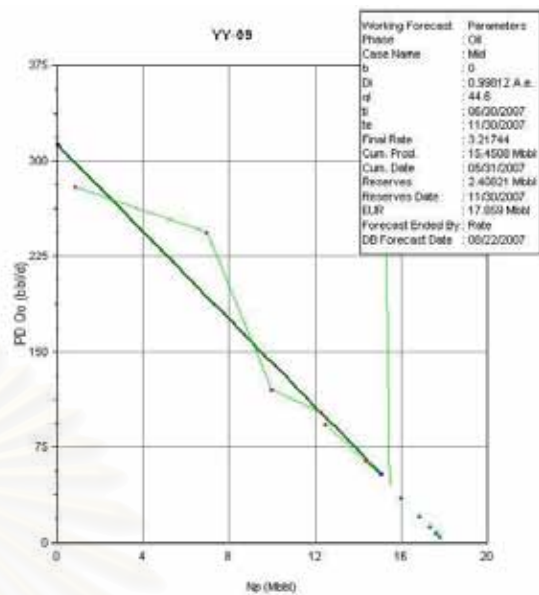
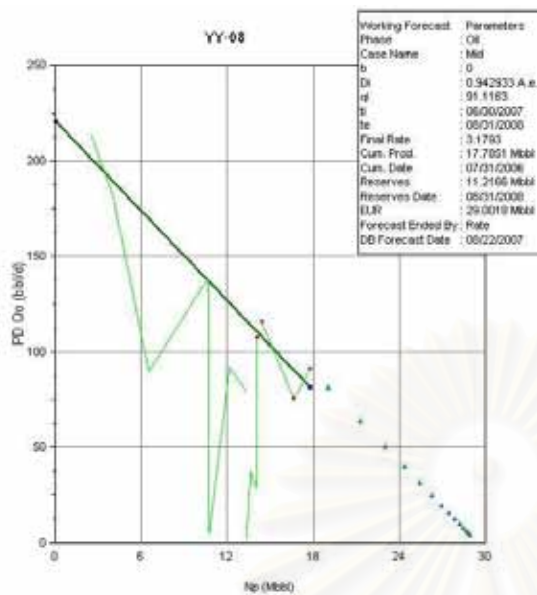


จุฬาลงกรณ์มหาวิทยาลัย



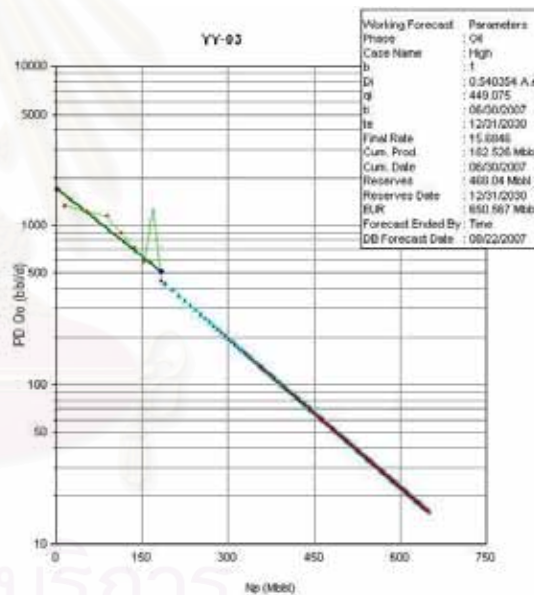
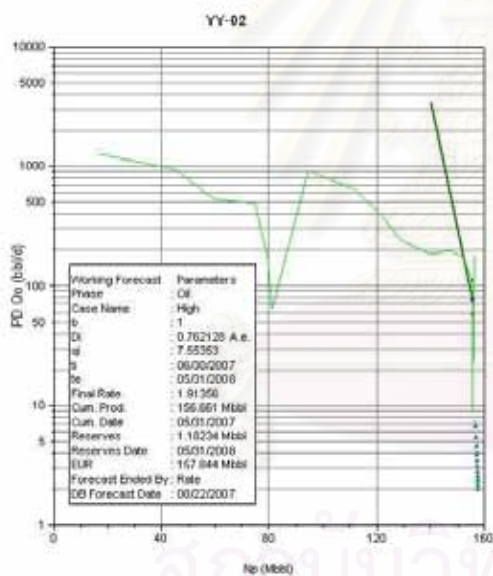
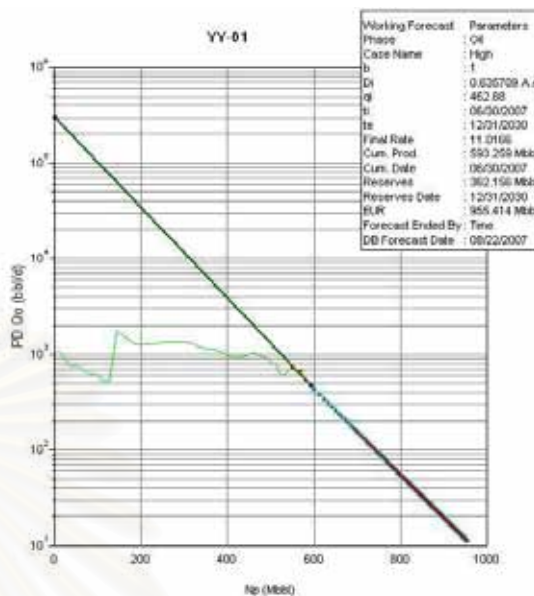
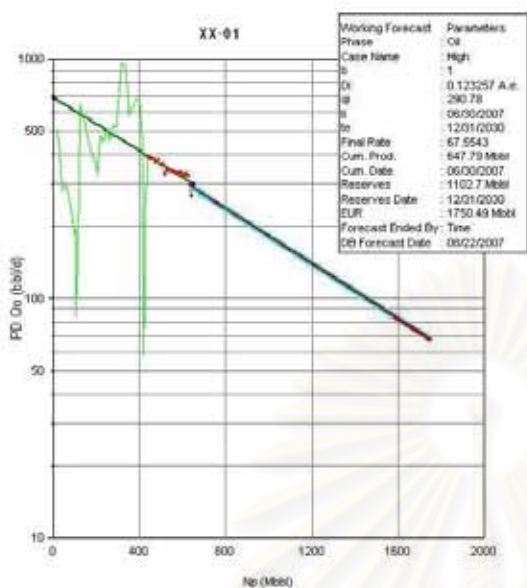


สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

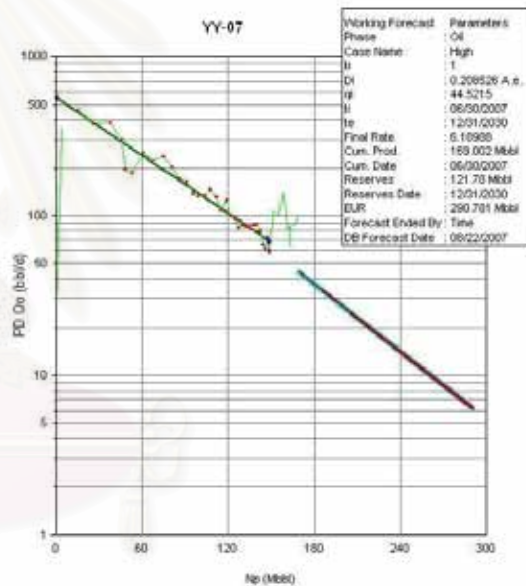
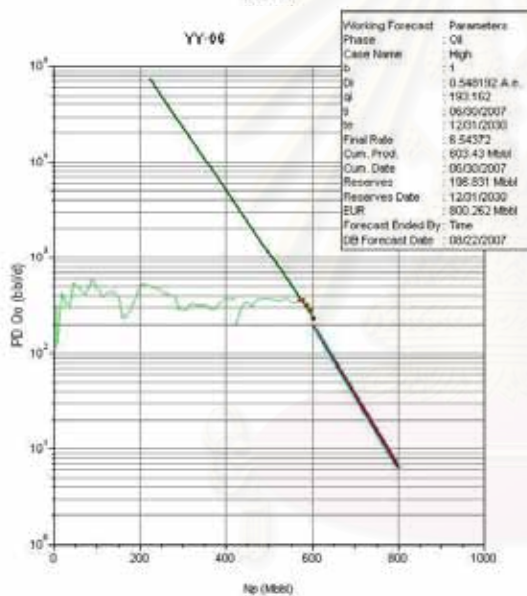
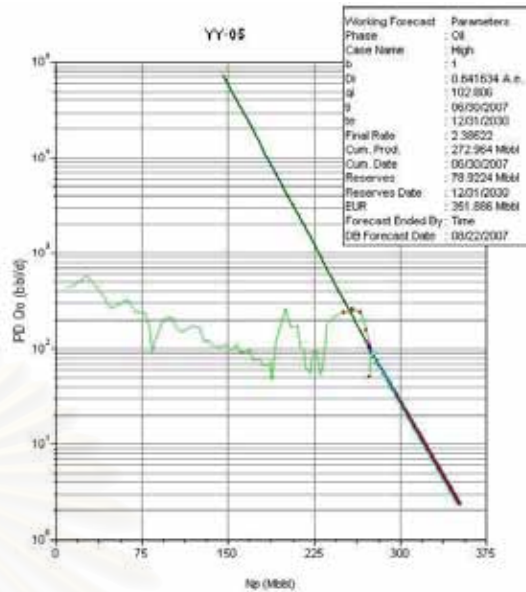
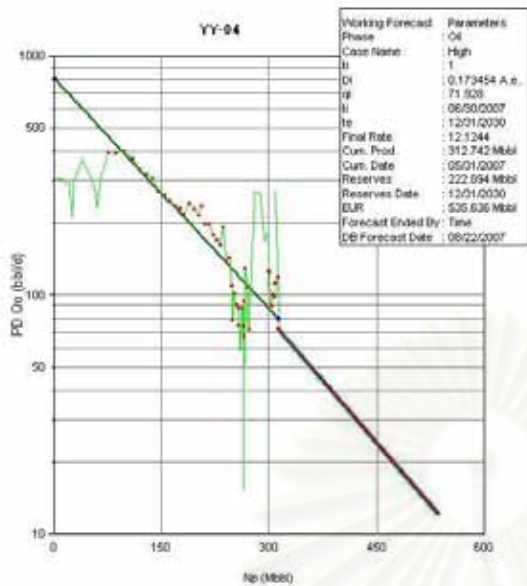


สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

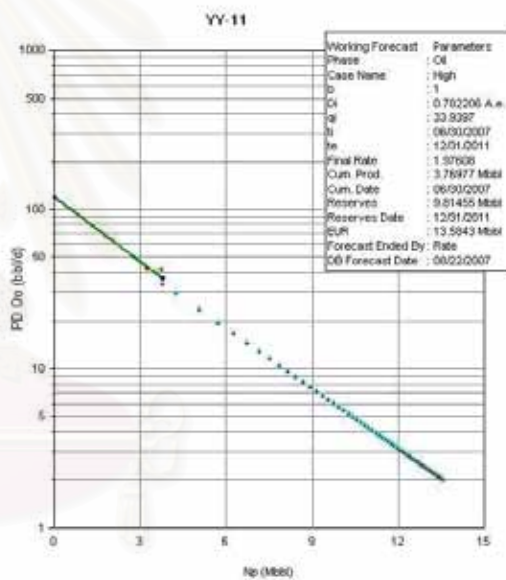
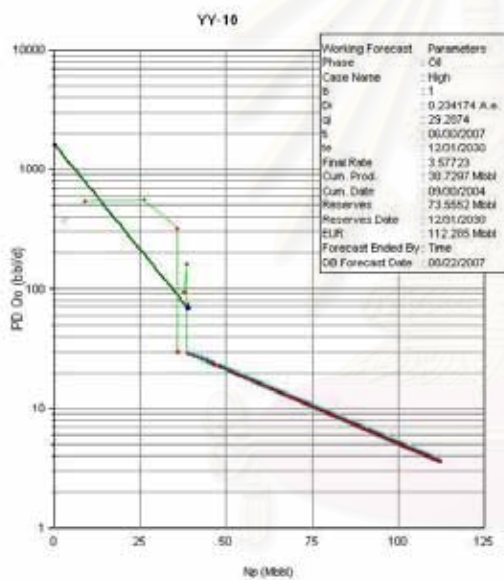
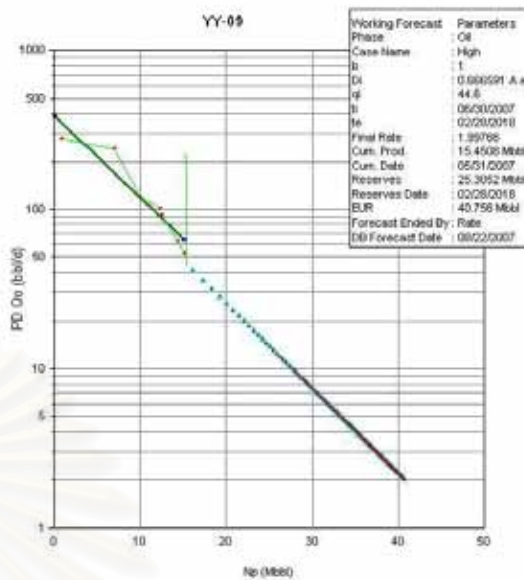
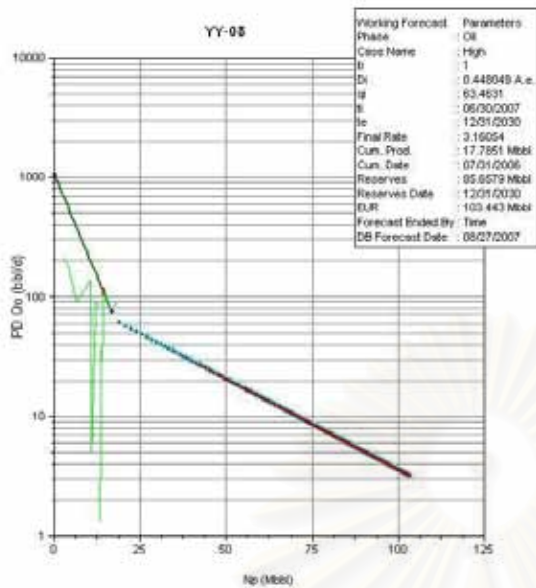
- High production case



สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย



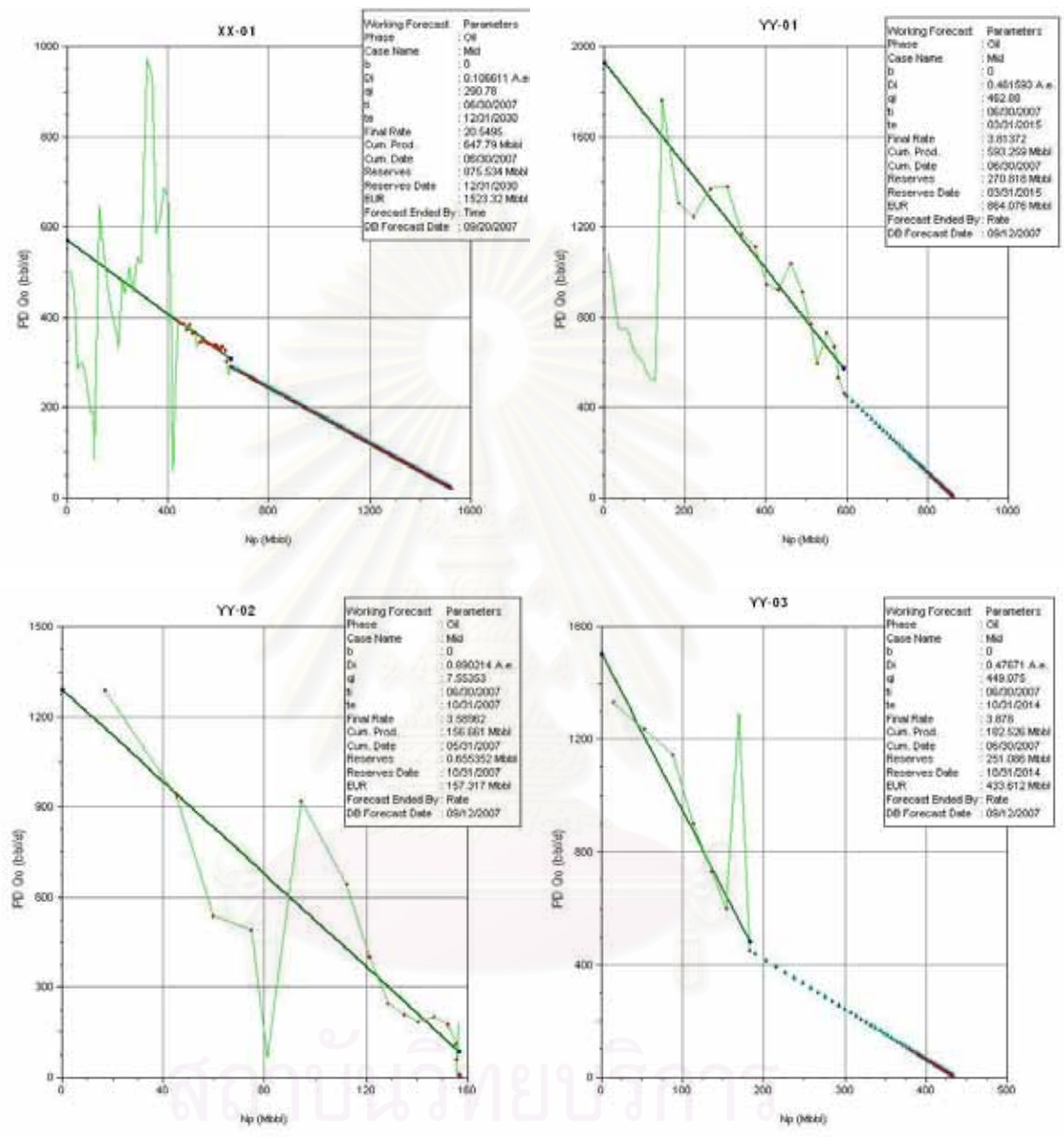
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สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

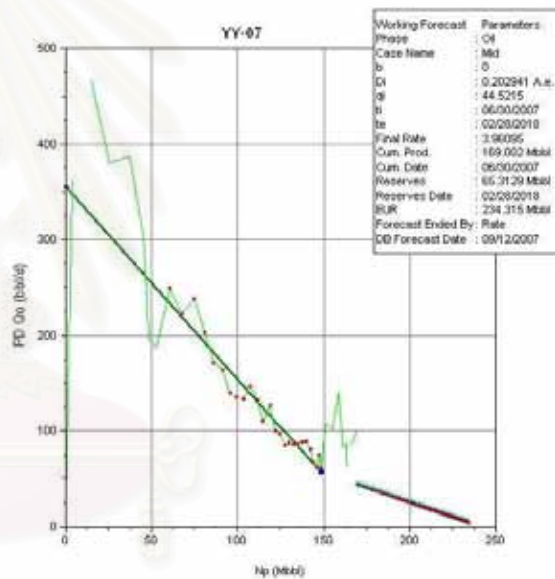
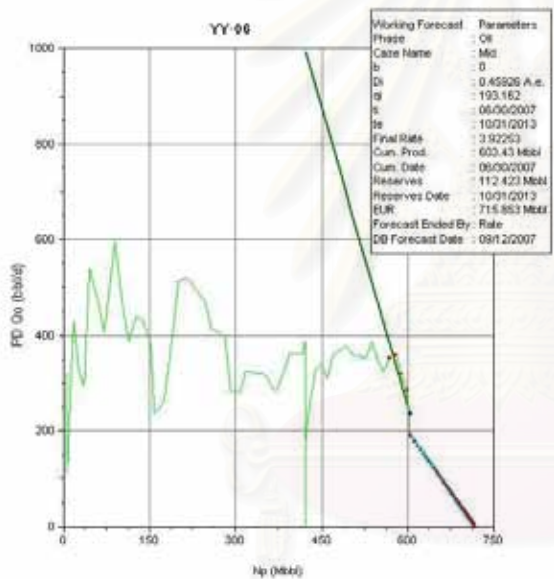
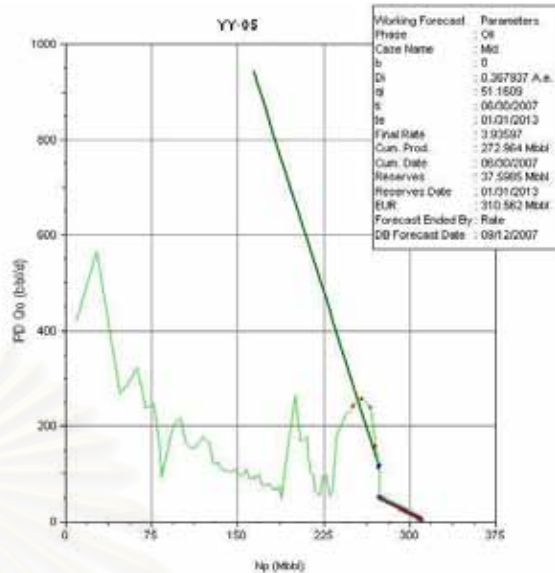
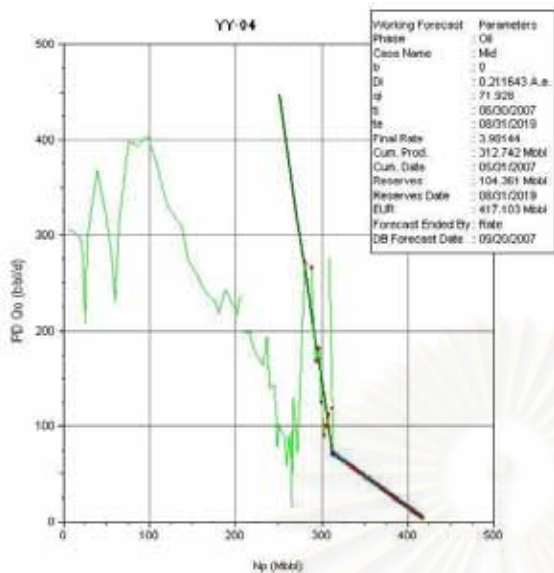


### A-2) Adjusted mid case plot

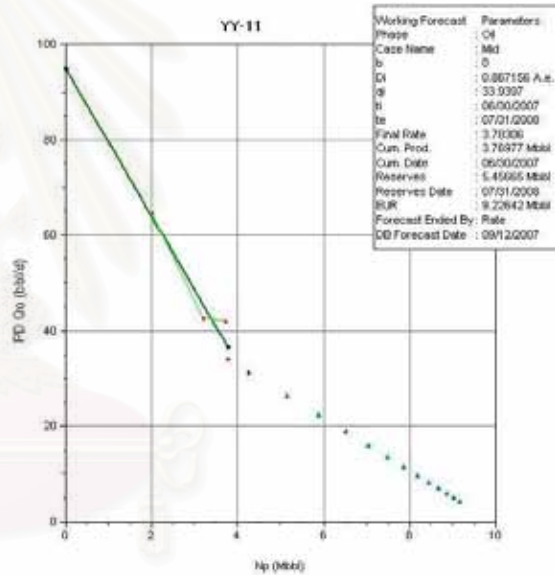
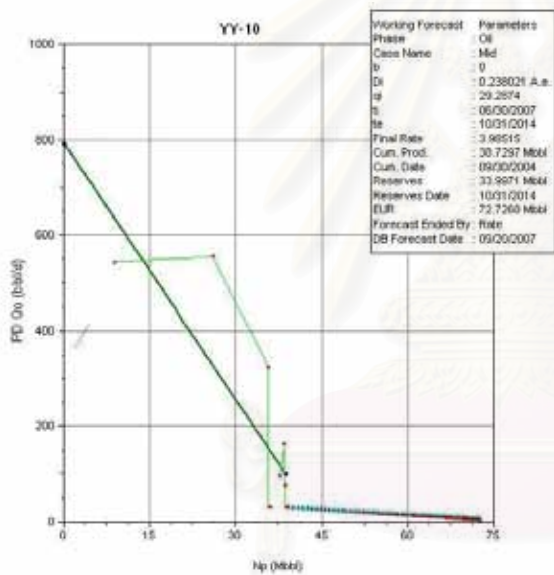
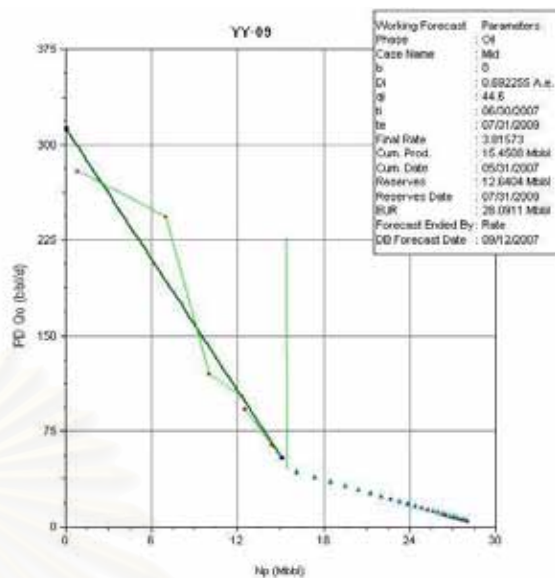
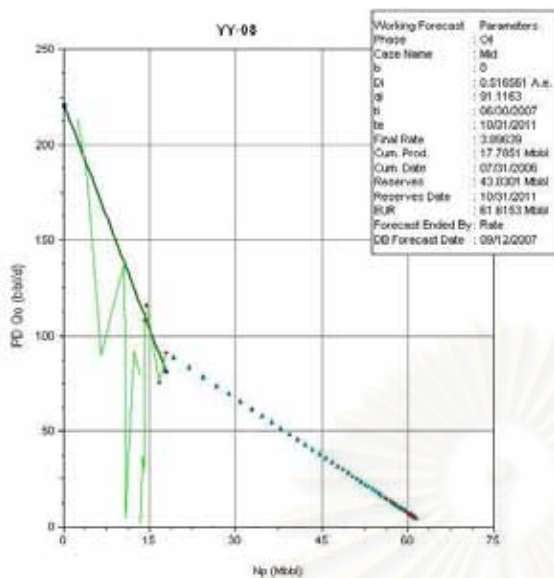


จุฬาลงกรณ์มหาวิทยาลัย



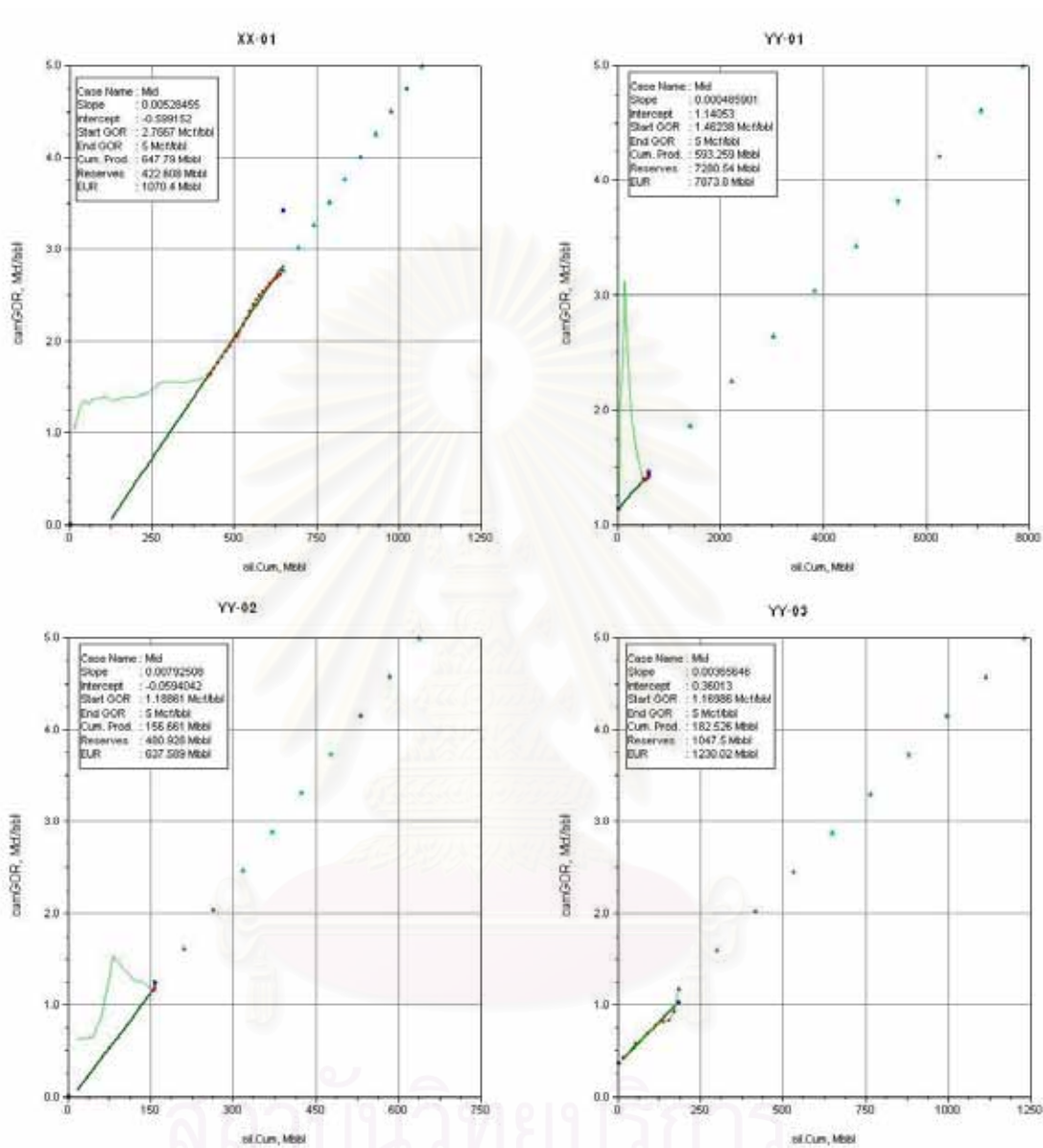


สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

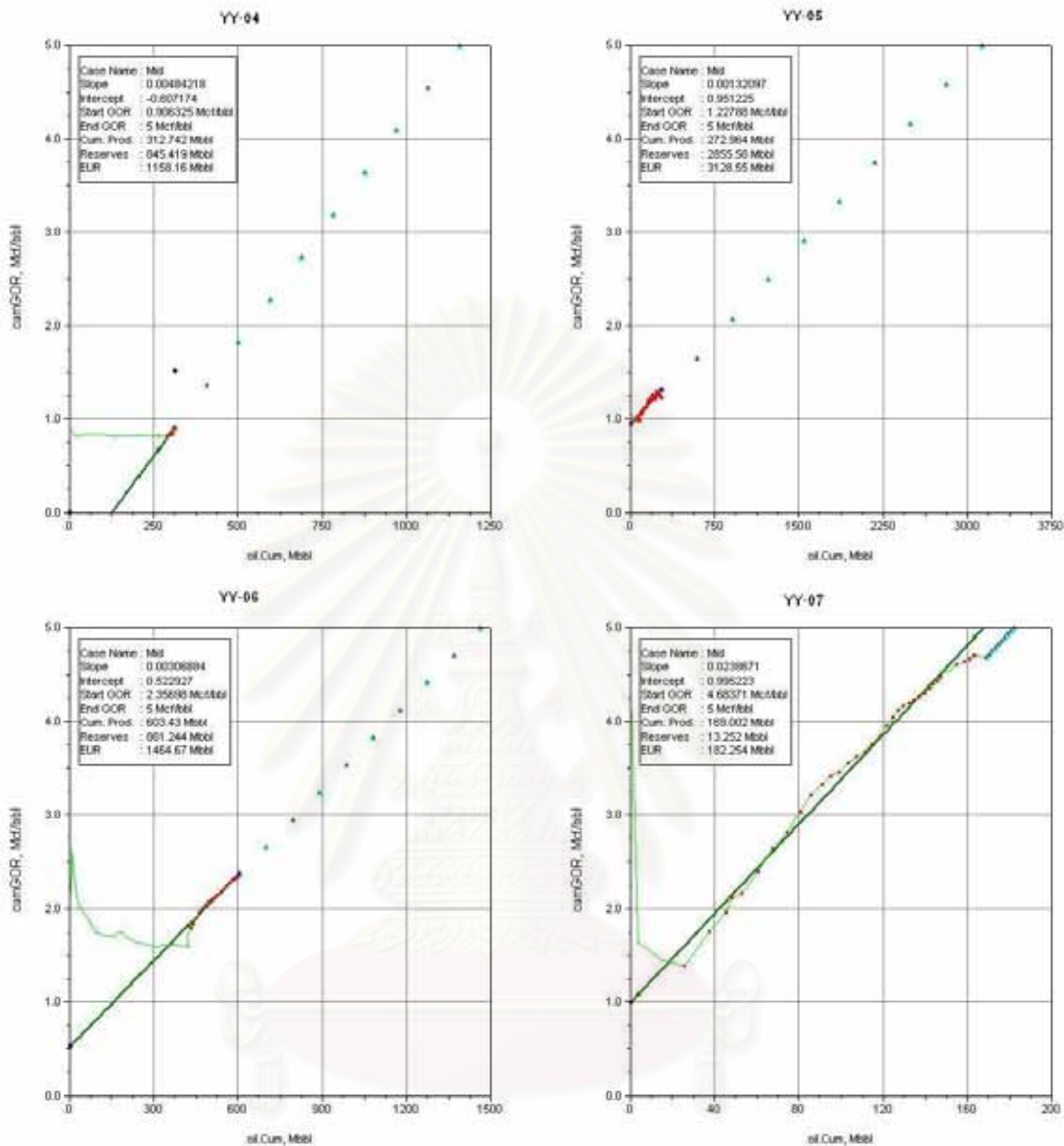


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จุฬาลงกรณ์มหาวิทยาลัย

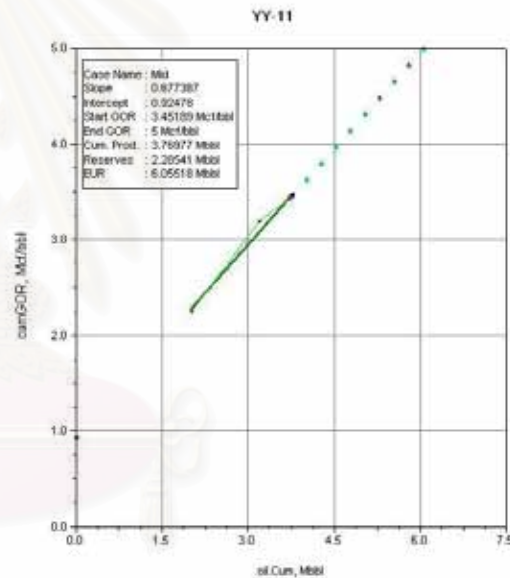
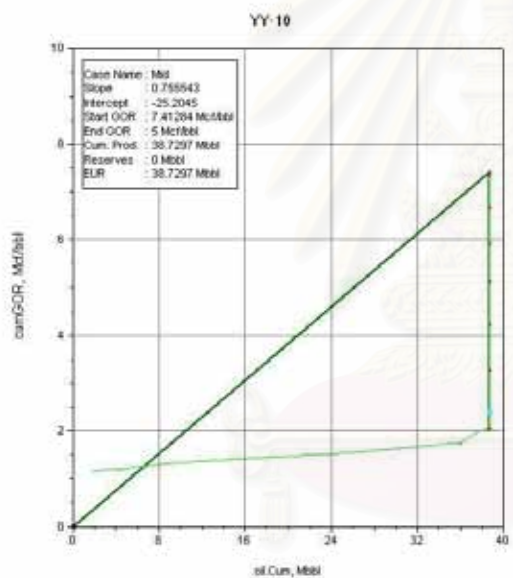
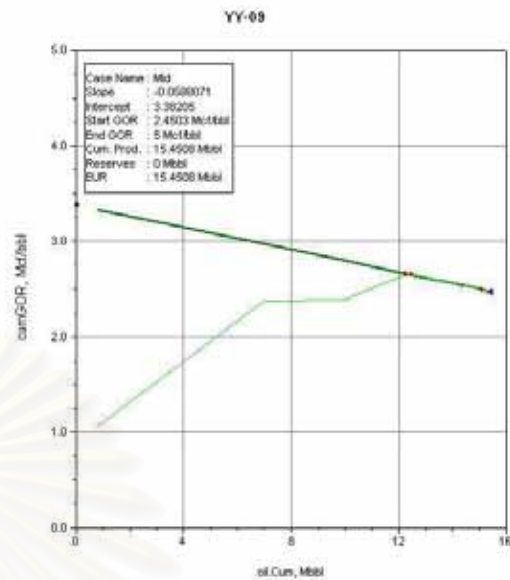
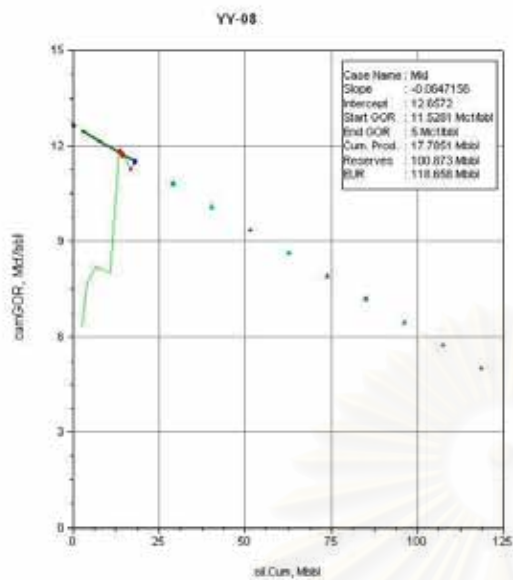
### A-3) Cumulative GOR plot



จุฬาลงกรณ์มหาวิทยาลัย



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จุฬาลงกรณ์มหาวิทยาลัย

## APPENDIX B

**B-1) Petroleum business scenario****Cash flow of field X: Power Generation Option**

สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย



- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50	-73.50
2009	1	642.02				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-57.91	14.17
2010	2	573.61				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-42.33	12.88
2011	3	512.49				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-26.74	11.71
2012	4	457.81				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-11.15	10.65
2013	5	408.96				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	4.43	9.68
2014	6	365.38				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	13.65	5.20
2015	7	326.44				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	22.87	4.73
2016	8	291.61				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	32.09	4.30
2017	9	260.50				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	41.30	3.91
2018	10	232.74				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	46.92	2.17
2019	11	207.94				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	52.54	1.97
2020	12	185.75														
2021	13	165.93														
2022	14	148.25														
2023	15	132.45														
2024	16	118.32														
2025	17	105.70														
2026	18	94.43														
2027	19	84.37														
2028	20	75.37														
2029	21	67.33														
2030	22	59.91														
	Total					12.600	232.89	29.11	18.00	72.00	113.78	61.24	52.54	52.54		7.86

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,881.31	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50	-73.50
2009	1	1,901.03				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-57.91	14.17
2010	2	1,874.17				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-42.33	12.88
2011	3	1,814.71				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-26.74	11.71
2012	4	1,733.17				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-11.15	10.65
2013	5	1,637.69				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	4.43	9.68
2014	6	1,534.47				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	20.02	8.80
2015	7	1,427.87				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	35.60	8.00
2016	8	1,321.00				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	51.19	7.27
2017	9	1,216.34				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	66.78	6.61
2018	10	1,115.65				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	78.76	4.62
2019	11	1,019.86				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	90.75	4.20
2020	12	929.50				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	102.74	3.82
2021	13	845.05				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	114.72	3.47
2022	14	766.73				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	126.71	3.16
2023	15	694.40				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	138.70	2.87
2024	16	627.80				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	150.68	2.61
2025	17	566.79				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	162.67	2.37
2026	18	511.15				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	174.65	2.16
2027	19	460.48				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	186.64	1.96
2028	20	414.39				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	198.63	1.78
2029	21	372.60				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	204.25	0.76
2030	22	333.48				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	209.86	0.69
	Total					33.08	611.35	76.42	34.50	72.00	428.43	218.56	209.86	209.86		50.73

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50	-73.50
2009	1	1,853.17				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-57.91	14.17
2010	2	1,840.23				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-42.33	12.88
2011	3	1,814.97				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-26.74	11.71
2012	4	1,782.71				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-11.15	10.65
2013	5	1,746.74				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	4.43	9.68
2014	6	1,709.06				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	20.02	8.80
2015	7	1,670.87				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	35.60	8.00
2016	8	1,632.86				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	51.19	7.27
2017	9	1,595.57				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	66.78	6.61
2018	10	1,559.32				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	78.76	4.62
2019	11	1,524.22				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	90.75	4.20
2020	12	1,490.32				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	102.74	3.82
2021	13	1,457.68				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	114.72	3.47
2022	14	1,426.37				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	126.71	3.16
2023	15	1,396.30				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	138.70	2.87
2024	16	1,367.40				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	150.68	2.61
2025	17	1,339.67				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	162.67	2.37
2026	18	1,313.09				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	174.65	2.16
2027	19	1,287.59				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	186.64	1.96
2028	20	1,263.06				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	198.63	1.78
2029	21	1,239.50				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	210.61	1.62
2030	22	1,216.88				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	222.60	1.47
	Total					34.65	640.46	80.06	34.50	72.00	453.90	231.30	222.60	222.60		52.37

- Optimization: 6 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	30.00	186.00	216.00	0.00	0.00	0.00	4.50	21.60	-26.10	0.00	-26.10	-220.50	-220.50	-220.50
2009	1	1,853.17				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	-173.74	42.51
2010	2	1,840.23				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	-126.98	38.64
2011	3	1,814.97				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	-80.22	35.13
2012	4	1,782.71				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	-33.46	31.94
2013	5	1,746.74				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	13.30	29.03
2014	6	1,709.06				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	60.05	26.39
2015	7	1,670.87				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	106.81	23.99
2016	8	1,632.86				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	153.57	21.81
2017	9	1,595.57				4.725	87.34	10.92	4.50	21.60	50.32	25.16	25.16	46.76	200.33	19.83
2018	10	1,559.32				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	236.29	13.86
2019	11	1,524.22				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	272.25	12.60
2020	12	1,490.32				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	308.21	11.46
2021	13	1,457.68				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	344.17	10.42
2022	14	1,426.37				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	380.13	9.47
2023	15	1,396.30				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	416.09	8.61
2024	16	1,367.40				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	452.05	7.83
2025	17	1,339.67				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	488.00	7.11
2026	18	1,313.09				4.725	87.34	10.92	4.50	0.00	71.92	35.96	35.96	35.96	523.96	6.47
2027	19	1,287.59				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	553.93	4.90
2028	20	1,263.06				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	583.89	4.45
2029	21	1,239.50				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	613.86	4.05
2030	22	1,216.88				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	643.83	3.68
	Total					100.800	1,863.15	232.89	100.50	216.00	1,313.75	669.93	643.83	643.83		153.70

## Cash flow of field X: LNG Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	718.71	10.00	11.13	173.91	10.84	16.50	30.46	236.34	263.05	0.00	0.00	0.00
2009	1	642.02								234.34	234.34	2,343	24.23
2010	2	573.61								209.37	209.37	2,094	21.65
2011	3	512.49								187.06	187.06	1,871	19.34
2012	4	457.81								167.56	167.56	1,676	17.33
2013	5	408.96								149.27	149.27	1,493	15.43
2014	6	365.38								133.36	133.36	1,334	13.79
2015	7	326.44								119.15	119.15	1,192	12.32
2016	8	291.61								106.73	106.73	1,067	11.04
2017	9	260.50								95.08	95.08	951	9.83
2018	10	232.74								84.95	84.95	850	8.78
2019	11	207.94								75.90	75.90	759	7.85
2020	12	185.75								67.99	67.99	680	7.03
2021	13	165.93								60.57	60.57	606	6.26
2022	14	148.25								54.11	54.11	541	5.60
2023	15	132.45								48.35	48.35	483	5.00
2024	16	118.32								43.31	43.31	433	4.48
2025	17	105.70								38.58	38.58	386	3.99
2026	18	94.43								34.47	34.47	345	3.56
2027	19	84.37								30.80	30.80	308	3.18
2028	20	75.37								27.58	27.58	276	2.85
2029	21	67.33								24.57	24.57	246	2.54
2030	22	59.91								21.87	21.87	219	2.26
	Total									2,278	2,015	20,150	208.35

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	1,406.03	21.09	99,594	2.32	47.64	5.95	8.74	23.63	9.31	4.65	4.65	28.29	-216.79	25.72
2010	1,256.21	18.84	88,981	2.07	42.56	5.32	8.74	23.63	4.87	2.43	2.43	26.07	-190.72	21.54
2011	1,122.35	16.84	79,499	1.85	38.03	4.75	8.74	23.63	0.90	0.45	0.45	24.08	-166.64	18.09
2012	1,005.34	15.08	71,212	1.66	34.06	4.26	8.74	23.63	-2.57	0.00	-2.57	21.06	-145.57	14.39
2013	895.62	13.43	63,440	1.48	30.34	3.79	8.74	23.63	-5.82	0.00	-5.82	17.81	-127.76	11.06
2014	800.18	12.00	56,680	1.32	27.11	3.39	8.74	23.63	-8.65	0.00	-8.65	14.98	-112.78	8.46
2015	714.91	10.72	50,640	1.18	24.22	3.03	8.74	23.63	-11.18	0.00	-11.18	12.45	-100.33	6.39
2016	640.39	9.61	45,361	1.05	21.70	2.71	8.74	23.63	-13.39	0.00	-13.39	10.24	-90.08	4.78
2017	570.49	8.56	40,410	0.94	19.33	2.42	8.74	23.63	-15.46	0.00	-15.46	8.17	-81.91	3.47
2018	509.70	7.65	36,104	0.84	17.27	2.16	8.74	0.00	6.37	3.19	3.19	3.19	-78.73	1.23
2019	455.39	6.83	32,257	0.75	15.43	1.93	8.74	0.00	4.76	2.38	2.38	2.38	-76.35	0.83
2020	407.91	6.12	28,894	0.67	13.82	1.73	8.74	0.00	3.35	1.68	1.68	1.68	-74.67	0.53
2021	363.39	5.45	25,740	0.60	12.31	1.54	8.74	0.00	2.03	1.02	1.02	1.02	-73.65	0.29
2022	324.67	4.87	22,997	0.53	11.00	1.38	8.74	0.00	0.88	0.44	0.44	0.44	-73.21	0.12
2023	290.07	4.35	20,547	0.48	9.83	1.23	8.74	0.00	-0.14	0.00	-0.14	-0.14	-73.35	-0.03
2024	259.83	3.90	18,405	0.43	8.80	1.10	8.74	0.00	-1.04	0.00	-1.04	-1.04	-74.39	-0.23
2025	231.48	3.47	16,396	0.38	7.84	0.98	8.74	0.00	-1.88	0.00	-1.88	-1.88	-76.27	-0.37
2026	206.81	3.10	14,649	0.34	7.01	0.88	8.74	0.00	-2.61	0.00	-2.61	-2.61	-78.87	-0.47
2027	184.77	2.77	13,088	0.30	6.26	0.78	8.74	0.00	-3.26	0.00	-3.26	-3.26	-82.14	-0.53
2028	165.51	2.48	11,724	0.27	5.61	0.70	8.74	0.00	-3.83	0.00	-3.83	-3.83	-85.97	-0.57
2029	147.45	2.21	10,444	0.24	5.00	0.62	8.74	0.00	-4.37	0.00	-4.37	-4.37	-90.34	-0.59
2030	131.21	1.97	9,294	0.22	4.45	0.56	8.74	0.00	-4.85	0.00	-4.85	-4.85	-95.19	-0.60
	12,090	181.35	856,355	19.92	409.61	51.20	201.02	236.34	-78.95	16.24	-95.19	-95.19		-131.57



- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,881.31	10.00	11.13	173.91	10.84	16.50	30.46	236.34	688.56	0.00	0.00	0.00
2009	1	1,901.03								693.88	693.88	6,939	71.75
2010	2	1,874.17								684.07	684.07	6,841	70.73
2011	3	1,814.71								662.37	662.37	6,624	68.49
2012	4	1,733.17								634.34	634.34	6,343	65.59
2013	5	1,637.69								597.76	597.76	5,978	61.81
2014	6	1,534.47								560.08	560.08	5,601	57.91
2015	7	1,427.87								521.17	521.17	5,212	53.89
2016	8	1,321.00								483.48	483.48	4,835	49.99
2017	9	1,216.34								443.96	443.96	4,440	45.91
2018	10	1,115.65								407.21	407.21	4,072	42.11
2019	11	1,019.86								372.25	372.25	3,722	38.49
2020	12	929.50								340.20	340.20	3,402	35.18
2021	13	845.05								308.44	308.44	3,084	31.89
2022	14	766.73								279.86	279.86	2,799	28.94
2023	15	694.40								253.46	253.46	2,535	26.21
2024	16	627.80								229.77	229.77	2,298	23.76
2025	17	566.79								206.88	206.88	2,069	21.39
2026	18	511.15								186.57	186.57	1,866	19.29
2027	19	460.48								168.08	168.08	1,681	17.38
2028	20	414.39								151.67	151.67	1,517	15.68
2029	21	372.60								136.00	136.00	1,360	14.06
2030	22	333.48								121.72	121.72	1,217	12.59
	Total									9,132	8,443	84,432	873.03

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	4,163	62.45	294,897	6.86	141.05	17.63	8.74	23.63	91.05	45.52	45.52	69.16	-175.92	62.87
2010	4,104	61.57	290,730	6.76	139.06	17.38	8.74	23.63	89.30	44.65	44.65	68.29	-107.63	56.43
2011	3,974	59.61	281,507	6.55	134.65	16.83	8.74	23.63	85.44	42.72	42.72	66.36	-41.28	49.85
2012	3,806	57.09	269,595	6.27	128.95	16.12	8.74	23.63	80.46	40.23	40.23	63.86	22.59	43.62
2013	3,587	53.80	254,047	5.91	121.51	15.19	8.74	23.63	73.95	36.98	36.98	60.61	83.20	37.63
2014	3,360	50.41	238,035	5.54	113.86	14.23	8.74	23.63	67.25	33.62	33.62	57.26	140.45	32.32
2015	3,127	46.91	221,498	5.15	105.95	13.24	8.74	23.63	60.33	30.16	30.16	53.80	194.25	27.61
2016	2,901	43.51	205,481	4.78	98.28	12.29	8.74	23.63	53.63	26.81	26.81	50.45	244.70	23.53
2017	2,664	39.96	188,685	4.39	90.25	11.28	8.74	23.63	46.60	23.30	23.30	46.93	291.63	19.90
2018	2,443	36.65	173,066	4.02	82.78	10.35	8.74	0.00	63.69	31.85	31.85	31.85	323.48	12.28
2019	2,233	33.50	158,206	3.68	75.67	9.46	8.74	0.00	57.47	28.74	28.74	28.74	352.21	10.07
2020	2,041	30.62	144,583	3.36	69.16	8.64	8.74	0.00	51.77	25.89	25.89	25.89	378.10	8.25
2021	1,851	27.76	131,088	3.05	62.70	7.84	8.74	0.00	46.12	23.06	23.06	23.06	401.16	6.68
2022	1,679	25.19	118,940	2.77	56.89	7.11	8.74	0.00	41.04	20.52	20.52	20.52	421.68	5.40
2023	1,521	22.81	107,719	2.51	51.52	6.44	8.74	0.00	36.34	18.17	18.17	18.17	439.85	4.35
2024	1,379	20.68	97,654	2.27	46.71	5.84	8.74	0.00	32.13	16.07	16.07	16.07	455.92	3.50
2025	1,241	18.62	87,923	2.04	42.05	5.26	8.74	0.00	28.06	14.03	14.03	14.03	469.94	2.78
2026	1,119	16.79	79,292	1.84	37.93	4.74	8.74	0.00	24.45	12.22	12.22	12.22	482.17	2.20
2027	1,008	15.13	71,433	1.66	34.17	4.27	8.74	0.00	21.16	10.58	10.58	10.58	492.75	1.73
2028	910	13.65	64,458	1.50	30.83	3.85	8.74	0.00	18.24	9.12	9.12	9.12	501.86	1.36
2029	816	12.24	57,799	1.34	27.65	3.46	8.74	0.00	15.45	7.73	7.73	7.73	509.59	1.04
2030	730	10.95	51,732	1.20	24.74	3.09	8.74	0.00	12.91	6.46	6.46	6.46	516.05	0.79
	50,659	759.89	3,588,366	83.45	1,716.37	214.55	201.02	236.34	1,064.46	548.42	516.05	516.05		169.12

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,844.48	10.00	11.13	173.91	10.84	16.50	30.46	236.34	675.08	0.00	0.00	0.00
2009	1	1,853.17								676.41	676.41	6,764	69.94
2010	2	1,840.23								671.68	671.68	6,717	69.45
2011	3	1,814.97								662.46	662.46	6,625	68.50
2012	4	1,782.71								652.47	652.47	6,525	67.47
2013	5	1,746.74								637.56	637.56	6,376	65.92
2014	6	1,709.06								623.81	623.81	6,238	64.50
2015	7	1,670.87								609.87	609.87	6,099	63.06
2016	8	1,632.86								597.63	597.63	5,976	61.79
2017	9	1,595.57								582.38	582.38	5,824	60.22
2018	10	1,559.32								569.15	569.15	5,692	58.85
2019	11	1,524.22								556.34	556.34	5,563	57.53
2020	12	1,490.32								545.46	545.46	5,455	56.40
2021	13	1,457.68								532.05	532.05	5,321	55.01
2022	14	1,426.37								520.62	520.62	5,206	53.83
2023	15	1,396.30								509.65	509.65	5,096	52.70
2024	16	1,367.40								500.47	500.47	5,005	51.75
2025	17	1,339.67								488.98	488.98	4,890	50.56
2026	18	1,313.09								479.28	479.28	4,793	49.56
2027	19	1,287.59								469.97	469.97	4,700	48.59
2028	20	1,263.06								462.28	462.28	4,623	47.80
2029	21	1,239.50								452.42	452.42	4,524	46.78
2030	22	1,216.88								444.16	444.16	4,442	45.93
	Total									12,920.18	12,245.10	122,451	1,266.14

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	4,058	60.88	287,473	6.69	137.50	17.19	8.74	23.63	87.94	43.97	43.97	67.60	-177.47	61.46
2010	4,030	60.45	285,466	6.64	136.54	17.07	8.74	23.63	87.10	43.55	43.55	67.18	-110.29	55.52
2011	3,975	59.62	281,547	6.55	134.67	16.83	8.74	23.63	85.46	42.73	42.73	66.36	-43.92	49.86
2012	3,915	58.72	277,301	6.45	132.64	16.58	8.74	23.63	83.68	41.84	41.84	65.48	21.55	44.72
2013	3,825	57.38	270,962	6.30	129.61	16.20	8.74	23.63	81.03	40.52	40.52	64.15	85.70	39.83
2014	3,743	56.14	265,118	6.17	126.81	15.85	8.74	23.63	78.59	39.29	39.29	62.93	148.63	35.52
2015	3,659	54.89	259,194	6.03	123.98	15.50	8.74	23.63	76.11	38.05	38.05	61.69	210.31	31.65
2016	3,586	53.79	253,992	5.91	121.49	15.19	8.74	23.63	73.93	36.96	36.96	60.60	270.91	28.27
2017	3,494	52.41	247,513	5.76	118.39	14.80	8.74	23.63	71.22	35.61	35.61	59.24	330.15	25.12
2018	3,415	51.22	241,889	5.63	115.70	14.46	8.74	0.00	92.50	46.25	46.25	46.25	376.40	17.83
2019	3,338	50.07	236,445	5.50	113.09	14.14	8.74	0.00	90.22	45.11	45.11	45.11	421.51	15.81
2020	3,273	49.09	231,819	5.39	110.88	13.86	8.74	0.00	88.28	44.14	44.14	44.14	465.65	14.06
2021	3,192	47.88	226,123	5.26	108.16	13.52	8.74	0.00	85.90	42.95	42.95	42.95	508.60	12.44
2022	3,124	46.86	221,265	5.15	105.83	13.23	8.74	0.00	83.87	41.93	41.93	41.93	550.53	11.04
2023	3,058	45.87	216,601	5.04	103.60	12.95	8.74	0.00	81.91	40.96	40.96	40.96	591.49	9.80
2024	3,003	45.04	212,699	4.95	101.74	12.72	8.74	0.00	80.28	40.14	40.14	40.14	631.63	8.74
2025	2,934	44.01	207,816	4.83	99.40	12.43	8.74	0.00	78.24	39.12	39.12	39.12	670.75	7.74
2026	2,876	43.14	203,694	4.74	97.43	12.18	8.74	0.00	76.51	38.26	38.26	38.26	709.00	6.88
2027	2,820	42.30	199,737	4.65	95.54	11.94	8.74	0.00	74.85	37.43	37.43	37.43	746.43	6.12
2028	2,774	41.61	196,469	4.57	93.97	11.75	8.74	0.00	73.49	36.74	36.74	36.74	783.17	5.46
2029	2,714	40.72	192,277	4.47	91.97	11.50	8.74	0.00	71.73	35.87	35.87	35.87	819.04	4.85
2030	2,665	39.97	188,769	4.39	90.29	11.29	8.74	0.00	70.26	35.13	35.13	35.13	854.17	4.32
	73,471	1,102.06	5,204,167	121.03	2,489.23	311.15	201.02	236.34	1,740.72	886.55	854.17	854.17		251.98

### Sensitivity analysis of field X: LNG Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR	
2.50	-161.63	-	@ 10th year
5.00	-141.72	-14.51%	@ 12th year
7.50	-112.07	-8.77%	@ 13th year
10.00	-91.23	-4.36%	@ 14th year
10.34	-88.60	-3.84%	@ 14th year
12.50	-71.98	-0.78%	@ 15th year
15.00	-53.75	2.25%	@ 16th year
17.50	-36.38	4.90%	@ 17th year
20.00	-19.69	7.30%	@ 18th year
22.50	-3.42	9.54%	@ 19th year
25.00	12.55	11.68%	@ 19th year

- Case 2 Oil reserve from MCS with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR
2.50	74.65	17.97%
5.00	129.47	23.82%
7.50	184.28	29.91%
10.00	239.09	36.36%
10.34	246.55	23.27%
12.50	293.91	43.29%
15.00	348.72	50.80%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR
2.50	124.81	20.31%
5.00	189.67	25.72%
7.50	254.53	31.40%
10.00	319.39	37.44%
10.34	328.21	38.30%
12.50	384.24	43.95%
15.00	449.10	51.02%

## Cash flow of field X: Gas to Community Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Sale (MMSCF/Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	1.00	57.00	58.00	263.05	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	642.02				234.34	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	573.61				209.37	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	512.49				187.06	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	457.81				167.56	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	408.96				149.27	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	365.38				133.36	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-28.13	2.81
2015	7	326.44				119.15	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-23.14	2.56
2016	8	291.61				106.73	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-18.15	2.33
2017	9	260.50				95.08	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-13.17	2.11
2018	10	232.74				84.95	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-10.67	0.96
2019	11	207.94				75.90	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-8.18	0.87
2020	12	185.75				67.99	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-5.69	0.79
2021	13	165.93				60.57	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-3.20	0.72
2022	14	148.25				54.11	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-0.70	0.66
2023	15	132.45				48.35	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	1.79	0.60
2024	16	118.32				43.31	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	4.28	0.54
2025	17	105.70				38.58	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	6.78	0.49
2026	18	94.43				34.47	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	9.27	0.45
2027	19	84.37				30.80	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	11.76	0.41
2028	20	75.37				27.58	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	14.26	0.37
2029	21	67.33				24.57	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	16.75	0.34
2030	22	59.91				21.87	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	19.24	0.31
	Total					2,278	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24		-21.82



- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Sale (MMSCF/Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,881.31	1.00	57.00	58.00	688.56	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	1,901.03				693.88	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	1,874.17				684.07	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	1,814.71				662.37	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	1,733.17				634.34	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	1,637.69				597.76	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	1,534.47				560.08	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-28.13	2.81
2015	7	1,427.87				521.17	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-23.14	2.56
2016	8	1,321.00				483.48	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-18.15	2.33
2017	9	1,216.34				443.96	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-13.17	2.11
2018	10	1,115.65				407.21	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-10.67	0.96
2019	11	1,019.86				372.25	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-8.18	0.87
2020	12	929.50				340.20	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-5.69	0.79
2021	13	845.05				308.44	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-3.20	0.72
2022	14	766.73				279.86	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-0.70	0.66
2023	15	694.40				253.46	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	1.79	0.60
2024	16	627.80				229.77	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	4.28	0.54
2025	17	566.79				206.88	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	6.78	0.49
2026	18	511.15				186.57	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	9.27	0.45
2027	19	460.48				168.08	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	11.76	0.41
2028	20	414.39				151.67	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	14.26	0.37
2029	21	372.60				136.00	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	16.75	0.34
2030	22	333.48				121.72	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	19.24	0.31
	Total					9,132	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24		-21.82

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Sale (MMSCF/Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	1.00	57.00	58.00	675.08	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	1,853.17				676.41	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	1,840.23				671.68	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	1,814.97				662.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	1,782.71				652.47	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	1,746.74				637.56	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	1,709.06				623.81	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-28.13	2.81
2015	7	1,670.87				609.87	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-23.14	2.56
2016	8	1,632.86				597.63	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-18.15	2.33
2017	9	1,595.57				582.38	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-13.17	2.11
2018	10	1,559.32				569.15	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-10.67	0.96
2019	11	1,524.22				556.34	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-8.18	0.87
2020	12	1,490.32				545.46	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-5.69	0.79
2021	13	1,457.68				532.05	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-3.20	0.72
2022	14	1,426.37				520.62	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-0.70	0.66
2023	15	1,396.30				509.65	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	1.79	0.60
2024	16	1,367.40				500.47	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	4.28	0.54
2025	17	1,339.67				488.98	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	6.78	0.49
2026	18	1,313.09				479.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	9.27	0.45
2027	19	1,287.59				469.97	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	11.76	0.41
2028	20	1,263.06				462.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	14.26	0.37
2029	21	1,239.50				452.42	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	16.75	0.34
2030	22	1,216.88				444.16	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	19.24	0.31
	Total					12,920	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24		-21.82

### Sensitivity analysis of field X: Gas to Community Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-16.79	4.37%
225.00	-13.46	5.51%
250.00	-9.12	6.98%
275.00	-6.17	7.99%
300.00	-3.22	8.96%
325.00	-0.27	9.91%
350.00	2.68	10.84%
375.00	5.63	11.76%
400.00	8.58	12.66%
416.67	10.55	13.25%

Usage (%)	NPV (Mil ฿)	IRR
40	-30.65	-0.66%
60	-16.79	4.37%
80	-5.84	8.10%
100	2.35	10.74%

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-16.79	4.37%
225.00	-13.46	5.51%
250.00	-9.12	6.98%
275.00	-6.17	7.99%
300.00	-3.22	8.96%
325.00	-0.27	9.91%
350.00	2.68	10.84%
375.00	5.63	11.76%
400.00	8.58	12.66%
416.67	10.55	13.25%

Usage (%)	NPV (Mil ฿)	IRR
40	-30.65	-0.66%
60	-16.79	4.37%
80	-5.84	8.10%
100	2.35	10.74%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-16.79	4.37%
225.00	-13.46	5.51%
250.00	-9.12	6.98%
275.00	-6.17	7.99%
300.00	-3.22	8.96%
325.00	-0.27	9.91%
350.00	2.68	10.84%
375.00	5.63	11.76%
400.00	8.58	12.66%
416.67	10.55	13.25%

Usage (%)	NPV (Mil ฿)	IRR
40	-30.65	-0.66%
60	-16.79	4.37%
80	-5.84	8.10%
100	2.35	10.74%

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## Cash flow of Field Y: Power Generation

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	10.00	62.00	72.00	0.00	0.00	0.00	1.50	14.40	-15.90	0.00	-15.90	-73.50	-73.50	-73.50
2009	1	832.54				1.575	29.11	3.64	1.50	14.40	9.57	4.79	4.79	19.19	-54.31	17.44
2010	2	505.05				1.575	29.11	3.64	1.50	14.40	9.57	4.79	4.79	19.19	-35.13	15.86
2011	3	277.54				0.788	14.56	1.82	1.50	14.40	-3.16	0.00	-3.16	11.24	-23.89	8.44
2012	4	190.07														
2013	5	122.24														
2014	6	57.10														
2015	7	40.00														
2016	8	31.78														
2017	9	25.27														
2018	10	4.30														
2019	11	3.58														
	Total					3.938	72.78	9.10	6.00	57.60	0.08	9.57	-9.49	-23.89		-31.76

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	10.00	62.00	72.00	0.00	0.00	0.00	1.50	12.00	-13.50	0.00	-13.50	-73.50	-73.50	-73.50
2009	1	2,308.79				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	-55.51	16.35
2010	2	1,662.89				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	-37.53	14.86
2011	3	1,179.14				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	-19.54	13.51
2012	4	890.29				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	-1.55	12.28
2013	5	655.32				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	16.43	11.17
2014	6	146.30														
2015	7	110.00														
2016	8	88.09														
2017	9	70.46														
2018	10	16.22														
2019	11	13.52														
	Total					7.875	145.56	18.19	9.00	72.00	46.36	29.93	16.43	16.43		-5.32



- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50	-73.50
2009	1	2,692.75				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-57.91	14.17
2010	2	2,377.45				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-42.33	12.88
2011	3	2,147.96				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-26.74	11.71
2012	4	1,935.04				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	-11.15	10.65
2013	5	1,794.10				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	4.43	9.68
2014	6	1,676.20				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	20.02	8.80
2015	7	1,575.58				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	35.60	8.00
2016	8	1,488.12				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	51.19	7.27
2017	9	1,411.58				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	66.78	6.61
2018	10	1,339.06				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	78.76	4.62
2019	11	1,278.73				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	90.75	4.20
2020	12	1,224.23				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	102.74	3.82
2021	13	1,174.96				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	114.72	3.47
2022	14	1,130.02				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	126.71	3.16
2023	15	1,088.86				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	138.70	2.87
2024	16	1,050.88				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	150.68	2.61
2025	17	1,015.89				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	162.67	2.37
2026	18	983.44				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	174.65	2.16
2027	19	953.27				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	186.64	1.96
2028	20	925.05				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	198.63	1.78
2029	21	898.72				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	210.61	1.62
2030	22	874.03				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	222.60	1.47
	Total					34.650	640.46	80.06	34.50	72.00	453.90	231.30	222.60	222.60		52.37

- Optional 4 MW of case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	20.00	124.00	144.00	0.00	0.00	0.00	3.00	14.40	-17.40	0.00	-17.40	-147.00	-147.00	-147.00
2009	1	2,692.75				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	-115.83	28.34
2010	2	2,377.45				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	-84.65	25.76
2011	3	2,147.96				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	-53.48	23.42
2012	4	1,935.04				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	-22.31	21.29
2013	5	1,794.10				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	8.86	19.36
2014	6	1,676.20				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	40.04	17.60
2015	7	1,575.58				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	71.21	16.00
2016	8	1,488.12				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	102.38	14.54
2017	9	1,411.58				3.150	58.22	7.28	3.00	14.40	33.55	16.77	16.77	31.17	133.55	13.22
2018	10	1,339.06				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	157.53	9.24
2019	11	1,278.73				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	181.50	8.40
2020	12	1,224.23				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	205.47	7.64
2021	13	1,174.96				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	229.45	6.94
2022	14	1,130.02				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	253.42	6.31
2023	15	1,088.86				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	277.39	5.74
2024	16	1,050.88				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	301.36	5.22
2025	17	1,015.89				3.150	58.22	7.28	3.00	0.00	47.95	23.97	23.97	23.97	325.34	4.74
2026	18	983.44				2.363	43.67	5.46	3.00	0.00	35.21	17.60	17.60	17.60	342.94	3.17
2027	19	953.27				2.363	43.67	5.46	3.00	0.00	35.21	17.60	17.60	17.60	360.55	2.88
2028	20	925.05				2.363	43.67	5.46	3.00	0.00	35.21	17.60	17.60	17.60	378.15	2.62
2029	21	898.72				2.363	43.67	5.46	3.00	0.00	35.21	17.60	17.60	17.60	395.75	2.38
2030	22	874.03				2.363	43.67	5.46	3.00	0.00	35.21	17.60	17.60	17.60	413.36	2.16
	Total					65.363	1,208.13	151.02	69.00	144.00	844.12	430.76	413.36	413.36		99.97

## Cash flow of field Y: LNG Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,446.10	10.00	11.13	173.91	10.84	16.50	30.46	236.34	691.11	0.00	0.00	0.00
2009	1	832.54								387.47	387.47	3,875	40.06
2010	2	505.05								228.80	228.80	2,288	23.66
2011	3	277.54								139.12	139.12	1,391	14.38
2012	4	190.07								81.39	81.39	814	8.42
2013	5	122.24								54.64	54.64	546	5.65
2014	6	57.10								35.21	35.21	352	3.64
2015	7	40.00								16.47	16.47	165	1.70
2016	8	31.78								12.70	12.70	127	1.31
2017	9	25.27								10.07	10.07	101	1.04
2018	10	4.30								2.82	2.82	28	0.29
2019	11	3.58								0.94	0.94	9	0.10
	Total									1,661	970	9,696	100.26

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Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	2,324.84	34.87	164,676	3.83	78.77	9.85	8.74	23.63	36.55	18.27	18.27	41.91	-203.17	38.10
2010	1,372.80	20.59	97,240	2.26	46.51	5.81	8.74	23.63	8.32	4.16	4.16	27.80	-175.37	22.97
2011	834.69	12.52	59,124	1.37	28.28	3.53	8.74	23.63	-7.63	0.00	-7.63	16.00	-159.37	12.02
2012	488.32	7.32	34,589	0.80	16.54	2.07	8.74	23.63	-17.90	0.00	-17.90	5.74	-153.63	3.92
2013	327.82	4.92	23,220	0.54	11.11	1.39	8.74	23.63	-22.66	0.00	-22.66	0.98	-152.65	0.61
2014	211.25	3.17	14,963	0.35	7.16	0.89	8.74	23.63	-26.11	0.00	-26.11	-2.48	-155.13	-1.40
2015	98.84	1.48	7,001	0.16	3.35	0.42	8.74	23.63	-29.44	0.00	-29.44	-5.81	-160.94	-2.98
2016	76.20	1.14	5,398	0.13	2.58	0.32	8.74	23.63	-30.11	0.00	-30.11	-6.48	-167.42	-3.02
2017	60.40	0.91	4,278	0.10	2.05	0.26	8.74	23.63	-30.58	0.00	-30.58	-6.95	-174.37	-2.95
2018	16.94	0.25	1,200	0.03	0.57	0.07	8.74	0.00	-8.24	0.00	-8.24	-8.24	-182.61	-3.18
2019	5.61	0.08	398	0.01	0.19	0.02	8.74	0.00	-8.57	0.00	-8.57	-8.57	-191.18	-3.01
	5,818	87.27	412,088	10	197.11	24.64	104.88	236.34	-168.75	22.44	-191.18	-191.18		-183.99

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	3,279.87	10.00	11.13	173.91	10.84	16.50	30.46	236.34	1,411.12	0.00	0.00	0.00
2009	1	2,308.79								974.33	700.00	7,000	72.38
2010	2	1,662.89								693.58	693.58	6,936	71.72
2011	3	1,179.14								502.00	502.00	5,020	51.91
2012	4	890.29								364.30	364.30	3,643	37.67
2013	5	655.32								272.65	272.65	2,726	28.19
2014	6	146.30								182.55	182.55	1,825	18.88
2015	7	110.00								44.36	44.36	444	4.59
2016	8	88.09								35.08	35.08	351	3.63
2017	9	70.46								28.00	28.00	280	2.89
2018	10	16.22								9.26	9.26	93	0.96
2019	11	13.52								3.53	3.53	35	0.37
	Total									4,521	2,835	28,353	293.17

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Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	4,200.00	63.00	297,500	6.92	142.30	17.79	8.74	23.63	92.14	46.07	46.07	69.70	-175.37	63.37
2010	4,161.47	62.42	294,771	6.86	140.99	17.62	8.74	23.63	91.00	45.50	45.50	69.13	-106.24	57.13
2011	3,012.01	45.18	213,350	4.96	102.05	12.76	8.74	23.63	56.92	28.46	28.46	52.09	-54.15	39.14
2012	2,185.80	32.79	154,828	3.60	74.06	9.26	8.74	23.63	32.43	16.21	16.21	39.85	-14.30	27.22
2013	1,635.89	24.54	115,876	2.69	55.43	6.93	8.74	23.63	16.12	8.06	8.06	31.70	17.39	19.68
2014	1,095.29	16.43	77,583	1.80	37.11	4.64	8.74	23.63	0.10	0.05	0.05	23.68	41.07	13.37
2015	266.18	3.99	18,854	0.44	9.02	1.13	8.74	23.63	-24.48	0.00	-24.48	-0.85	40.22	-0.44
2016	210.47	3.16	14,908	0.35	7.13	0.89	8.74	23.63	-26.13	0.00	-26.13	-2.50	37.72	-1.17
2017	167.98	2.52	11,898	0.28	5.69	0.71	8.74	23.63	-27.39	0.00	-27.39	-3.76	33.96	-1.59
2018	55.54	0.83	3,934	0.09	1.88	0.24	8.74	0.00	-7.09	0.00	-7.09	-7.09	26.87	-2.73
2019	21.20	0.32	1,501	0.03	0.72	0.09	8.74	0.00	-8.11	0.00	-8.11	-8.11	18.76	-2.84
	17,012	255.18	1,205,004	28.02	576.37	72.05	104.88	236.34	163.11	144.35	18.76	18.76		-33.95

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	3,183.64	10.00	11.13	173.91	10.84	16.50	30.46	236.34	1,283.15	0.00	0.00	0.00
2009	1	2,692.75								1,036.52	700.00	7,000	72.38
2010	2	2,377.45								899.23	700.00	7,000	72.38
2011	3	2,147.96								804.54	700.00	7,000	72.38
2012	4	1,935.04								721.91	721.91	7,219	74.65
2013	5	1,794.10								664.46	664.46	6,645	68.71
2014	6	1,676.20								618.70	618.70	6,187	63.97
2015	7	1,575.58								579.99	579.99	5,800	59.97
2016	8	1,488.12								548.12	548.12	5,481	56.68
2017	9	1,411.58								517.51	517.51	5,175	53.51
2018	10	1,339.06								490.40	490.40	4,904	50.71
2019	11	1,278.73								467.39	467.39	4,674	48.33
2020	12	1,224.23								448.19	448.19	4,482	46.34
2021	13	1,174.96								428.49	428.49	4,285	44.31
2022	14	1,130.02								411.71	411.71	4,117	42.57
2023	15	1,088.86								396.38	396.38	3,964	40.99
2024	16	1,050.88								383.32	383.32	3,833	39.64
2025	17	1,015.89								369.27	369.27	3,693	38.18
2026	18	983.44								357.25	357.25	3,573	36.94
2027	19	953.27								346.09	346.09	3,461	35.79
2028	20	925.05								336.59	336.59	3,366	34.80
2029	21	898.72								325.94	325.94	3,259	33.70
2030	22	874.03								316.84	316.84	3,168	32.76
	Total									12,751.98	10,828.55	108,286	1,119.67

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.74	23.63	-32.37	0.00	-32.37	-245.08	-245.08	-245.08
2009	4,200.00	63.00	297,500	6.92	142.30	17.79	8.74	23.63	92.14	46.07	46.07	69.70	-175.37	63.37
2010	4,200.00	63.00	297,500	6.92	142.30	17.79	8.74	23.63	92.14	46.07	46.07	69.70	-105.67	57.61
2011	4,200.00	63.00	297,500	6.92	142.30	17.79	8.74	23.63	92.14	46.07	46.07	69.70	-35.97	52.37
2012	4,331.43	64.97	306,810	7.14	146.75	18.34	8.74	23.63	96.03	48.02	48.02	71.65	35.68	48.94
2013	3,986.76	59.80	282,395	6.57	135.07	16.88	8.74	23.63	85.82	42.91	42.91	66.54	102.22	41.32
2014	3,712.18	55.68	262,946	6.12	125.77	15.72	8.74	23.63	77.68	38.84	38.84	62.47	164.69	35.26
2015	3,479.93	52.20	246,495	5.73	117.90	14.74	8.74	23.63	70.79	35.40	35.40	59.03	223.72	30.29
2016	3,288.73	49.33	232,951	5.42	111.42	13.93	8.74	23.63	65.12	32.56	32.56	56.19	279.92	26.22
2017	3,105.04	46.58	219,940	5.11	105.20	13.15	8.74	23.63	59.68	29.84	29.84	53.47	333.39	22.68
2018	2,942.42	44.14	208,421	4.85	99.69	12.46	8.74	0.00	78.49	39.24	39.24	39.24	372.64	15.13
2019	2,804.35	42.07	198,642	4.62	95.01	11.88	8.74	0.00	74.40	37.20	37.20	37.20	409.83	13.04
2020	2,689.11	40.34	190,479	4.43	91.11	11.39	8.74	0.00	70.98	35.49	35.49	35.49	445.32	11.31
2021	2,570.94	38.56	182,108	4.24	87.10	10.89	8.74	0.00	67.48	33.74	33.74	33.74	479.06	9.77
2022	2,470.29	37.05	174,979	4.07	83.69	10.46	8.74	0.00	64.49	32.25	32.25	32.25	511.31	8.49
2023	2,378.27	35.67	168,461	3.92	80.58	10.07	8.74	0.00	61.77	30.88	30.88	30.88	542.19	7.39
2024	2,299.94	34.50	162,912	3.79	77.92	9.74	8.74	0.00	59.44	29.72	29.72	29.72	571.91	6.47
2025	2,215.63	33.23	156,940	3.65	75.07	9.38	8.74	0.00	56.94	28.47	28.47	28.47	600.38	5.63
2026	2,143.51	32.15	151,832	3.53	72.62	9.08	8.74	0.00	54.81	27.40	27.40	27.40	627.79	4.93
2027	2,076.52	31.15	147,087	3.42	70.35	8.79	8.74	0.00	52.82	26.41	26.41	26.41	654.20	4.32
2028	2,019.56	30.29	143,052	3.33	68.42	8.55	8.74	0.00	51.13	25.57	25.57	25.57	679.76	3.80
2029	1,955.66	29.33	138,526	3.22	66.26	8.28	8.74	0.00	49.24	24.62	24.62	24.62	704.38	3.33
2030	1,901.06	28.52	134,658	3.13	64.41	8.05	8.74	0.00	47.62	23.81	23.81	23.81	728.19	2.92
	64,971	974.57	4,602,136	107.03	2,201.27	275.16	201.02	236.34	1,488.75	760.56	728.19	728.19		229.50

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### Sensitivity analysis of field Y: LNG Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

LNG Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR	
2.50	-146.72	-	@ 4th year
5.00	-127.66	-	@ 4th year
7.50	-109.70	-33.88%	@ 4th year
10.00	-92.22	-26.40%	@ 5th year
10.34	-89.81	-25.40%	@ 5th year
12.50	-74.49	-19.29%	@ 5th year
15.00	-56.77	-12.49%	@ 5th year
17.50	-39.45	-5.92%	@ 5th year
20.00	-22.59	0.67%	@ 6th year
22.50	-5.57	7.63%	@ 6th year
25.00	11.44	15.03%	@ 6th year
27.50	28.46	23.05%	@ 6th year

- Case 2 Oil reserve from MCS with increasing cumulative GOR

LNG Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR	
2.50	-47.35	-0.96%	@ 6th year
5.00	-14.71	6.60%	@ 6th year
7.50	17.13	14.01%	@ 6th year
10.00	48.96	21.70%	@ 6th year
10.34	53.27	22.76%	@ 6th year
12.50	79.80	29.64%	@ 6th year
15.00	111.01	38.20%	@ 7th year

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

LNG Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
2.50	112.37	17.60%
5.00	174.73	24.06%
7.50	237.10	30.73%
10.00	299.46	37.71%
10.34	307.94	38.69%
12.50	361.83	45.13%
15.00	424.19	53.10%

## Cash flow of field Y: Gas to Community Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Sale (MMSCF/Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	1.00	57.00	58.00	691.11	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	832.54				387.47	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	505.05				228.80	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	277.54				139.12	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	190.07				81.39	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	122.24				54.64	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	57.10				35.21	14.90	4.16	0.52	0.045	5.80	-2.20	0.00	-2.20	3.60	-29.52	2.03
2015	7	40.00				16.47	10.44	2.92	0.36	0.045	5.80	-3.29	0.00	-3.29	2.51	-27.01	1.29
2016	8	31.78				12.70	8.29	2.32	0.29	0.045	5.80	-3.82	0.00	-3.82	1.98	-25.03	0.92
2017	9	25.27				10.07	6.59	1.84	0.23	0.045	5.80	-4.23	0.00	-4.23	1.57	-23.46	0.66
2018	10	4.30				2.82	1.12	0.31	0.04	0.045	0.00	0.23	0.11	0.11	0.11	-23.34	0.04
2019	11	3.58				0.94	0.93	0.26	0.03	0.045	0.00	0.18	0.09	0.09	0.09	-23.25	0.03
	Total					1,661	145	40.56	5.07	0.540	58.00	-23.05	0.21	-23.25	-23.25		-34.16

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	1.00	57.00	58.00	1,411.12	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	2,308.79				974.33	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	1,662.89				693.58	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	1,179.14				502.00	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	890.29				364.30	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	655.32				272.65	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	146.30				182.55	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-28.13	2.81
2015	7	110.00				44.36	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-23.14	2.56
2016	8	88.09				35.08	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-18.15	2.33
2017	9	70.46				28.00	18.39	5.14	0.64	0.045	5.80	-1.35	0.00	-1.35	4.45	-13.70	1.89
2018	10	16.22				9.26	4.23	1.18	0.15	0.045	0.00	0.99	0.49	0.49	0.49	-13.21	0.19
2019	11	13.52				3.53	3.53	0.99	0.12	0.045	0.00	0.82	0.41	0.41	0.41	-12.80	0.14
	Total					4,521	191	53.31	6.66	0.540	58.00	-11.90	0.90	-12.80	-12.80		-29.22

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	1.00	57.00	58.00	1,283.15	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-58.05
2009	1	2,692.75				1,036.52	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-53.06	4.53
2010	2	2,377.45				899.23	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-48.07	4.12
2011	3	2,147.96				804.54	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-43.09	3.75
2012	4	1,935.04				721.91	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-38.10	3.41
2013	5	1,794.10				664.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-33.11	3.10
2014	6	1,676.20				618.70	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-28.13	2.81
2015	7	1,575.58				579.99	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-23.14	2.56
2016	8	1,488.12				548.12	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-18.15	2.33
2017	9	1,411.58				517.51	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	-13.17	2.11
2018	10	1,339.06				490.40	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-10.67	0.96
2019	11	1,278.73				467.39	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-8.18	0.87
2020	12	1,224.23				448.19	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-5.69	0.79
2021	13	1,174.96				428.49	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-3.20	0.72
2022	14	1,130.02				411.71	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	-0.70	0.66
2023	15	1,088.86				396.38	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	1.79	0.60
2024	16	1,050.88				383.32	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	4.28	0.54
2025	17	1,015.89				369.27	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	6.78	0.49
2026	18	983.44				357.25	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	9.27	0.45
2027	19	953.27				346.09	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	11.76	0.41
2028	20	925.05				336.59	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	14.26	0.37
2029	21	898.72				325.94	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	16.75	0.34
2030	22	874.03				316.84	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	19.24	0.31
	Total					12,751.98	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24		-21.82



### Sensitivity analysis of field Y: Gas to Community Option

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-29.13	-9.01%
225.00	-26.79	-7.33%
250.00	-23.75	-5.16%
275.00	-21.69	-3.64%
300.00	-19.64	-2.17%
325.00	-17.58	-0.76%
350.00	-15.60	0.54%
375.00	-13.67	1.78%
400.00	-11.74	2.99%
416.67	-10.45	3.79%

Usage (%)	NPV (Mil ฿)	IRR
40	-37.33	-13.71%
60	-29.13	-9.01%
80	-23.16	-5.44%
100	-19.33	-3.10%

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-24.19	-3.02%
225.00	-21.46	-1.42%
250.00	-17.97	0.57%
275.00	-15.81	1.79%
300.00	-13.74	2.91%
325.00	-11.67	4.01%
350.00	-9.60	5.10%
375.00	-7.53	6.18%
400.00	-5.47	7.24%
416.67	-4.09	7.94%

Usage (%)	NPV (Mil ฿)	IRR
40	-35.30	-9.90%
60	-24.19	-3.02%
80	-16.61	1.08%
100	-12.04	3.45%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
208.33	-16.79	4.37%
225.00	-13.46	5.51%
250.00	-9.12	6.98%
275.00	-6.17	7.99%
300.00	-3.22	8.96%
325.00	-0.27	9.91%
350.00	2.68	10.84%
375.00	5.63	11.76%
400.00	8.58	12.66%
416.67	10.55	13.25%

Usage (%)	NPV (Mil ฿)	IRR
40	-30.65	-0.66%
60	-16.79	4.37%
80	-5.84	8.10%
100	2.35	10.74%

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**B-2) Power generation scenario****Cash flow of field X: Gas Seller**

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- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	10.00	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	642.02		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-8.02	2.25
2010	2	573.61		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-5.55	2.05
2011	3	512.49		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-3.07	1.86
2012	4	457.81		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-0.59	1.69
2013	5	408.96		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	1.88	1.54
2014	6	365.38		73	2.54	0.64	0.50	1.00	0.41	0.20	0.20	1.20	3.09	0.68
2015	7	326.44		73	2.54	0.64	0.50	1.00	0.41	0.20	0.20	1.20	4.29	0.62
2016	8	291.61		73	2.54	0.64	0.50	1.00	0.41	0.20	0.20	1.20	5.50	0.56
2017	9	260.50		73	2.54	0.64	0.50	1.00	0.41	0.20	0.20	1.20	6.70	0.51
2018	10	232.74		73	2.54	0.64	0.50	0.00	1.41	0.70	0.70	0.70	7.41	0.27
2019	11	207.94		73	2.54	0.64	0.50	0.00	1.41	0.70	0.70	0.70	8.11	0.25
2020	12	185.75												
2021	13	165.93												
2022	14	148.25												
2023	15	132.45												
2024	16	118.32												
2025	17	105.70												
2026	18	94.43												
2027	19	84.37												
2028	20	75.37												
2029	21	67.33												
2030	22	59.91												
	Total			1,168	40.72	7.00	6.00	10.00	17.72	9.61	8.11	8.11		1.78

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
0	1,881.31	10.00	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
1	1,901.03		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-8.02	2.25
2	1,874.17		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-5.55	2.05
3	1,814.71		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-3.07	1.86
4	1,733.17		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-0.59	1.69
5	1,637.69		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	1.88	1.54
6	1,534.47		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	4.36	1.40
7	1,427.87		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	6.84	1.27
8	1,321.00		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	9.31	1.16
9	1,216.34		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	11.79	1.05
10	1,115.65		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	13.77	0.76
11	1,019.86		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	15.74	0.69
12	929.50		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	17.72	0.63
13	845.05		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	19.70	0.57
14	766.73		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	21.67	0.52
15	694.40		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	23.65	0.47
16	627.80		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	25.63	0.43
17	566.79		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	27.61	0.39
18	511.15		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	29.58	0.36
19	460.48		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	31.56	0.32
20	414.39		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	33.54	0.29
21	372.60		73	2.54	0.64	0.50	0.00	1.41	0.70	0.70	0.70	34.24	0.10
22	333.48		73	2.54	0.64	0.50	0.00	1.41	0.70	0.70	0.70	34.94	0.09
Total			3,066	106.89	14.00	11.50	10.00	71.39	36.44	34.94	34.94		9.39

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	10.00	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	1,853.17		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-8.02	2.25
2010	2	1,840.23		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-5.55	2.05
2011	3	1,814.97		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-3.07	1.86
2012	4	1,782.71		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-0.59	1.69
2013	5	1,746.74		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	1.88	1.54
2014	6	1,709.06		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	4.36	1.40
2015	7	1,670.87		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	6.84	1.27
2016	8	1,632.86		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	9.31	1.16
2017	9	1,595.57		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	11.79	1.05
2018	10	1,559.32		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	13.77	0.76
2019	11	1,524.22		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	15.74	0.69
2020	12	1,490.32		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	17.72	0.63
2021	13	1,457.68		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	19.70	0.57
2022	14	1,426.37		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	21.67	0.52
2023	15	1,396.30		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	23.65	0.47
2024	16	1,367.40		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	25.63	0.43
2025	17	1,339.67		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	27.61	0.39
2026	18	1,313.09		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	29.58	0.36
2027	19	1,287.59		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	31.56	0.32
2028	20	1,263.06		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	33.54	0.29
2029	21	1,239.50		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	35.51	0.27
2030	22	1,216.88		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	37.49	0.24
	Total			3,212	111.98	14.00	11.50	10.00	76.48	38.99	37.49	37.49		9.72



- Optimization 6 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	30.00	0.00	0.00	0.00	1.50	3.00	-4.50	0.00	-4.50	-31.50	-31.50	-31.50
2009	1	1,853.17		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	-24.07	6.75
2010	2	1,840.23		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	-16.64	6.14
2011	3	1,814.97		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	-9.21	5.58
2012	4	1,782.71		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	-1.78	5.08
2013	5	1,746.74		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	5.65	4.61
2014	6	1,709.06		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	13.08	4.19
2015	7	1,670.87		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	20.51	3.81
2016	8	1,632.86		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	27.94	3.47
2017	9	1,595.57		438	15.27	1.91	1.50	3.00	8.86	4.43	4.43	7.43	35.37	3.15
2018	10	1,559.32		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	41.30	2.29
2019	11	1,524.22		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	47.23	2.08
2020	12	1,490.32		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	53.16	1.89
2021	13	1,457.68		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	59.09	1.72
2022	14	1,426.37		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	65.02	1.56
2023	15	1,396.30		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	70.96	1.42
2024	16	1,367.40		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	76.89	1.29
2025	17	1,339.67		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	82.82	1.17
2026	18	1,313.09		438	15.27	1.91	1.50	0.00	11.86	5.93	5.93	5.93	88.75	1.07
2027	19	1,287.59		365	12.72	1.91	1.25	0.00	9.57	4.78	4.78	4.78	93.53	0.78
2028	20	1,263.06		365	12.72	1.91	1.25	0.00	9.57	4.78	4.78	4.78	98.31	0.71
2029	21	1,239.50		365	12.72	1.91	1.25	0.00	9.57	4.78	4.78	4.78	103.10	0.65
2030	22	1,216.88		365	12.72	1.91	1.25	0.00	9.57	4.78	4.78	4.78	107.88	0.59
	Total			9,344	325.75	41.99	33.50	30.00	220.26	112.38	107.88	107.88		28.50

### Sensitivity analysis of field X: Gas Seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-4.15	-6.66%
15.00	-1.24	5.63%
20.00	1.67	15.54%
25.00	4.25	24.26%
26.00	4.75	26.04%
30.00	6.79	33.41%

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-0.82	8.40%
15.00	3.30	15.99%
20.00	7.42	23.23%
25.00	11.54	30.74%
26.00	12.37	32.30%
30.00	15.66	38.86%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-0.69	8.70%
15.00	3.49	16.14%
20.00	7.67	23.30%
25.00	11.86	30.77%
26.00	12.70	32.33%
30.00	16.04	38.88%

- Optimization 6 MW of case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-2.29	8.54%
15.00	10.12	16.04%
20.00	22.54	23.24%
25.00	34.95	30.74%
26.00	37.43	32.31%
30.00	47.36	38.86%

## Cash flow of field X: Power Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Building, Equipment, and Machine Cost (Mil Baht)	Power Production (MW)	Power Producer Revenue (Mil Baht)	Gas Cost (Mil Baht)	Power Producer Operation & Maintenance Expense (Mil Baht)	Power Producer Straight Line Depreciation (Mil Baht)	Power Producer Taxable Income (Mil Baht)	Gas Seller 15% Income Tax (Mil Baht)	Power Producer Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	62.00	0.00	0.00	0.00	1.00	5.17	-6.17	0.00	-6.17	-63.00	-63.00	-63.00
2009	1	642.02		1.575	29.11	5.09	1.00	5.17	17.86	2.68	15.18	20.34	-42.66	18.49
2010	2	573.61		1.575	29.11	5.09	1.00	5.17	17.86	2.68	15.18	20.34	-22.31	16.81
2011	3	512.49		1.575	29.11	5.09	1.00	5.17	17.86	2.68	15.18	20.34	-1.97	15.28
2012	4	457.81		1.575	29.11	5.09	1.00	5.17	17.86	2.68	15.18	20.34	18.37	13.89
2013	5	408.96		1.575	29.11	5.09	1.00	5.17	17.86	2.68	15.18	20.34	38.72	12.63
2014	6	365.38		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	48.85	5.72
2015	7	326.44		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	58.99	5.20
2016	8	291.61		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	69.12	4.73
2017	9	260.50		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	79.26	4.30
2018	10	232.74		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	89.39	3.91
2019	11	207.94		0.788	14.56	2.54	1.00	5.17	5.84	0.88	4.97	10.13	99.52	3.55
2020	12	185.75												
2021	13	165.93												
2022	14	148.25												
2023	15	132.45												
2024	16	118.32												
2025	17	105.70												
2026	18	94.43												
2027	19	84.37												
2028	20	75.37												
2029	21	67.33												
2030	22	59.91												
	Total			12.600	232.89		12.00	62.00	118.18	18.65	99.52	99.52		41.52

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Building, Equipment, and Machine Cost (Mil Baht)	Power Production (MW)	Power Producer Revenue (Mil Baht)	Gas Cost (Mil Baht)	Power Producer Operation & Maintenance Expense (Mil Baht)	Power Producer Straight Line Depreciation (Mil Baht)	Power Producer Taxable Income (Mil Baht)	Gas Seller 15% Income Tax (Mil Baht)	Power Producer Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,881.31	62.00	0.00	0.00	0.00	1.00	2.70	-3.70	0.00	-3.70	-63.00	-63.00	-63.00
2009	1	1,901.03		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-43.03	18.16
2010	2	1,874.17		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-23.05	16.51
2011	3	1,814.71		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-3.08	15.01
2012	4	1,733.17		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	16.89	13.64
2013	5	1,637.69		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	36.86	12.40
2014	6	1,534.47		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	56.84	11.27
2015	7	1,427.87		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	76.81	10.25
2016	8	1,321.00		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	96.78	9.32
2017	9	1,216.34		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	116.76	8.47
2018	10	1,115.65		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	136.73	7.70
2019	11	1,019.86		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	156.70	7.00
2020	12	929.50		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	176.68	6.36
2021	13	845.05		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	196.65	5.79
2022	14	766.73		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	216.62	5.26
2023	15	694.40		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	236.59	4.78
2024	16	627.80		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	256.57	4.35
2025	17	566.79		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	276.54	3.95
2026	18	511.15		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	296.51	3.59
2027	19	460.48		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	316.49	3.27
2028	20	414.39		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	336.46	2.97
2029	21	372.60		0.788	14.56	2.54	1.00	2.70	8.32	1.25	7.07	9.76	346.22	1.32
2030	22	333.48		0.788	14.56	2.54	1.00	2.70	8.32	1.25	7.07	9.76	355.99	1.20
	Total			33.075	611.35		23.00	62.00	419.46	63.47	355.99	355.99		109.56

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Building, Equipment, and Machine Cost (Mil Baht)	Power Production (MW)	Power Producer Revenue (Mil Baht)	Gas Cost (Mil Baht)	Power Producer Operation & Maintenance Expense (Mil Baht)	Power Producer Straight Line Depreciation (Mil Baht)	Power Producer Taxable Income (Mil Baht)	Gas Seller 15% Income Tax (Mil Baht)	Power Producer Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	62.00	0.00	0.00	0.00	1.00	2.70	-3.70	0.00	-3.70	-63.00	-63.00	-63.00
2009	1	1,853.17		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-43.03	18.16
2010	2	1,840.23		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-23.05	16.51
2011	3	1,814.97		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	-3.08	15.01
2012	4	1,782.71		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	16.89	13.64
2013	5	1,746.74		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	36.86	12.40
2014	6	1,709.06		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	56.84	11.27
2015	7	1,670.87		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	76.81	10.25
2016	8	1,632.86		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	96.78	9.32
2017	9	1,595.57		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	116.76	8.47
2018	10	1,559.32		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	136.73	7.70
2019	11	1,524.22		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	156.70	7.00
2020	12	1,490.32		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	176.68	6.36
2021	13	1,457.68		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	196.65	5.79
2022	14	1,426.37		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	216.62	5.26
2023	15	1,396.30		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	236.59	4.78
2024	16	1,367.40		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	256.57	4.35
2025	17	1,339.67		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	276.54	3.95
2026	18	1,313.09		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	296.51	3.59
2027	19	1,287.59		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	316.49	3.27
2028	20	1,263.06		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	336.46	2.97
2029	21	1,239.50		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	356.43	2.70
2030	22	1,216.88		1.575	29.11	5.09	1.00	2.70	20.33	3.05	17.28	19.97	376.40	2.45
	Total			34.650	640.46		23.00	62.00	443.48	67.08	376.40	376.40		112.19

- Optimization 6 MW of case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Building, Equipment, and Machine Cost (Mil Baht)	Power Production (MW)	Power Producer Revenue (Mil Baht)	Gas Cost (Mil Baht)	Power Producer Operation & Maintenance Expense (Mil Baht)	Power Producer Straight Line Depreciation (Mil Baht)	Power Producer Taxable Income (Mil Baht)	Gas Seller 15% Income Tax (Mil Baht)	Power Producer Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	186.00	0.00	0.00	0.00	3.00	18.60	-21.60	0.00	-21.60	-189.00	-189.00	-189.00
2009	1	1,853.17		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	-153.46	32.31
2010	2	1,840.23		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	-117.92	29.37
2011	3	1,814.97		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	-82.39	26.70
2012	4	1,782.71		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	-46.85	24.27
2013	5	1,746.74		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	-11.31	22.07
2014	6	1,709.06		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	24.23	20.06
2015	7	1,670.87		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	59.77	18.24
2016	8	1,632.86		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	95.30	16.58
2017	9	1,595.57		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	130.84	15.07
2018	10	1,559.32		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	166.38	13.70
2019	11	1,524.22		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	201.92	12.46
2020	12	1,490.32		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	237.45	11.32
2021	13	1,457.68		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	272.99	10.29
2022	14	1,426.37		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	308.53	9.36
2023	15	1,396.30		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	344.07	8.51
2024	16	1,367.40		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	379.61	7.73
2025	17	1,339.67		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	415.14	7.03
2026	18	1,313.09		4.725	87.34	45.81	3.00	18.60	19.93	2.99	16.94	35.54	450.68	6.39
2027	19	1,287.59		3.938	72.78	38.17	3.00	18.60	13.01	1.95	11.05	29.65	480.34	4.85
2028	20	1,263.06		3.938	72.78	38.17	3.00	18.60	13.01	1.95	11.05	29.65	509.99	4.41
2029	21	1,239.50		3.938	72.78	38.17	3.00	18.60	13.01	1.95	11.05	29.65	539.65	4.01
2030	22	1,216.88		3.938	72.78	38.17	3.00	18.60	13.01	1.95	11.05	29.65	569.30	3.64
	Total			100.800	1,863.15		69.00	427.80	389.11	61.61	327.50	569.30		119.37



## Cash flow of field Y: Gas Seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	10.00	0.00	0.00	0.00	0.50	2.00	-2.50	0.00	-2.50	-10.50	-10.50	-10.50
2009	1	832.54		146	5.09	0.64	0.50	2.00	1.95	0.98	0.98	2.98	-7.52	2.71
2010	2	505.05		146	5.09	0.64	0.50	2.00	1.95	0.98	0.98	2.98	-4.55	2.46
2011	3	277.54		73	2.54	0.32	0.50	2.00	-0.27	0.00	-0.27	1.73	-2.82	1.30
2012	4	190.07		73	2.54	0.32	0.50	2.00	-0.27	0.00	-0.27	1.73	-1.09	1.18
2013	5	122.24												
2014	6	57.10												
2015	7	40.00												
2016	8	31.78												
2017	9	25.27												
2018	10	4.30												
2019	11	3.58												
	Total			438	15.27	1.91	2.50	10.00	0.86	1.95	-1.09	-1.09		-2.86

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	10.00	0.00	0.00	0.00	0.50	1.67	-2.17	0.00	-2.17	-10.50	-10.50	-10.50
2009	1	2,308.79		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-7.69	2.55
2010	2	1,662.89		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-4.88	2.32
2011	3	1,179.14		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-2.07	2.11
2012	4	890.29		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	0.74	1.92
2013	5	655.32		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	3.55	1.74
2014	6	146.30												
2015	7	110.00												
2016	8	88.09												
2017	9	70.46												
2018	10	16.22												
2019	11	13.52												
	Total			730	25.45	3.18	3.00	10.00	9.27	5.72	3.55	3.55		0.15

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	10.00	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	2,692.75		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-8.02	2.25
2010	2	2,377.45		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-5.55	2.05
2011	3	2,147.96		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-3.07	1.86
2012	4	1,935.04		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-0.59	1.69
2013	5	1,794.10		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	1.88	1.54
2014	6	1,676.20		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	4.36	1.40
2015	7	1,575.58		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	6.84	1.27
2016	8	1,488.12		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	9.31	1.16
2017	9	1,411.58		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	11.79	1.05
2018	10	1,339.06		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	13.77	0.76
2019	11	1,278.73		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	15.74	0.69
2020	12	1,224.23		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	17.72	0.63
2021	13	1,174.96		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	19.70	0.57
2022	14	1,130.02		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	21.67	0.52
2023	15	1,088.86		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	23.65	0.47
2024	16	1,050.88		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	25.63	0.43
2025	17	1,015.89		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	27.61	0.39
2026	18	983.44		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	29.58	0.36
2027	19	953.27		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	31.56	0.32
2028	20	925.05		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	33.54	0.29
2029	21	898.72		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	35.51	0.27
2030	22	874.03		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	37.49	0.24
	Total			3,212	111.98	14.00	11.50	10.00	76.48	38.99	37.49	37.49		9.72

- Optimization 4 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Year	Year No.	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	20.00	0.00	0.00	0.00	1.00	2.00	2008	0	-3.00	0.00	-3.00	-21.00	-21.00	-21.00
2009	1	2,692.75		292	10.18	1.27	1.00	2.00	2009	1	5.91	2.95	2.95	4.95	-16.05	4.50
2010	2	2,377.45		292	10.18	1.27	1.00	2.00	2010	2	5.91	2.95	2.95	4.95	-11.09	4.09
2011	3	2,147.96		292	10.18	1.27	1.00	2.00	2011	3	5.91	2.95	2.95	4.95	-6.14	3.72
2012	4	1,935.04		292	10.18	1.27	1.00	2.00	2012	4	5.91	2.95	2.95	4.95	-1.19	3.38
2013	5	1,794.10		292	10.18	1.27	1.00	2.00	2013	5	5.91	2.95	2.95	4.95	3.77	3.08
2014	6	1,676.20		292	10.18	1.27	1.00	2.00	2014	6	5.91	2.95	2.95	4.95	8.72	2.80
2015	7	1,575.58		292	10.18	1.27	1.00	2.00	2015	7	5.91	2.95	2.95	4.95	13.67	2.54
2016	8	1,488.12		292	10.18	1.27	1.00	2.00	2016	8	5.91	2.95	2.95	4.95	18.63	2.31
2017	9	1,411.58		292	10.18	1.27	1.00	2.00	2017	9	5.91	2.95	2.95	4.95	23.58	2.10
2018	10	1,339.06		292	10.18	1.27	1.00	0.00	2018	10	7.91	3.95	3.95	3.95	27.54	1.52
2019	11	1,278.73		292	10.18	1.27	1.00	0.00	2019	11	7.91	3.95	3.95	3.95	31.49	1.39
2020	12	1,224.23		292	10.18	1.27	1.00	0.00	2020	12	7.91	3.95	3.95	3.95	35.44	1.26
2021	13	1,174.96		292	10.18	1.27	1.00	0.00	2021	13	7.91	3.95	3.95	3.95	39.40	1.15
2022	14	1,130.02		292	10.18	1.27	1.00	0.00	2022	14	7.91	3.95	3.95	3.95	43.35	1.04
2023	15	1,088.86		292	10.18	1.27	1.00	0.00	2023	15	7.91	3.95	3.95	3.95	47.30	0.95
2024	16	1,050.88		292	10.18	1.27	1.00	0.00	2024	16	7.91	3.95	3.95	3.95	51.26	0.86
2025	17	1,015.89		292	10.18	1.27	1.00	0.00	2025	17	7.91	3.95	3.95	3.95	55.21	0.78
2026	18	983.44		219	7.63	1.27	1.00	0.00	2026	18	5.36	2.68	2.68	2.68	57.89	0.48
2027	19	953.27		219	7.63	1.27	1.00	0.00	2027	19	5.36	2.68	2.68	2.68	60.57	0.44
2028	20	925.05		219	7.63	1.27	1.00	0.00	2028	20	5.36	2.68	2.68	2.68	63.25	0.40
2029	21	898.72		219	7.63	1.27	1.00	0.00	2029	21	5.36	2.68	2.68	2.68	65.94	0.36
2030	22	874.03		219	7.63	1.27	1.00	0.00	2030	22	5.36	2.68	2.68	2.68	68.62	0.33
	Total			6,059	211.23	27.99	23.00	20.00		Total	140.23	71.62	68.62	68.62		18.48

### Sensitivity analysis of field Y: Gas Seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-6.17	-
15.00	-3.31	-22.62%
20.00	-1.52	-10.13%
25.00	0.26	1.74%
26.00	0.62	4.11%
30.00	2.00	13.42%

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-4.19	-11.21%
15.00	-1.05	4.80%
20.00	1.00	14.96%
25.00	3.05	25.34%
26.00	3.46	27.47%
30.00	5.10	36.23%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-0.69	8.70%
15.00	3.49	16.14%
20.00	7.67	23.30%
25.00	11.86	30.77%
26.00	12.70	32.33%
30.00	16.04	38.88%

- Optimization of case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (฿/MMBTU)	NPV (Mil ฿)	IRR
10.00	-1.76	8.27%
15.00	6.43	15.91%
20.00	14.61	23.17%
25.00	22.80	30.70%
26.00	24.44	32.28%
30.00	30.99	38.85%

## Cash flow of field Y: Power Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	10.00	0.00	0.00	0.00	0.50	2.00	-2.50	0.00	-2.50	-10.50	-10.50	-10.50
2009	1	832.54		146	5.09	0.64	0.50	2.00	1.95	0.98	0.98	2.98	-7.52	2.71
2010	2	505.05		146	5.09	0.64	0.50	2.00	1.95	0.98	0.98	2.98	-4.55	2.46
2011	3	277.54		73	2.54	0.32	0.50	2.00	-0.27	0.00	-0.27	1.73	-2.82	1.30
2012	4	190.07		73	2.54	0.32	0.50	2.00	-0.27	0.00	-0.27	1.73	-1.09	1.18
2013	5	122.24												
2014	6	57.10												
2015	7	40.00												
2016	8	31.78												
2017	9	25.27												
2018	10	4.30												
2019	11	3.58												
	Total			438	15.27	1.91	2.50	10.00	0.86	1.95	-1.09	-1.09		-2.86

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	10.00	0.00	0.00	0.00	0.50	1.67	-2.17	0.00	-2.17	-10.50	-10.50	-10.50
2009	1	2,308.79		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-7.69	2.55
2010	2	1,662.89		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-4.88	2.32
2011	3	1,179.14		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	-2.07	2.11
2012	4	890.29		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	0.74	1.92
2013	5	655.32		146	5.09	0.64	0.50	1.67	2.29	1.14	1.14	2.81	3.55	1.74
2014	6	146.30												
2015	7	110.00												
2016	8	88.09												
2017	9	70.46												
2018	10	16.22												
2019	11	13.52												
	Total			730	25.45	3.18	3.00	10.00	9.27	5.72	3.55	3.55		0.15

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	10.00	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	2,692.75		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-8.02	2.25
2010	2	2,377.45		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-5.55	2.05
2011	3	2,147.96		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-3.07	1.86
2012	4	1,935.04		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	-0.59	1.69
2013	5	1,794.10		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	1.88	1.54
2014	6	1,676.20		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	4.36	1.40
2015	7	1,575.58		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	6.84	1.27
2016	8	1,488.12		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	9.31	1.16
2017	9	1,411.58		146	5.09	0.64	0.50	1.00	2.95	1.48	1.48	2.48	11.79	1.05
2018	10	1,339.06		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	13.77	0.76
2019	11	1,278.73		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	15.74	0.69
2020	12	1,224.23		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	17.72	0.63
2021	13	1,174.96		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	19.70	0.57
2022	14	1,130.02		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	21.67	0.52
2023	15	1,088.86		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	23.65	0.47
2024	16	1,050.88		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	25.63	0.43
2025	17	1,015.89		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	27.61	0.39
2026	18	983.44		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	29.58	0.36
2027	19	953.27		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	31.56	0.32
2028	20	925.05		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	33.54	0.29
2029	21	898.72		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	35.51	0.27
2030	22	874.03		146	5.09	0.64	0.50	0.00	3.95	1.98	1.98	1.98	37.49	0.24
	Total			3,212	111.98	14.00	11.50	10.00	76.48	38.99	37.49	37.49		9.72

- Optimization 4 MW of case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Gas Sale (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	20.00	0.00	0.00	0.00	1.00	2.00	-3.00	0.00	-3.00	-21.00	-21.00	-21.00
2009	1	2,692.75		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	-16.05	4.50
2010	2	2,377.45		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	-11.09	4.09
2011	3	2,147.96		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	-6.14	3.72
2012	4	1,935.04		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	-1.19	3.38
2013	5	1,794.10		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	3.77	3.08
2014	6	1,676.20		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	8.72	2.80
2015	7	1,575.58		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	13.67	2.54
2016	8	1,488.12		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	18.63	2.31
2017	9	1,411.58		292	10.18	1.27	1.00	2.00	5.91	2.95	2.95	4.95	23.58	2.10
2018	10	1,339.06		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	27.54	1.52
2019	11	1,278.73		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	31.49	1.39
2020	12	1,224.23		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	35.44	1.26
2021	13	1,174.96		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	39.40	1.15
2022	14	1,130.02		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	43.35	1.04
2023	15	1,088.86		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	47.30	0.95
2024	16	1,050.88		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	51.26	0.86
2025	17	1,015.89		292	10.18	1.27	1.00	0.00	7.91	3.95	3.95	3.95	55.21	0.78
2026	18	983.44		219	7.63	1.27	1.00	0.00	5.36	2.68	2.68	2.68	57.89	0.48
2027	19	953.27		219	7.63	1.27	1.00	0.00	5.36	2.68	2.68	2.68	60.57	0.44
2028	20	925.05		219	7.63	1.27	1.00	0.00	5.36	2.68	2.68	2.68	63.25	0.40
2029	21	898.72		219	7.63	1.27	1.00	0.00	5.36	2.68	2.68	2.68	65.94	0.36
2030	22	874.03		219	7.63	1.27	1.00	0.00	5.36	2.68	2.68	2.68	68.62	0.33
	Total			6,059	211.23	27.99	23.00	20.00	140.23	71.62	68.62	68.62		18.48

**B-3) LNG scenario****Cash flow of field X: Gas Seller**

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จุฬาลงกรณ์มหาวิทยาลัย

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/ Year)	Annual Gas Supplied (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	10.00	263.05	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	642.02		234.34	234.34	8.17	1.02	0.50	1.00	5.65	2.82	2.82	3.82	-6.68	3.48
2010	2	573.61		209.37	209.37	7.30	0.91	0.50	1.00	4.89	2.44	2.44	3.44	-3.23	2.85
2011	3	512.49		187.06	187.06	6.52	0.82	0.50	1.00	4.21	2.10	2.10	3.10	-0.13	2.33
2012	4	457.81		167.56	167.56	5.84	0.73	0.50	1.00	3.61	1.81	1.81	2.81	2.68	1.92
2013	5	408.96		149.27	149.27	5.20	0.65	0.50	1.00	3.05	1.53	1.53	2.53	5.20	1.57
2014	6	365.38		133.36	133.36	4.65	0.58	0.50	1.00	2.57	1.28	1.28	2.28	7.49	1.29
2015	7	326.44		119.15	119.15	4.15	0.52	0.50	1.00	2.13	1.07	1.07	2.07	9.55	1.06
2016	8	291.61		106.73	106.73	3.72	0.47	0.50	1.00	1.76	0.88	0.88	1.88	11.43	0.88
2017	9	260.50		95.08	95.08	3.31	0.41	0.50	1.00	1.40	0.70	0.70	1.70	13.13	0.72
2018	10	232.74		84.95	84.95	2.96	0.37	0.50	0.00	2.09	1.05	1.05	1.05	14.18	0.40
2019	11	207.94		75.90	75.90	2.65	0.33	0.50	0.00	1.82	0.91	0.91	0.91	15.09	0.32
2020	12	185.75		67.99	67.99	2.37	0.30	0.50	0.00	1.57	0.79	0.79	0.79	15.87	0.25
2021	13	165.93		60.57	60.57	2.11	0.26	0.50	0.00	1.35	0.67	0.67	0.67	16.55	0.20
2022	14	148.25		54.11	54.11	1.89	0.24	0.50	0.00	1.15	0.58	0.58	0.58	17.12	0.15
2023	15	132.45		48.35	48.35	1.69	0.21	0.50	0.00	0.97	0.49	0.49	0.49	17.61	0.12
2024	16	118.32		43.31	43.31	1.51	0.19	0.50	0.00	0.82	0.41	0.41	0.41	18.02	0.09
2025	17	105.70		38.58	38.58	1.34	0.17	0.50	0.00	0.68	0.34	0.34	0.34	18.36	0.07
2026	18	94.43		34.47	34.47	1.20	0.15	0.50	0.00	0.55	0.28	0.28	0.28	18.63	0.05
2027	19	84.37		30.80	30.80	1.07	0.13	0.50	0.00	0.44	0.22	0.22	0.22	18.85	0.04
2028	20	75.37		27.58	27.58	0.96	0.12	0.50	0.00	0.34	0.17	0.17	0.17	19.02	0.03
2029	21	67.33		24.57	24.57	0.86	0.11	0.50	0.00	0.25	0.12	0.12	0.12	19.15	0.02
2030	22	59.91		21.87	21.87	0.76	0.10	0.50	0.00	0.17	0.08	0.08	0.08	19.23	0.01
	Total			2,278	2,015	70.24	8.78	11.50	10.00	39.96	20.73	19.23	19.23		7.32

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/ Year)	Annual Gas Supplied (MMSCF/ Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,881.31	10.00	688.56	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	1,901.03		693.88	693.88	24.19	3.02	0.50	1.00	19.67	9.83	9.83	10.83	0.33	9.85
2010	2	1,874.17		684.07	684.07	23.85	2.98	0.50	1.00	19.37	9.68	9.68	10.68	11.02	8.83
2011	3	1,814.71		662.37	662.37	23.09	2.89	0.50	1.00	18.70	9.35	9.35	10.35	21.37	7.78
2012	4	1,733.17		634.34	634.34	22.11	2.76	0.50	1.00	17.85	8.92	8.92	9.92	31.29	6.78
2013	5	1,637.69		597.76	597.76	20.84	2.60	0.50	1.00	16.73	8.37	8.37	9.37	40.66	5.82
2014	6	1,534.47		560.08	560.08	19.53	2.44	0.50	1.00	15.58	7.79	7.79	8.79	49.45	4.96
2015	7	1,427.87		521.17	521.17	18.17	2.27	0.50	1.00	14.40	7.20	7.20	8.20	57.65	4.21
2016	8	1,321.00		483.48	483.48	16.86	2.11	0.50	1.00	13.25	6.62	6.62	7.62	65.28	3.56
2017	9	1,216.34		443.96	443.96	15.48	1.93	0.50	1.00	12.04	6.02	6.02	7.02	72.30	2.98
2018	10	1,115.65		407.21	407.21	14.20	1.77	0.50	0.00	11.92	5.96	5.96	5.96	78.26	2.30
2019	11	1,019.86		372.25	372.25	12.98	1.62	0.50	0.00	10.86	5.43	5.43	5.43	83.69	1.90
2020	12	929.50		340.20	340.20	11.86	1.48	0.50	0.00	9.88	4.94	4.94	4.94	88.62	1.57
2021	13	845.05		308.44	308.44	10.75	1.34	0.50	0.00	8.91	4.45	4.45	4.45	93.08	1.29
2022	14	766.73		279.86	279.86	9.76	1.22	0.50	0.00	8.04	4.02	4.02	4.02	97.10	1.06
2023	15	694.40		253.46	253.46	8.84	1.10	0.50	0.00	7.23	3.62	3.62	3.62	100.71	0.87
2024	16	627.80		229.77	229.77	8.01	1.00	0.50	0.00	6.51	3.25	3.25	3.25	103.97	0.71
2025	17	566.79		206.88	206.88	7.21	0.90	0.50	0.00	5.81	2.91	2.91	2.91	106.87	0.57
2026	18	511.15		186.57	186.57	6.50	0.81	0.50	0.00	5.19	2.60	2.60	2.60	109.47	0.47
2027	19	460.48		168.08	168.08	5.86	0.73	0.50	0.00	4.63	2.31	2.31	2.31	111.78	0.38
2028	20	414.39		151.67	151.67	5.29	0.66	0.50	0.00	4.13	2.06	2.06	2.06	113.84	0.31
2029	21	372.60		136.00	136.00	4.74	0.59	0.50	0.00	3.65	1.82	1.82	1.82	115.67	0.25
2030	22	333.48		121.72	121.72	4.24	0.53	0.50	0.00	3.21	1.61	1.61	1.61	117.28	0.20
	Total			9,132	8,443	294.34	36.79	11.50	10.00	236.05	118.78	117.28	117.28		56.12



- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	10.00	675.08	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	1,853.17		676.41	676.41	23.58	2.95	0.50	1.00	19.13	9.57	9.57	10.57	0.07	9.61
2010	2	1,840.23		671.68	671.68	23.42	2.93	0.50	1.00	18.99	9.49	9.49	10.49	10.56	8.67
2011	3	1,814.97		662.46	662.46	23.09	2.89	0.50	1.00	18.71	9.35	9.35	10.35	20.91	7.78
2012	4	1,782.71		652.47	652.47	22.75	2.84	0.50	1.00	18.40	9.20	9.20	10.20	31.12	6.97
2013	5	1,746.74		637.56	637.56	22.23	2.78	0.50	1.00	17.95	8.97	8.97	9.97	41.09	6.19
2014	6	1,709.06		623.81	623.81	21.75	2.72	0.50	1.00	17.53	8.76	8.76	9.76	50.85	5.51
2015	7	1,670.87		609.87	609.87	21.26	2.66	0.50	1.00	17.10	8.55	8.55	9.55	60.41	4.90
2016	8	1,632.86		597.63	597.63	20.83	2.60	0.50	1.00	16.73	8.36	8.36	9.36	69.77	4.37
2017	9	1,595.57		582.38	582.38	20.30	2.54	0.50	1.00	16.26	8.13	8.13	9.13	78.90	3.87
2018	10	1,559.32		569.15	569.15	19.84	2.48	0.50	0.00	16.86	8.43	8.43	8.43	87.33	3.25
2019	11	1,524.22		556.34	556.34	19.39	2.42	0.50	0.00	16.47	8.24	8.24	8.24	95.57	2.89
2020	12	1,490.32		545.46	545.46	19.02	2.38	0.50	0.00	16.14	8.07	8.07	8.07	103.64	2.57
2021	13	1,457.68		532.05	532.05	18.55	2.32	0.50	0.00	15.73	7.86	7.86	7.86	111.50	2.28
2022	14	1,426.37		520.62	520.62	18.15	2.27	0.50	0.00	15.38	7.69	7.69	7.69	119.19	2.03
2023	15	1,396.30		509.65	509.65	17.77	2.22	0.50	0.00	15.05	7.52	7.52	7.52	126.72	1.80
2024	16	1,367.40		500.47	500.47	17.45	2.18	0.50	0.00	14.77	7.38	7.38	7.38	134.10	1.61
2025	17	1,339.67		488.98	488.98	17.05	2.13	0.50	0.00	14.42	7.21	7.21	7.21	141.31	1.43
2026	18	1,313.09		479.28	479.28	16.71	2.09	0.50	0.00	14.12	7.06	7.06	7.06	148.37	1.27
2027	19	1,287.59		469.97	469.97	16.38	2.05	0.50	0.00	13.84	6.92	6.92	6.92	155.29	1.13
2028	20	1,263.06		462.28	462.28	16.12	2.01	0.50	0.00	13.60	6.80	6.80	6.80	162.09	1.01
2029	21	1,239.50		452.42	452.42	15.77	1.97	0.50	0.00	13.30	6.65	6.65	6.65	168.74	0.90
2030	22	1,216.88		444.16	444.16	15.48	1.94	0.50	0.00	13.05	6.52	6.52	6.52	175.26	0.80
	Total			12,920.18	12,245.10	426.88	53.36	11.50	10.00	352.02	176.76	175.26	175.26		70.33

### Sensitivity of field X – LNG option: Gas seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR
10.00	-1.16	5.58%
15.00	3.12	20.31%
20.00	7.20	34.85%
25.00	11.26	52.56%
26.00	12.08	56.64%
30.00	15.33	75.39%

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR
10.00	20.34	72.74%
15.00	35.03	170.00%
20.00	49.73	500.26%
25.00	64.43	-
26.00	67.37	-
30.00	79.13	-

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR
10.00	25.72	71.59%
15.00	43.11	161.81%
20.00	60.51	446.56%
25.00	77.90	-
26.00	81.38	-
30.00	95.29	-

## Cash flow of field X: LNG Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	718.71	11.13	173.91	10.84	16.50	30.46	226.34	263.05	0.00	0.00	0.00
2009	1	642.02							234.34	234.34	2,343	24.23
2010	2	573.61							209.37	209.37	2,094	21.65
2011	3	512.49							187.06	187.06	1,871	19.34
2012	4	457.81							167.56	167.56	1,676	17.33
2013	5	408.96							149.27	149.27	1,493	15.43
2014	6	365.38							133.36	133.36	1,334	13.79
2015	7	326.44							119.15	119.15	1,192	12.32
2016	8	291.61							106.73	106.73	1,067	11.04
2017	9	260.50							95.08	95.08	951	9.83
2018	10	232.74							84.95	84.95	850	8.78
2019	11	207.94							75.90	75.90	759	7.85
2020	12	185.75							67.99	67.99	680	7.03
2021	13	165.93							60.57	60.57	606	6.26
2022	14	148.25							54.11	54.11	541	5.60
2023	15	132.45							48.35	48.35	483	5.00
2024	16	118.32							43.31	43.31	433	4.48
2025	17	105.70							38.58	38.58	386	3.99
2026	18	94.43							34.47	34.47	345	3.56
2027	19	84.37							30.80	30.80	308	3.18
2028	20	75.37							27.58	27.58	276	2.85
2029	21	67.33							24.57	24.57	246	2.54
2030	22	59.91							21.87	21.87	219	2.26
	Total								2,278.00	2,014.95	20,149.52	208.35

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	9.84	-18.28	0.00	-18.28	-234.78	-234.78	-234.78
2009	1,406.03	21.09	99,594	2.32	47.64	8.17	8.44	9.84	21.19	6.36	14.83	24.67	-210.10	22.43
2010	1,256.21	18.84	88,981	2.07	42.56	7.30	8.44	9.84	16.98	5.09	11.89	21.73	-188.38	17.96
2011	1,122.35	16.84	79,499	1.85	38.03	6.52	8.44	9.84	13.22	3.97	9.26	19.10	-169.28	14.35
2012	1,005.34	15.08	71,212	1.66	34.06	5.84	8.44	9.84	9.94	2.98	6.96	16.80	-152.48	11.47
2013	895.62	13.43	63,440	1.48	30.34	5.20	8.44	9.84	6.86	2.06	4.80	14.64	-137.84	9.09
2014	800.18	12.00	56,680	1.32	27.11	4.65	8.44	9.84	4.18	1.25	2.93	12.77	-125.07	7.21
2015	714.91	10.72	50,640	1.18	24.22	4.15	8.44	9.84	1.79	0.54	1.25	11.09	-113.98	5.69
2016	640.39	9.61	45,361	1.05	21.70	3.72	8.44	9.84	-0.30	0.00	-0.30	9.54	-104.44	4.45
2017	570.49	8.56	40,410	0.94	19.33	3.31	8.44	9.84	-2.27	0.00	-2.27	7.57	-96.87	3.21
2018	509.70	7.65	36,104	0.84	17.27	2.96	8.44	9.84	-3.97	0.00	-3.97	5.87	-91.00	2.26
2019	455.39	6.83	32,257	0.75	15.43	2.65	8.44	9.84	-5.50	0.00	-5.50	4.34	-86.66	1.52
2020	407.91	6.12	28,894	0.67	13.82	2.37	8.44	9.84	-6.83	0.00	-6.83	3.01	-83.65	0.96
2021	363.39	5.45	25,740	0.60	12.31	2.11	8.44	9.84	-8.08	0.00	-8.08	1.76	-81.89	0.51
2022	324.67	4.87	22,997	0.53	11.00	1.89	8.44	9.84	-9.17	0.00	-9.17	0.67	-81.22	0.18
2023	290.07	4.35	20,547	0.48	9.83	1.69	8.44	9.84	-10.14	0.00	-10.14	-0.30	-81.51	-0.07
2024	259.83	3.90	18,405	0.43	8.80	1.51	8.44	9.84	-10.99	0.00	-10.99	-1.15	-82.66	-0.25
2025	231.48	3.47	16,396	0.38	7.84	1.34	8.44	9.84	-11.78	0.00	-11.78	-1.94	-84.60	-0.38
2026	206.81	3.10	14,649	0.34	7.01	1.20	8.44	9.84	-12.48	0.00	-12.48	-2.63	-87.24	-0.47
2027	184.77	2.77	13,088	0.30	6.26	1.07	8.44	9.84	-13.09	0.00	-13.09	-3.25	-90.49	-0.53
2028	165.51	2.48	11,724	0.27	5.61	0.96	8.44	9.84	-13.63	0.00	-13.63	-3.79	-94.29	-0.56
2029	147.45	2.21	10,444	0.24	5.00	0.86	8.44	9.84	-14.14	0.00	-14.14	-4.30	-98.59	-0.58
2030	131.21	1.97	9,294	0.22	4.45	0.76	8.44	9.84	-14.60	0.00	-14.60	-4.76	-103.34	-0.58
	12,089.71	181.35	856,355	19.92	409.61	70.24	194.12	226.34	-81.10	22.25	-103.34	-103.34		-136.93

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,881.31	11.13	173.91	10.84	16.50	30.46	226.34	688.56	0.00	0.00	0.00
2009	1	1,901.03							693.88	693.88	6,939	71.75
2010	2	1,874.17							684.07	684.07	6,841	70.73
2011	3	1,814.71							662.37	662.37	6,624	68.49
2012	4	1,733.17							634.34	634.34	6,343	65.59
2013	5	1,637.69							597.76	597.76	5,978	61.81
2014	6	1,534.47							560.08	560.08	5,601	57.91
2015	7	1,427.87							521.17	521.17	5,212	53.89
2016	8	1,321.00							483.48	483.48	4,835	49.99
2017	9	1,216.34							443.96	443.96	4,440	45.91
2018	10	1,115.65							407.21	407.21	4,072	42.11
2019	11	1,019.86							408.21	408.21	4,082	42.21
2020	12	929.50							409.21	409.21	4,092	42.31
2021	13	845.05							410.21	410.21	4,102	42.42
2022	14	766.73							411.21	411.21	4,112	42.52
2023	15	694.40							412.21	412.21	4,122	42.62
2024	16	627.80							413.21	413.21	4,132	42.73
2025	17	566.79							414.21	414.21	4,142	42.83
2026	18	511.15							415.21	415.21	4,152	42.93
2027	19	460.48							416.21	416.21	4,162	43.04
2028	20	414.39							417.21	417.21	4,172	43.14
2029	21	372.60							418.21	418.21	4,182	43.24
2030	22	333.48							419.21	419.21	4,192	43.35
	Total								11,341.45	6,096.54	60,965.43	630.38

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	9.84	-18.28	0.00	-18.28	-234.78	-234.78	-234.78
2009	4,163.26	62.45	294,897	6.86	141.05	24.19	8.44	9.84	98.58	29.57	69.01	78.85	-155.93	71.68
2010	4,104.42	61.57	290,730	6.76	139.06	23.85	8.44	9.84	96.93	29.08	67.85	77.69	-78.23	64.21
2011	3,974.22	59.61	281,507	6.55	134.65	23.09	8.44	9.84	93.28	27.98	65.29	75.13	-3.10	56.45
2012	3,806.04	57.09	269,595	6.27	128.95	22.11	8.44	9.84	88.56	26.57	61.99	71.83	68.73	49.06
2013	3,586.54	53.80	254,047	5.91	121.51	20.84	8.44	9.84	82.39	24.72	57.68	67.52	136.25	41.92
2014	3,360.49	50.41	238,035	5.54	113.86	19.53	8.44	9.84	76.05	22.81	53.23	63.08	199.32	35.60
2015	3,127.03	46.91	221,498	5.15	105.95	18.17	8.44	9.84	69.50	20.85	48.65	58.49	257.81	30.01
2016	2,900.91	43.51	205,481	4.78	98.28	16.86	8.44	9.84	63.15	18.94	44.20	54.04	311.86	25.21
2017	2,663.78	39.96	188,685	4.39	90.25	15.48	8.44	9.84	56.49	16.95	39.54	49.39	361.24	20.94
2018	2,443.28	36.65	173,066	4.02	82.78	14.20	8.44	9.84	50.30	15.09	35.21	45.05	406.29	17.37
2019	2,449.28	36.74	173,491	4.03	82.98	14.23	8.44	9.84	50.47	15.14	35.33	45.17	451.46	15.83
2020	2,455.28	36.83	173,916	4.04	83.19	14.27	8.44	9.84	50.64	15.19	35.45	45.29	496.75	14.43
2021	2,461.28	36.92	174,341	4.05	83.39	14.30	8.44	9.84	50.81	15.24	35.57	45.41	542.16	13.15
2022	2,467.28	37.01	174,766	4.06	83.59	14.34	8.44	9.84	50.98	15.29	35.68	45.52	587.68	11.99
2023	2,473.28	37.10	175,191	4.07	83.80	14.37	8.44	9.84	51.15	15.34	35.80	45.64	633.33	10.93
2024	2,479.28	37.19	175,616	4.08	84.00	14.41	8.44	9.84	51.31	15.39	35.92	45.76	679.09	9.96
2025	2,485.28	37.28	176,041	4.09	84.20	14.44	8.44	9.84	51.48	15.44	36.04	45.88	724.96	9.08
2026	2,491.28	37.37	176,466	4.10	84.41	14.47	8.44	9.84	51.65	15.50	36.16	46.00	770.96	8.27
2027	2,497.28	37.46	176,891	4.11	84.61	14.51	8.44	9.84	51.82	15.55	36.27	46.11	817.07	7.54
2028	2,503.28	37.55	177,316	4.12	84.81	14.54	8.44	9.84	51.99	15.60	36.39	46.23	863.31	6.87
2029	2,509.28	37.64	177,741	4.13	85.02	14.58	8.44	9.84	52.16	15.65	36.51	46.35	909.66	6.26
2030	2,515.28	37.73	178,166	4.14	85.22	14.61	8.44	9.84	52.32	15.70	36.63	46.47	956.12	5.71
	36,579	548.69	2,591,031	60.26	1,239.33		101.28	226.34	807.42	247.71	559.71	451.46		297.71

สถาบันวิจัยปิโตรเลียม  
จุฬาลงกรณ์มหาวิทยาลัย



- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,844.48	11.13	173.91	10.84	16.50	30.46	226.34	675.08	0.00	0.00	0.00
2009	1	1,853.17							676.41	676.41	6,764	69.94
2010	2	1,840.23							671.68	671.68	6,717	69.45
2011	3	1,814.97							662.46	662.46	6,625	68.50
2012	4	1,782.71							652.47	652.47	6,525	67.47
2013	5	1,746.74							637.56	637.56	6,376	65.92
2014	6	1,709.06							623.81	623.81	6,238	64.50
2015	7	1,670.87							609.87	609.87	6,099	63.06
2016	8	1,632.86							597.63	597.63	5,976	61.79
2017	9	1,595.57							582.38	582.38	5,824	60.22
2018	10	1,559.32							569.15	569.15	5,692	58.85
2019	11	1,524.22							556.34	556.34	5,563	57.53
2020	12	1,490.32							545.46	545.46	5,455	56.40
2021	13	1,457.68							532.05	532.05	5,321	55.01
2022	14	1,426.37							520.62	520.62	5,206	53.83
2023	15	1,396.30							509.65	509.65	5,096	52.70
2024	16	1,367.40							500.47	500.47	5,005	51.75
2025	17	1,339.67							488.98	488.98	4,890	50.56
2026	18	1,313.09							479.28	479.28	4,793	49.56
2027	19	1,287.59							469.97	469.97	4,700	48.59
2028	20	1,263.06							462.28	462.28	4,623	47.80
2029	21	1,239.50							452.42	452.42	4,524	46.78
2030	22	1,216.88							444.16	444.16	4,442	45.93
	Total								12,920.18	12,245.10	122,451	1,266.14

Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	9.84	-18.28	0.00	-18.28	-234.78	-234.78	-234.78
2009	4,058	60.88	287,473	6.69	137.50	23.58	8.44	9.84	95.64	28.69	66.95	76.79	-157.99	69.81
2010	4,030	60.45	285,466	6.64	136.54	23.42	8.44	9.84	94.85	28.45	66.39	76.23	-81.75	63.00
2011	3,975	59.62	281,547	6.55	134.67	23.09	8.44	9.84	93.29	27.99	65.30	75.15	-6.61	56.46
2012	3,915	58.72	277,301	6.45	132.64	22.75	8.44	9.84	91.61	27.48	64.13	73.97	67.36	50.52
2013	3,825	57.38	270,962	6.30	129.61	22.23	8.44	9.84	89.10	26.73	62.37	72.21	139.57	44.84
2014	3,743	56.14	265,118	6.17	126.81	21.75	8.44	9.84	86.78	26.03	60.75	70.59	210.16	39.85
2015	3,659	54.89	259,194	6.03	123.98	21.26	8.44	9.84	84.43	25.33	59.10	68.94	279.10	35.38
2016	3,586	53.79	253,992	5.91	121.49	20.83	8.44	9.84	82.37	24.71	57.66	67.50	346.60	31.49
2017	3,494	52.41	247,513	5.76	118.39	20.30	8.44	9.84	79.81	23.94	55.86	65.70	412.31	27.87
2018	3,415	51.22	241,889	5.63	115.70	19.84	8.44	9.84	77.58	23.27	54.30	64.14	476.45	24.73
2019	3,338	50.07	236,445	5.50	113.09	19.39	8.44	9.84	75.42	22.63	52.79	62.63	539.09	21.95
2020	3,273	49.09	231,819	5.39	110.88	19.02	8.44	9.84	73.59	22.08	51.51	61.35	600.44	19.55
2021	3,192	47.88	226,123	5.26	108.16	18.55	8.44	9.84	71.33	21.40	49.93	59.77	660.21	17.31
2022	3,124	46.86	221,265	5.15	105.83	18.15	8.44	9.84	69.40	20.82	48.58	58.42	718.63	15.38
2023	3,058	45.87	216,601	5.04	103.60	17.77	8.44	9.84	67.56	20.27	47.29	57.13	775.76	13.68
2024	3,003	45.04	212,699	4.95	101.74	17.45	8.44	9.84	66.01	19.80	46.21	56.05	831.81	12.20
2025	2,934	44.01	207,816	4.83	99.40	17.05	8.44	9.84	64.07	19.22	44.85	54.69	886.50	10.82
2026	2,876	43.14	203,694	4.74	97.43	16.71	8.44	9.84	62.44	18.73	43.71	53.55	940.05	9.63
2027	2,820	42.30	199,737	4.65	95.54	16.38	8.44	9.84	60.87	18.26	42.61	52.45	992.50	8.58
2028	2,774	41.61	196,469	4.57	93.97	16.12	8.44	9.84	59.58	17.87	41.70	51.54	1,044.05	7.66
2029	2,714	40.72	192,277	4.47	91.97	15.77	8.44	9.84	57.92	17.37	40.54	50.38	1,094.43	6.81
2030	2,665	39.97	188,769	4.39	90.29	15.48	8.44	9.84	56.53	16.96	39.57	49.41	1,143.84	6.07
	73,471	1,102.06	5,204,167	121.03	2,489.23	426.88	194.12	226.34	1,641.89	498.05	1,143.84	1,143.84		358.80

### Sensitivity analysis of field X: LNG Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR	
2.50	-175.78	-	@ 9th year
5.00	-150.39	-	@ 11th year
7.50	-125.30	-11.14%	@ 13th year
10.00	-100.38	-13.23%	@ 14th year
10.34	-96.99	-4.91%	@ 14th year
12.50	-75.58	-1.09%	@ 15th year
15.00	-50.84	2.80%	@ 16th year
17.50	-26.17	6.38%	@ 17th year
20.00	-1.54	9.79%	@ 18th year
22.50	23.06	13.15%	@ 19th year
25.00	47.64	16.54%	@ 20th year

- Case 2 Oil reserve from MCS with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR
2.50	86.65	17.38%
5.00	181.58	26.22%
7.50	276.52	36.28%
10.00	371.46	47.91%
10.34	384.37	49.64%
12.50	466.40	61.53%
15.00	561.34	77.69%

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR
2.50	118.45	19.09%
5.00	222.22	27.64%
7.50	325.99	37.22%
10.00	429.76	48.21%
10.34	443.87	49.83%
12.50	533.53	61.01%
15.00	637.30	76.14%

## Cash flow of field Y: Gas Seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	10.00	691.11	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	832.54		387.47	387.47	13.51	1.69	0.50	1.00	10.32	5.16	5.16	6.16	-4.34	5.60
2010	2	505.05		228.80	228.80	7.98	1.00	0.50	1.00	5.48	2.74	2.74	3.74	-0.60	3.09
2011	3	277.54		139.12	139.12	4.85	0.61	0.50	1.00	2.74	1.37	1.37	2.37	1.77	1.78
2012	4	190.07		81.39	81.39	2.84	0.35	0.50	1.00	0.98	0.49	0.49	1.49	3.26	1.02
2013	5	122.24		54.64	54.64	1.90	0.24	0.50	1.00	0.17	0.08	0.08	1.08	4.35	0.67
2014	6	57.10		35.21	35.21	1.23	0.15	0.50	1.00	-0.43	0.00	-0.43	0.57	4.92	0.32
2015	7	40.00		16.47	16.47	0.57	0.07	0.50	1.00	-1.00	0.00	-1.00	0.00	4.92	0.00
2016	8	31.78		12.70	12.70	0.44	0.06	0.50	1.00	-1.11	0.00	-1.11	-0.11	4.81	-0.05
2017	9	25.27		10.07	10.07	0.35	0.04	0.50	1.00	-1.19	0.00	-1.19	-0.19	4.62	-0.08
2018	10	4.30		2.82	2.82	0.10	0.01	0.50	0.00	-0.41	0.00	-0.41	-0.41	4.20	-0.16
2019	11	3.58		0.94	0.94	0.03	0.00	0.50	0.00	-0.47	0.00	-0.47	-0.47	3.73	-0.17
	Total			1,661	970		4.23	6.00	10.00	13.58	9.85	3.73	3.73		1.53

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	10.00	1,411.12	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	2,308.79		974.33	700.00	24.40	3.05	0.50	1.00	19.85	9.93	9.93	10.93	0.43	9.93
2010	2	1,662.89		693.58	693.58	24.18	3.02	0.50	1.00	19.66	9.83	9.83	10.83	11.25	8.95
2011	3	1,179.14		502.00	502.00	17.50	2.19	0.50	1.00	13.81	6.91	6.91	7.91	19.16	5.94
2012	4	890.29		364.30	364.30	12.70	1.59	0.50	1.00	9.61	4.81	4.81	5.81	24.97	3.97
2013	5	655.32		272.65	272.65	9.50	1.19	0.50	1.00	6.82	3.41	3.41	4.41	29.38	2.74
2014	6	146.30		182.55	182.55	6.36	0.80	0.50	1.00	4.07	2.03	2.03	3.03	32.41	1.71
2015	7	110.00		44.36	44.36	1.55	0.19	0.50	1.00	-0.15	0.00	-0.15	0.85	33.26	0.44
2016	8	88.09		35.08	35.08	1.22	0.15	0.50	1.00	-0.43	0.00	-0.43	0.57	33.83	0.27
2017	9	70.46		28.00	28.00	0.98	0.12	0.50	1.00	-0.65	0.00	-0.65	0.35	34.19	0.15
2018	10	16.22		9.26	9.26	0.32	0.04	0.50	0.00	-0.22	0.00	-0.22	-0.22	33.97	-0.08
2019	11	13.52		3.53	3.53	0.12	0.02	0.50	0.00	-0.39	0.00	-0.39	-0.39	33.58	-0.14
	Total			4,521	2,835		12.36	6.00	10.00	70.49	36.91	33.58	33.58		23.37

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Pipe Laying Cost (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Gas Sale Revenue (Mil Baht)	Gas Seller 12.5% Royalty (Mil Baht)	Gas Seller Operation & Maintenance Expense (Mil Baht)	Gas Seller Straight Line Depreciation (Mil Baht)	Gas Seller Taxable Income (Mil Baht)	Gas Seller 50% Income Tax (Mil Baht)	Gas Seller Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	Gas Seller 10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	10.00	1283.15	0.00	0.00	0.00	0.50	1.00	-1.50	0.00	-1.50	-10.50	-10.50	-10.50
2009	1	2,692.75		1036.52	700.00	24.40	3.05	0.50	1.00	19.85	9.93	9.93	10.93	0.43	9.93
2010	2	2,377.45		899.23	700.00	24.40	3.05	0.50	1.00	19.85	9.93	9.93	10.93	11.35	9.03
2011	3	2,147.96		804.54	700.00	24.40	3.05	0.50	1.00	19.85	9.93	9.93	10.93	22.28	8.21
2012	4	1,935.04		721.91	721.91	25.17	3.15	0.50	1.00	20.52	10.26	10.26	11.26	33.54	7.69
2013	5	1,794.10		664.46	664.46	23.16	2.90	0.50	1.00	18.77	9.38	9.38	10.38	43.92	6.45
2014	6	1,676.20		618.70	618.70	21.57	2.70	0.50	1.00	17.37	8.69	8.69	9.69	53.61	5.47
2015	7	1,575.58		579.99	579.99	20.22	2.53	0.50	1.00	16.19	8.10	8.10	9.10	62.71	4.67
2016	8	1,488.12		548.12	548.12	19.11	2.39	0.50	1.00	15.22	7.61	7.61	8.61	71.32	4.02
2017	9	1,411.58		517.51	517.51	18.04	2.26	0.50	1.00	14.29	7.14	7.14	8.14	79.46	3.45
2018	10	1,339.06		490.40	490.40	17.10	2.14	0.50	0.00	14.46	7.23	7.23	7.23	86.69	2.79
2019	11	1,278.73		467.39	467.39	16.29	2.04	0.50	0.00	13.76	6.88	6.88	6.88	93.57	2.41
2020	12	1,224.23		448.19	448.19	15.62	1.95	0.50	0.00	13.17	6.59	6.59	6.59	100.15	2.10
2021	13	1,174.96		428.49	428.49	14.94	1.87	0.50	0.00	12.57	6.29	6.29	6.29	106.44	1.82
2022	14	1,130.02		411.71	411.71	14.35	1.79	0.50	0.00	12.06	6.03	6.03	6.03	112.47	1.59
2023	15	1,088.86		396.38	396.38	13.82	1.73	0.50	0.00	11.59	5.80	5.80	5.80	118.26	1.39
2024	16	1,050.88		383.32	383.32	13.36	1.67	0.50	0.00	11.19	5.60	5.60	5.60	123.86	1.22
2025	17	1,015.89		369.27	369.27	12.87	1.61	0.50	0.00	10.76	5.38	5.38	5.38	129.24	1.06
2026	18	983.44		357.25	357.25	12.45	1.56	0.50	0.00	10.40	5.20	5.20	5.20	134.44	0.94
2027	19	953.27		346.09	346.09	12.07	1.51	0.50	0.00	10.06	5.03	5.03	5.03	139.47	0.82
2028	20	925.05		336.59	336.59	11.73	1.47	0.50	0.00	9.77	4.88	4.88	4.88	144.35	0.73
2029	21	898.72		325.94	325.94	11.36	1.42	0.50	0.00	9.44	4.72	4.72	4.72	149.07	0.64
2030	22	874.03		316.84	316.84	11.05	1.38	0.50	0.00	9.16	4.58	4.58	4.58	153.66	0.56
	Total			12,751.98	10,828.55	377.50	47.19	11.50	10.00	308.81	155.16	153.66	153.66		66.48



### Sensitivity of field Y – LNG option: Gas seller

- Case 1 Oil reserve from MCS with constant cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR	
10.00	-0.89	0.72%	@ 5th year
15.00	3.63	61.16%	@ 6th year
20.00	8.05	253.80%	@ 6th year
25.00	12.42	-	@ 6th year
26.00	12.95	-	@ 7th year
30.00	16.76	-	@ 7th year

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR	
10.00	7.82	62.43%	@ 7th year
15.00	16.24	168.99%	@ 8th year
20.00	24.78	545.74%	@ 9th year
25.00	33.31	-	@ 9th year
26.00	35.02	-	@ 9th year
30.00	41.83	-	@ 9th year

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Gas Sale Price (Baht/MMBTU)	NPV (Mil ฿)	IRR
10.00	24.38	76.39%
15.00	41.11	178.42%
20.00	57.83	550.47%
25.00	74.56	-
26.00	77.90	-
30.00	91.28	-

## Cash flow of field Y: LNG Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	1,446.10	11.13	173.91	10.84	16.50	30.46	226.34	691.11	0.00	0.00	0.00
2009	1	832.54							387.47	387.47	3,875	40.06
2010	2	505.05							228.80	228.80	2,288	23.66
2011	3	277.54							139.12	139.12	1,391	14.38
2012	4	190.07							81.39	81.39	814	8.42
2013	5	122.24							54.64	54.64	546	5.65
2014	6	57.10							35.21	35.21	352	3.64
2015	7	40.00							16.47	16.47	165	1.70
2016	8	31.78							12.70	12.70	127	1.31
2017	9	25.27							10.07	10.07	101	1.04
2018	10	4.30							2.82	2.82	28	0.29
2019	11	3.58							0.94	0.94	9	0.10
	Total								1,660.73	969.62	9,696	100.26

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Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	18.86	-27.30	0.00	-27.30	-234.78	-234.78	-234.78
2009	2,324.84	34.87	164,676	3.83	78.77	13.51	8.44	18.86	37.96	11.39	26.57	45.43	-189.34	41.30
2010	1,372.80	20.59	97,240	2.26	46.51	7.98	8.44	18.86	11.23	3.37	7.86	26.72	-162.62	22.09
2011	834.69	12.52	59,124	1.37	28.28	4.85	8.44	18.86	-3.87	0.00	-3.87	14.99	-147.63	11.26
2012	488.32	7.32	34,589	0.80	16.54	2.84	8.44	18.86	-13.59	0.00	-13.59	5.27	-142.36	3.60
2013	327.82	4.92	23,220	0.54	11.11	1.90	8.44	18.86	-18.10	0.00	-18.10	0.76	-141.60	0.47
2014	211.25	3.17	14,963	0.35	7.16	1.23	8.44	18.86	-21.37	0.00	-21.37	-2.51	-144.11	-1.42
2015	98.84	1.48	7,001	0.16	3.35	0.57	8.44	18.86	-24.53	0.00	-24.53	-5.67	-149.78	-2.91
2016	76.20	1.14	5,398	0.13	2.58	0.44	8.44	18.86	-25.16	0.00	-25.16	-6.30	-156.08	-2.94
2017	60.40	0.91	4,278	0.10	2.05	0.35	8.44	18.86	-25.61	0.00	-25.61	-6.74	-162.82	-2.86
2018	16.94	0.25	1,200	0.03	0.57	0.10	8.44	18.86	-26.83	0.00	-26.83	-7.96	-170.79	-3.07
2019	5.61	0.08	398	0.01	0.19	0.03	8.44	18.86	-27.14	0.00	-27.14	-8.28	-179.07	-2.90
	5,818	87.27	412,088	9.58	197.11		101.28	226.34	-164.31	14.76	-179.07	-179.07		-172.15

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- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	3,279.87	11.13	173.91	10.84	16.50	30.46	226.34	1,411.12	0.00	0.00	0.00
2009	1	2,308.79							974.33	700.00	7,000	72.38
2010	2	1,662.89							693.58	693.58	6,936	71.72
2011	3	1,179.14							502.00	502.00	5,020	51.91
2012	4	890.29							364.30	364.30	3,643	37.67
2013	5	655.32							272.65	272.65	2,726	28.19
2014	6	146.30							182.55	182.55	1,825	18.88
2015	7	110.00							44.36	44.36	444	4.59
2016	8	88.09							35.08	35.08	351	3.63
2017	9	70.46							28.00	28.00	280	2.89
2018	10	16.22							9.26	9.26	93	0.96
2019	11	13.52							3.53	3.53	35	0.37
	Total								4,521	2,835	28,353	293.17

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Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	18.86	-27.30	0.00	-27.30	-234.78	-234.78	-234.78
2009	4,200.00	63.00	297,500	6.92	142.30	24.40	8.44	18.86	90.59	27.18	63.42	82.28	-152.50	74.80
2010	4,161.47	62.42	294,771	6.86	140.99	24.18	8.44	18.86	89.51	26.85	62.66	81.52	-70.98	67.37
2011	3,012.01	45.18	213,350	4.96	102.05	17.50	8.44	18.86	57.25	17.17	40.07	58.93	-12.05	44.28
2012	2,185.80	32.79	154,828	3.60	74.06	12.70	8.44	18.86	34.05	10.22	23.84	42.70	30.65	29.16
2013	1,635.89	24.54	115,876	2.69	55.43	9.50	8.44	18.86	18.62	5.59	13.03	31.89	62.55	19.80
2014	1,095.29	16.43	77,583	1.80	37.11	6.36	8.44	18.86	3.44	1.03	2.41	21.27	83.82	12.01
2015	266.18	3.99	18,854	0.44	9.02	1.55	8.44	18.86	-19.83	0.00	-19.83	-0.97	82.85	-0.50
2016	210.47	3.16	14,908	0.35	7.13	1.22	8.44	18.86	-21.39	0.00	-21.39	-2.53	80.32	-1.18
2017	167.98	2.52	11,898	0.28	5.69	0.98	8.44	18.86	-22.59	0.00	-22.59	-3.72	76.60	-1.58
2018	55.54	0.83	3,934	0.09	1.88	0.32	8.44	18.86	-25.74	0.00	-25.74	-6.88	69.71	-2.65
2019	21.20	0.32	1,501	0.03	0.72	0.12	8.44	18.86	-26.71	0.00	-26.71	-7.85	61.87	-2.75
	17,012	255.18	1,205,004	28.02	576.37		101.28	226.34	149.91	88.04	61.87	61.87		3.99

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Area for Plant and Site Preparation (Mil Baht)	Liquefaction Facilities (Mil Baht)	LNG Production Storage (1 day) (Mil Baht)	Delivery Units (Mil Baht)	Regas & 2 days Storage at User's Site (Mil Baht)	LNG Producer Capital Expense (Mil Baht)	Annual Gas Available (MMSCF/Year)	Annual Gas Supplied (MMSCF/Year)	Annual LNG Sale (ton/Year)	LNG Revenue (Mil Baht)
2008	0	3,183.64	11.13	173.91	10.84	16.50	30.46	226.34	1,283.15	0.00	0.00	0.00
2009	1	2,692.75							1,036.52	700.00	7,000	72.38
2010	2	2,377.45							899.23	700.00	7,000	72.38
2011	3	2,147.96							804.54	700.00	7,000	72.38
2012	4	1,935.04							721.91	721.91	7,219	74.65
2013	5	1,794.10							664.46	664.46	6,645	68.71
2014	6	1,676.20							618.70	618.70	6,187	63.97
2015	7	1,575.58							579.99	579.99	5,800	59.97
2016	8	1,488.12							548.12	548.12	5,481	56.68
2017	9	1,411.58							517.51	517.51	5,175	53.51
2018	10	1,339.06							490.40	490.40	4,904	50.71
2019	11	1,278.73							467.39	467.39	4,674	48.33
2020	12	1,224.23							448.19	448.19	4,482	46.34
2021	13	1,174.96							428.49	428.49	4,285	44.31
2022	14	1,130.02							411.71	411.71	4,117	42.57
2023	15	1,088.86							396.38	396.38	3,964	40.99
2024	16	1,050.88							383.32	383.32	3,833	39.64
2025	17	1,015.89							369.27	369.27	3,693	38.18
2026	18	983.44							357.25	357.25	3,573	36.94
2027	19	953.27							346.09	346.09	3,461	35.79
2028	20	925.05							336.59	336.59	3,366	34.80
2029	21	898.72							325.94	325.94	3,259	33.70
2030	22	874.03							316.84	316.84	3,168	32.76
	Total								12,751.98	10,828.55	108,286	1,119.67



Year	Annual C2+ Production & Sale (ton/year)	C2+ Revenue (Mil Baht)	Annual NGL Production & Sale (kg/year)	NGL Revenue (Mil Baht)	Total Revenue (Mil Baht)	Gas Cost (Mil Baht)	LNG Operation & Maintenance Expense (Mil Baht)	LNG Straight Line Depreciation (Mil Baht)	LNG Taxable Income (Mil Baht)	LNG 30% Income Tax (Mil Baht)	LNG Net Income After Tax (Mil Baht)	Net Cash Flow (Mil Baht)	Cumulative Net Cash Flow (Mil Baht)	LNG 10 % Discount Cash Flow (Mil Baht)
2008	0.00	0.00	0.00	0.00	0.00	0.00	8.44	9.84	-18.28	0.00	-18.28	-234.78	-234.78	-234.78
2009	4,200.00	63.00	297,500	6.92	142.30	24.40	8.44	9.84	99.61	29.88	69.73	79.57	-155.21	72.34
2010	4,200.00	63.00	297,500	6.92	142.30	24.40	8.44	9.84	99.61	29.88	69.73	79.57	-75.63	65.76
2011	4,200.00	63.00	297,500	6.92	142.30	24.40	8.44	9.84	99.61	29.88	69.73	79.57	3.94	59.78
2012	4,331.43	64.97	306,810	7.14	146.75	25.17	8.44	9.84	103.30	30.99	72.31	82.15	86.09	56.11
2013	3,986.76	59.80	282,395	6.57	135.07	23.16	8.44	9.84	93.63	28.09	65.54	75.38	161.47	46.81
2014	3,712.18	55.68	262,946	6.12	125.77	21.57	8.44	9.84	85.92	25.78	60.14	69.99	231.46	39.51
2015	3,479.93	52.20	246,495	5.73	117.90	20.22	8.44	9.84	79.40	23.82	55.58	65.42	296.88	33.57
2016	3,288.73	49.33	232,951	5.42	111.42	19.11	8.44	9.84	74.03	22.21	51.82	61.67	358.54	28.77
2017	3,105.04	46.58	219,940	5.11	105.20	18.04	8.44	9.84	68.88	20.66	48.22	58.06	416.60	24.62
2018	2,942.42	44.14	208,421	4.85	99.69	17.10	8.44	9.84	64.31	19.29	45.02	54.86	471.46	21.15
2019	2,804.35	42.07	198,642	4.62	95.01	16.29	8.44	9.84	60.44	18.13	42.31	52.15	523.61	18.28
2020	2,689	40.34	190,479	4.43	91.11	15.62	8.44	9.84	57.20	17.16	40.04	49.88	573.49	15.89
2021	2,571	38.56	182,108	4.24	87.10	14.94	8.44	9.84	53.89	16.17	37.72	47.56	621.05	13.78
2022	2,470	37.05	174,979	4.07	83.69	14.35	8.44	9.84	51.06	15.32	35.74	45.58	666.64	12.00
2023	2,378	35.67	168,461	3.92	80.58	13.82	8.44	9.84	48.48	14.54	33.93	43.78	710.41	10.48
2024	2,300	34.50	162,912	3.79	77.92	13.36	8.44	9.84	46.28	13.88	32.40	42.24	752.65	9.19
2025	2,216	33.23	156,940	3.65	75.07	12.87	8.44	9.84	43.91	13.17	30.74	40.58	793.23	8.03
2026	2,144	32.15	151,832	3.53	72.62	12.45	8.44	9.84	41.89	12.57	29.32	39.16	832.39	7.04
2027	2,077	31.15	147,087	3.42	70.35	12.07	8.44	9.84	40.01	12.00	28.01	37.85	870.24	6.19
2028	2,020	30.29	143,052	3.33	68.42	11.73	8.44	9.84	38.41	11.52	26.89	36.73	906.96	5.46
2029	1,956	29.33	138,526	3.22	66.26	11.36	8.44	9.84	36.62	10.98	25.63	35.47	942.43	4.79
2030	1,901	28.52	134,658	3.13	64.41	11.05	8.44	9.84	35.08	10.52	24.56	34.40	976.83	4.23
	64,971	974.57	4,602,136	107.03	2,201.27		194.12	226.34	1,403.31	426.48	976.83	976.83		329.00

สถาบันวิจัยปิโตรเลียม  
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### Sensitivity analysis of field Y: LNG Producer

- Case 1 Oil reserve from MCS with constant cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR	
2.50	-147.95	-	@ 3rd year
5.00	-121.72	-	@ 4th year
7.50	-95.91	-33.36%	@ 4th year
10.00	-69.98	-22.15%	@ 5th year
10.34	-66.39	-20.57%	@ 5th year
12.50	-43.56	-10.58%	@ 5th year
15.00	-17.73	1.16%	@ 5th year
17.50	7.91	14.24%	@ 6th year
20.00	34.04	29.80%	@ 6th year

- Case 2 Oil reserve from MCS with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR	
2.50	-53.09	-3.52%	@ 6th year
5.00	-2.66	9.32%	@ 6th year
7.50	47.25	22.50%	@ 6th year
10.00	96.68	36.83%	@ 6th year
10.34	103.36	38.91%	@ 6th year
12.50	145.82	53.04%	@ 6th year
15.00	195.52	71.93%	@ 7th year

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

LNG Sale Price (Baht/kg)	NPV (Mil ฿)	IRR
2.50	35.27	15.95%
5.00	113.47	26.60%
7.50	191.67	37.93%
10.00	269.86	50.50%
10.34	280.50	52.34%
12.50	348.06	64.88%
15.00	426.26	81.77%

**B-4) Combined options scenario****Cash flow of field X: Power Generation + Gas to community**

สถาบันวิทยบริการ  
จุฬาลงกรณ์มหาวิทยาลัย

- Case 1 Oil reserve from MCS with constant cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	718.71	263.05	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50
2009	1	642.02	234.34				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	14.17
2010	2	573.61	209.37				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	12.88
2011	3	512.49	187.06				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	11.71
2012	4	457.81	167.56				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	10.65
2013	5	408.96	149.27				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	9.68
2014	6	365.38	133.36				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	5.20
2015	7	326.44	119.15				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	4.73
2016	8	291.61	106.73				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	4.30
2017	9	260.50	95.08				0.788	14.56	1.82	1.50	7.20	4.04	2.02	2.02	9.22	3.91
2018	10	232.74	84.95				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	2.17
2019	11	207.94	75.90				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	1.97
2020	12	185.75	67.99													
2021	13	165.93	60.57													
2022	14	148.25	54.11													
2023	15	132.45	48.35													
2024	16	118.32	43.31													
2025	17	105.70	38.58													
2026	18	94.43	34.47													
2027	19	84.37	30.80													
2028	20	75.37	27.58													
2029	21	67.33	24.57													
2030	22	59.91	21.87													
	Total		2,278				12.600	232.89	29.11	18.00	72.00	113.78	61.24	52.54	52.54	7.86

o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	718.71	263.05	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			242.02	88.34	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	20.57	-110.97	18.70
			173.61	63.37	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	20.57	-90.40	17.00
			112.49	41.06	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	20.57	-69.83	15.46
			57.81	21.56	15.09	4.21	0.53	0.045	5.80	-2.16	0.00	-2.16	3.64	2.49	19.23	-50.60	13.13
			8.96	3.27	2.34	0.65	0.08	0.045	5.80	-5.27	0.00	-5.27	0.53	0.33	16.11	-34.49	10.00
			165.38	60.36	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	14.20	-20.28	8.02
			126.44	46.15	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	14.20	-6.08	7.29
			91.61	33.73	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	14.20	8.13	6.63
			60.50	22.08	15.79	4.41	0.55	0.045	5.80	-1.99	0.00	-1.99	3.81	1.62	13.03	21.16	5.53
			32.74	11.95	8.55	2.39	0.30	0.045	0.00	2.04	1.02	1.02	1.02	0.39	6.64	27.80	2.56
			7.94	2.90	2.07	0.58	0.07	0.045	0.00	0.46	0.23	0.23	0.23	0.08	5.85	33.65	2.05
			185.75	67.99	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	2.49	36.14	0.79
			165.93	60.57	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	2.49	38.64	0.72
			148.25	54.11	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	2.49	41.13	0.66
			132.45	48.35	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	2.49	43.62	0.60
			118.32	43.31	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	2.49	46.12	0.54
			105.70	38.58	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	2.49	48.61	0.49
			94.43	34.47	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	2.49	51.10	0.45
			84.37	30.80	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.41	2.49	53.60	0.41
			75.37	27.58	19.67	5.49	0.69	0.045	0.00	4.76	2.38	2.38	2.38	0.35	2.38	55.98	0.35
			67.33	24.57	17.57	4.91	0.61	0.045	0.00	4.25	2.13	2.13	2.13	0.29	2.13	58.10	0.29
			59.91	21.87	15.64	4.37	0.55	0.045	0.00	3.78	1.89	1.89	1.89	0.23	1.89	59.99	0.23
			1,110	385	107.52	13.44	1.035	58.00	35.04	27.59	7.45	7.45	-27.50	59.99		-19.64	

- Case 2 Oil reserve from MCS with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,881.31	688.56	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50
2009	1	1,901.03	693.88				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	14.17
2010	2	1,874.17	684.07				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	12.88
2011	3	1,814.71	662.37				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	11.71
2012	4	1,733.17	634.34				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	10.65
2013	5	1,637.69	597.76				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	9.68
2014	6	1,534.47	560.08				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.80
2015	7	1,427.87	521.17				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.00
2016	8	1,321.00	483.48				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	7.27
2017	9	1,216.34	443.96				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	6.61
2018	10	1,115.65	407.21				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.62
2019	11	1,019.86	372.25				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.20
2020	12	929.50	340.20				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.82
2021	13	845.05	308.44				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.47
2022	14	766.73	279.86				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.16
2023	15	694.40	253.46				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.87
2024	16	627.80	229.77				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.61
2025	17	566.79	206.88				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.37
2026	18	511.15	186.57				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.16
2027	19	460.48	168.08				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.96
2028	20	414.39	151.67				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.78
2029	21	372.60	136.00				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	0.76
2030	22	333.48	121.72				0.788	14.56	1.82	1.50	0.00	11.24	5.62	5.62	5.62	0.69
	Total		9,132				33.08	611.35	76.42	34.50	72.00	428.43	218.56	209.86	209.86	50.73



o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	1,881.31	688.56	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			1,501.03	547.88	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	20.57	-110.97	18.70
			1,474.17	538.07	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	20.57	-90.40	17.00
			1,414.71	516.37	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	20.57	-69.83	15.46
			1,333.17	488.34	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	20.57	-49.25	14.05
			1,237.69	451.76	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	20.57	-28.68	12.77
			1,134.47	414.08	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	20.57	-8.11	11.61
			1,027.87	375.17	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	20.57	12.46	10.56
			921.00	337.48	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	20.57	33.04	9.60
			816.34	297.96	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.11	20.57	53.61	8.72
			715.65	261.21	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.96	14.48	68.09	5.58
			619.86	226.25	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.87	14.48	82.57	5.07
			529.50	194.20	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	14.48	97.05	4.61
			445.05	162.44	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	14.48	111.53	4.19
			366.73	133.86	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	14.48	126.01	3.81
			294.40	107.46	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	14.48	140.49	3.47
			227.80	83.77	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	14.48	154.97	3.15
			166.79	60.88	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	14.48	169.45	2.86
			111.15	40.57	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	14.48	183.92	2.60
			60.48	22.08	15.79	4.41	0.55	0.045	0.00	3.81	1.91	1.91	1.91	0.31	13.89	197.82	2.27
			14.39	5.67	3.76	1.05	0.13	0.045	0.00	0.87	0.44	0.44	0.44	0.06	12.42	210.24	1.85
			172.60	63.00	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.34	8.11	218.35	1.10
			133.48	48.72	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.31	8.11	226.46	1.00
				6,066	431	120.46	15.06	1.035	58.00	46.37	29.77	16.60	16.60	-22.22	226.46		28.51

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	675.08	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50
2009	1	1,853.17	676.41				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	14.17
2010	2	1,840.23	671.68				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	12.88
2011	3	1,814.97	662.46				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	11.71
2012	4	1,782.71	652.47				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	10.65
2013	5	1,746.74	637.56				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	9.68
2014	6	1,709.06	623.81				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.80
2015	7	1,670.87	609.87				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.00
2016	8	1,632.86	597.63				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	7.27
2017	9	1,595.57	582.38				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	6.61
2018	10	1,559.32	569.15				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.62
2019	11	1,524.22	556.34				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.20
2020	12	1,490.32	545.46				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.82
2021	13	1,457.68	532.05				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.47
2022	14	1,426.37	520.62				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.16
2023	15	1,396.30	509.65				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.87
2024	16	1,367.40	500.47				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.61
2025	17	1,339.67	488.98				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.37
2026	18	1,313.09	479.28				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.16
2027	19	1,287.59	469.97				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.96
2028	20	1,263.06	462.28				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.78
2029	21	1,239.50	452.42				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.62
2030	22	1,216.88	444.16				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.47
	Total		12,920				34.650	640.46	80.06	34.50	72.00	453.90	231.30	222.60	222.60	52.37

o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	1,844.48	675.08	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			1,453.17	530.41	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	20.57	-110.97	18.70
			1,440.23	525.68	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	20.57	-90.40	17.00
			1,414.97	516.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	20.57	-69.83	15.46
			1,382.71	506.47	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	20.57	-49.25	14.05
			1,346.74	491.56	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	20.57	-28.68	12.77
			1,309.06	477.81	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	20.57	-8.11	11.61
			1,270.87	463.87	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	20.57	12.46	10.56
			1,232.86	451.63	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	20.57	33.04	9.60
			1,195.57	436.38	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.11	20.57	53.61	8.72
			1,159.32	423.15	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.96	14.48	68.09	5.58
			1,124.22	410.34	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.87	14.48	82.57	5.07
			1,090.32	399.46	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	14.48	97.05	4.61
			1,057.68	386.05	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	14.48	111.53	4.19
			1,026.37	374.62	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	14.48	126.01	3.81
			996.30	363.65	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	14.48	140.49	3.47
			967.40	354.47	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	14.48	154.97	3.15
			939.67	342.98	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	14.48	169.45	2.86
			913.09	333.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	14.48	183.92	2.60
			887.59	323.97	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.41	14.48	198.40	2.37
			863.06	316.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.37	14.48	212.88	2.15
			839.50	306.42	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.34	14.48	227.36	1.96
			816.88	298.16	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.31	14.48	241.84	1.78
				9,708	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24	-21.82	241.84		30.55

- Optimization 5 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,844.48	675.08	25.00	155.00	180.00	0.00	0.00	0.00	3.75	18.00	-21.75	0.00	-21.75	-183.75	-183.75
2009	1	1,853.17	676.41				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	35.42
2010	2	1,840.23	671.68				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	32.20
2011	3	1,814.97	662.46				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	29.28
2012	4	1,782.71	652.47				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	26.61
2013	5	1,746.74	637.56				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	24.19
2014	6	1,709.06	623.81				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	22.00
2015	7	1,670.87	609.87				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	20.00
2016	8	1,632.86	597.63				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	18.18
2017	9	1,595.57	582.38				3.938	72.78	9.10	3.75	18.00	41.93	20.97	20.97	38.97	16.53
2018	10	1,559.32	569.15				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	11.55
2019	11	1,524.22	556.34				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	10.50
2020	12	1,490.32	545.46				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	9.55
2021	13	1,457.68	532.05				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	8.68
2022	14	1,426.37	520.62				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	7.89
2023	15	1,396.30	509.65				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	7.17
2024	16	1,367.40	500.47				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	6.52
2025	17	1,339.67	488.98				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	5.93
2026	18	1,313.09	479.28				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	5.39
2027	19	1,287.59	469.97				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	4.90
2028	20	1,263.06	462.28				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	4.45
2029	21	1,239.50	452.42				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	4.05
2030	22	1,216.88	444.16				3.938	72.78	9.10	3.75	0.00	59.93	29.97	29.97	29.97	3.68
	Total		12,920				86.625	1,601.14	200.14	86.25	180.00	1,134.75	578.25	556.50	556.50	130.93

o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	1,844.48	675.08	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-241.80	-241.80	-241.80
			853.17	311.41	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	43.95	-197.84	39.96
			840.23	306.68	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	43.95	-153.89	36.32
			814.97	297.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	43.95	-109.94	33.02
			782.71	287.47	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	43.95	-65.99	30.02
			746.74	272.56	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	43.95	-22.03	27.29
			709.06	258.81	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	43.95	21.92	24.81
			670.87	244.87	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	43.95	65.87	22.55
			632.86	232.63	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	43.95	109.82	20.50
			595.57	217.38	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.11	43.95	153.77	18.64
			559.32	204.15	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.96	32.46	186.23	12.51
			524.22	191.34	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.87	32.46	218.69	11.38
			490.32	180.46	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	32.46	251.15	10.34
			457.68	167.05	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	32.46	283.61	9.40
			426.37	155.62	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	32.46	316.07	8.55
			396.30	144.65	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	32.46	348.53	7.77
			367.40	135.47	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	32.46	380.99	7.06
			339.67	123.98	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	32.46	413.45	6.42
			313.09	114.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	32.46	445.91	5.84
			287.59	104.97	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.41	32.46	478.37	5.31
			263.06	97.28	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.37	32.46	510.82	4.82
			239.50	87.42	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.34	32.46	543.28	4.39
			216.88	79.16	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.31	32.46	575.74	3.99
				4,890	453	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24	-21.82	575.74		109.11

Summary of combined options of field X

	NPV of options combined		
	Power	Gas to community	Cumulative
Oil reserve from MCS with constant cumulative GOR	24.95	-22.47	2.48
Oil reserve from MCS with increasing cumulative GOR	67.81	-17.19	50.63
Oil reserve from harmonic decline with increasing cumulative GOR	69.46	-16.79	52.67
Oil reserve from harmonic decline with increasing cum GOR: Optimization 5 MW of power	173.64	-16.79	156.86

### Cash flow of field Y: Power Generation + Gas to community

- Case 1 Oil reserve from MCS with constant cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	1,446.10	691.11	10.00	62.00	72.00	0.00	0.00	0.00	1.50	14.40	-15.90	0.00	-15.90	-73.50	-73.50
2009	1	832.54	387.47				1.575	29.11	3.64	1.50	14.40	9.57	4.79	4.79	19.19	17.44
2010	2	505.05	228.80				1.575	29.11	3.64	1.50	14.40	9.57	4.79	4.79	19.19	15.86
2011	3	277.54	139.12				0.788	14.56	1.82	1.50	14.40	-3.16	0.00	-3.16	11.24	8.44
2012	4	190.07	81.39													
2013	5	122.24	54.64													
2014	6	57.10	35.21													
2015	7	40.00	16.47													
2016	8	31.78	12.70													
2017	9	25.27	10.07													
2018	10	4.30	2.82													
2019	11	3.58	0.94													
	Total		1,661				3.938	72.78	9.10	6.00	57.60	0.08	9.57	-9.49	-23.89	-31.76



o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	1,446.10	691.11	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			432.54	241.47	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	24.17	-107.37	21.98
			105.05	82.80	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	24.17	-83.20	19.98
			77.54	66.12	20.24	5.65	0.71	0.045	5.80	-0.90	0.00	-0.90	4.90	3.68	16.14	-67.06	12.12
			190.07	81.39	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	4.99	-62.08	3.41
			122.24	54.64	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	4.99	-57.09	3.10
			57.10	35.21	14.90	4.16	0.52	0.045	5.80	-2.20	0.00	-2.20	3.60	2.03	3.60	-53.49	2.03
			40.00	16.47	10.44	2.92	0.36	0.045	5.80	-3.29	0.00	-3.29	2.51	1.29	2.51	-50.98	1.29
			31.78	12.70	8.29	2.32	0.29	0.045	5.80	-3.82	0.00	-3.82	1.98	0.92	1.98	-49.00	0.92
			25.27	10.07	6.59	1.84	0.23	0.045	5.80	-4.23	0.00	-4.23	1.57	0.66	1.57	-47.44	0.66
			4.30	2.82	1.12	0.31	0.04	0.045	0.00	0.23	0.11	0.11	0.11	0.04	0.11	-47.32	0.04
			3.58	0.94	0.93	0.26	0.03	0.045	0.00	0.18	0.09	0.09	0.09	0.03	0.09	-47.23	0.03
			2,535.58	1,295.73	144.86	40.47	5.06	0.540	58.00	-23.13	0.21	-23.34	-23.34	-34.22	-47.23		-65.98

สถาบันวิทยบริการ  
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- Case 2 Oil reserve from MCS with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,279.87	1,411.12	10.00	62.00	72.00	0.00	0.00	0.00	1.50	12.00	-13.50	0.00	-13.50	-73.50	-73.50
2009	1	2,308.79	974.33				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	16.35
2010	2	1,662.89	693.58				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	14.86
2011	3	1,179.14	502.00				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	13.51
2012	4	890.29	364.30				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	12.28
2013	5	655.32	272.65				1.575	29.11	3.64	1.50	12.00	11.97	5.99	5.99	17.99	11.17
2014	6	146.30	182.55													
2015	7	110.00	44.36													
2016	8	88.09	35.08													
2017	9	70.46	28.00													
2018	10	16.22	9.26													
2019	11	13.52	3.53													
	Total		4,521				7.875	145.56	18.19	9.00	72.00	46.36	29.93	16.43	16.43	-5.32

สถาบันวิทยบริการ  
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o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	3,279.87	1,411.12	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			1,908.79	828.33	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	22.97	-108.57	20.88
			1,262.89	547.58	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	22.97	-85.60	18.99
			779.14	356.00	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	22.97	-62.63	17.26
			490.29	218.30	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	22.97	-39.65	15.69
			255.32	126.65	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	22.97	-16.68	14.26
			146.30	182.55	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	4.99	-11.70	2.81
			110.00	44.36	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	4.99	-6.71	2.56
			88.09	35.08	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	4.99	-1.72	2.33
			70.46	28.00	18.39	5.14	0.64	0.045	5.80	-1.35	0.00	-1.35	4.45	1.89	4.45	2.73	1.89
			16.22	9.26	4.23	1.18	0.15	0.045	0.00	0.99	0.49	0.49	0.49	0.19	0.49	3.22	0.19
			13.52	3.53	3.53	0.99	0.12	0.045	0.00	0.82	0.41	0.41	0.41	0.14	0.41	3.63	0.14
			8,420.90	3,790.75	190.83	53.31	6.66	0.540	58.00	-11.90	0.90	-12.80	-12.80	-29.22	3.63		-34.54

สถาบันวิทยบริการ  
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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	1283.15	10.00	62.00	72.00	0.00	0.00	0.00	1.50	7.20	-8.70	0.00	-8.70	-73.50	-73.50
2009	1	2,692.75	1036.52				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	14.17
2010	2	2,377.45	899.23				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	12.88
2011	3	2,147.96	804.54				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	11.71
2012	4	1,935.04	721.91				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	10.65
2013	5	1,794.10	664.46				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	9.68
2014	6	1,676.20	618.70				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.80
2015	7	1,575.58	579.99				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	8.00
2016	8	1,488.12	548.12				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	7.27
2017	9	1,411.58	517.51				1.575	29.11	3.64	1.50	7.20	16.77	8.39	8.39	15.59	6.61
2018	10	1,339.06	490.40				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.62
2019	11	1,278.73	467.39				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	4.20
2020	12	1,224.23	448.19				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.82
2021	13	1,174.96	428.49				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.47
2022	14	1,130.02	411.71				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	3.16
2023	15	1,088.86	396.38				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.87
2024	16	1,050.88	383.32				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.61
2025	17	1,015.89	369.27				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.37
2026	18	983.44	357.25				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	2.16
2027	19	953.27	346.09				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.96
2028	20	925.05	336.59				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.78
2029	21	898.72	325.94				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.62
2030	22	874.03	316.84				1.575	29.11	3.64	1.50	0.00	23.97	11.99	11.99	11.99	1.47
	Total		12,751.98				34.650	640.46	80.06	34.50	72.00	453.90	231.30	222.60	222.60	52.37

o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	3,183.64	1,283.15	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-131.55	-131.55	-131.55
			2,292.75	890.52	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	20.57	-110.97	18.70
			1,977.45	753.23	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	20.57	-90.40	17.00
			1,747.96	658.54	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	20.57	-69.83	15.46
			1,535.04	575.91	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	20.57	-49.25	14.05
			1,394.10	518.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	20.57	-28.68	12.77
			1,276.20	472.70	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	20.57	-8.11	11.61
			1,175.58	433.99	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	20.57	12.46	10.56
			1,088.12	402.12	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	20.57	33.04	9.60
			1,011.58	371.51	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.11	20.57	53.61	8.72
			939.06	344.40	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.96	14.48	68.09	5.58
			878.73	321.39	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.87	14.48	82.57	5.07
			824.23	302.19	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	14.48	97.05	4.61
			774.96	282.49	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	14.48	111.53	4.19
			730.02	265.71	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	14.48	126.01	3.81
			688.86	250.38	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	14.48	140.49	3.47
			650.88	237.32	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	14.48	154.97	3.15
			615.89	223.27	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	14.48	169.45	2.86
			583.44	211.25	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	14.48	183.92	2.60
			553.27	200.09	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.41	14.48	198.40	2.37
			525.05	190.59	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.37	14.48	212.88	2.15
			498.72	179.94	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.34	14.48	227.36	1.96
			474.03	170.84	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.31	14.48	241.84	1.78
				9,539.98	452.86	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24	-21.82	241.84		30.55

- Optimization 3 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR
  - o Part of power generation option

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/Year)	Pipe Laying Cost (Mil Baht)	Building, Equipment, and Machine Cost (Mil Baht)	Capital Expense (Mil Baht)	Power Production (MW)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	Operation & Maintenance Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Power Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)
2008	0	3,183.64	1283.15	15.00	93.00	108.00	0.00	0.00	0.00	2.25	10.80	-13.05	0.00	-13.05	-110.25	-110.25
2009	1	2,692.75	1036.52				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	21.25
2010	2	2,377.45	899.23				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	19.32
2011	3	2,147.96	804.54				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	17.57
2012	4	1,935.04	721.91				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	15.97
2013	5	1,794.10	664.46				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	14.52
2014	6	1,676.20	618.70				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	13.20
2015	7	1,575.58	579.99				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	12.00
2016	8	1,488.12	548.12				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	10.91
2017	9	1,411.58	517.51				2.363	43.67	5.46	2.25	10.80	25.16	12.58	12.58	23.38	9.92
2018	10	1,339.06	490.40				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	6.93
2019	11	1,278.73	467.39				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	6.30
2020	12	1,224.23	448.19				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	5.73
2021	13	1,174.96	428.49				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	5.21
2022	14	1,130.02	411.71				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	4.73
2023	15	1,088.86	396.38				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	4.30
2024	16	1,050.88	383.32				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	3.91
2025	17	1,015.89	369.27				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	3.56
2026	18	983.44	357.25				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	3.23
2027	19	953.27	346.09				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	2.94
2028	20	925.05	336.59				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	2.67
2029	21	898.72	325.94				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	2.43
2030	22	874.03	316.84				2.363	43.67	5.46	2.25	0.00	35.96	17.98	17.98	17.98	2.21
	Total		12,751.98				51.975	960.69	120.09	51.75	108.00	680.85	346.95	333.90	333.90	78.56

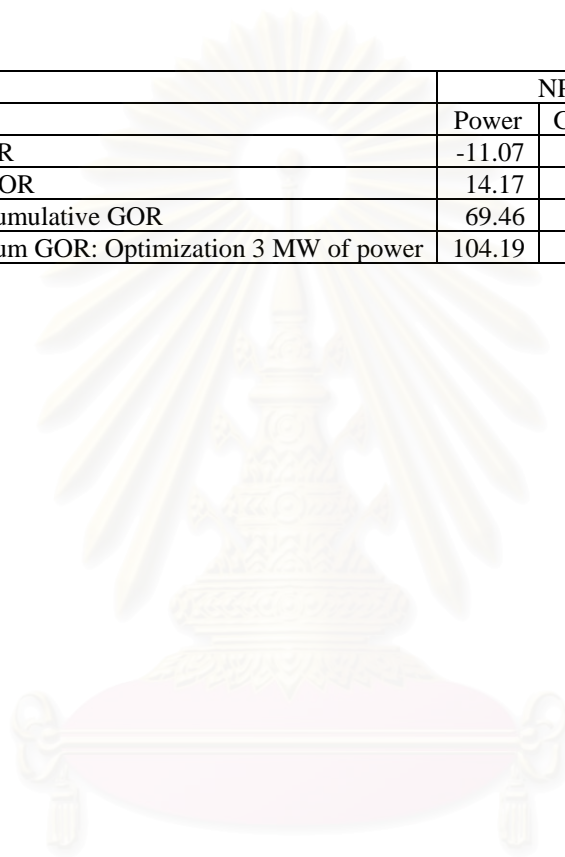


o Part of gas to community option

Pipe Laying Cost (Baht)	Building, Equipment, and Machine Cost (Baht)	Capital Expense (Baht)	Available Daily Gas @ the end of the year (MSCFD)	Annual Gas Available (MMSCF/ Year)	Annual Gas Sale (MMSCF/ Year)	Revenue (Mil Baht)	12.5% Royalty (Mil Baht)	O & M Expense (Mil Baht)	Straight Line Depreciation (Mil Baht)	Taxable Income (Mil Baht)	50% Income Tax (Mil Baht)	Net Income After Tax (Mil Baht)	Gas to Community Net Cash Flow (Mil Baht)	10 % Discount Cash Flow (Mil Baht)	Combined Net Cash Flow (Mil Baht)	Cum Net Cash Flow (Mil Baht)	Combined Discount Cash Flow (Mil Baht)
1.00	57.00	58.00	3,183.64	1,283.15	0.00	0.00	0.00	0.045	5.80	-5.85	0.00	-5.85	-58.05	-58.05	-168.30	-168.30	-168.30
			2,092.75	817.52	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.53	28.37	-139.93	25.79
			1,777.45	680.23	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	4.12	28.37	-111.56	23.44
			1,547.96	585.54	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.75	28.37	-83.20	21.31
			1,335.04	502.91	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.41	28.37	-54.83	19.37
			1,194.10	445.46	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	3.10	28.37	-26.47	17.61
			1,076.20	399.70	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.81	28.37	1.90	16.01
			975.58	360.99	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.56	28.37	30.27	14.56
			888.12	329.12	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.33	28.37	58.63	13.23
			811.58	298.51	20.58	5.75	0.72	0.045	5.80	-0.81	0.00	-0.81	4.99	2.11	28.37	87.00	12.03
			739.06	271.40	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.96	20.47	107.47	7.89
			678.73	248.39	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.87	20.47	127.94	7.18
			624.23	229.19	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.79	20.47	148.42	6.52
			574.96	209.49	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.72	20.47	168.89	5.93
			530.02	192.71	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.66	20.47	189.36	5.39
			488.86	177.38	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.60	20.47	209.83	4.90
			450.88	164.32	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.54	20.47	230.31	4.46
			415.89	150.27	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.49	20.47	250.78	4.05
			383.44	138.25	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.45	20.47	271.25	3.68
			353.27	127.09	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.41	20.47	291.72	3.35
			325.05	117.59	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.37	20.47	312.20	3.04
			298.72	106.94	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.34	20.47	332.67	2.77
			274.03	97.84	20.58	5.75	0.72	0.045	0.00	4.99	2.49	2.49	2.49	0.31	20.47	353.14	2.51
				7,933.98	452.86	126.50	15.81	1.035	58.00	51.65	32.41	19.24	19.24	-21.82	353.14		56.74

### Summary of combined options of field Y

	NPV of options combined		
	Power	Gas to community	Cumulative
Oil reserve from MCS with constant cumulative GOR	-11.07	-29.19	-40.27
Oil reserve from MCS with increasing cumulative GOR	14.17	-24.19	-10.02
Oil reserve from harmonic decline with increasing cumulative GOR	69.46	-16.79	52.67
Oil reserve from harmonic decline with increasing cum GOR: Optimization 3 MW of power	104.19	-16.79	87.40



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## APPENDIX C

**Green House Gas Reduction & Energy Efficiency****C-1) Power generation option****Field X**

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	263.05	146	117.05	9,767.54	112.66	7,831	14.72	5.37
2009	1	234.34	146	88.34	9,767.54	112.66	5,910	11.11	5.37
2010	2	209.37	146	63.37	9,767.54	112.66	4,239	7.97	5.37
2011	3	187.06	146	41.06	9,767.54	112.66	2,747	5.16	5.37
2012	4	167.56	146	21.56	9,767.54	112.66	1,442	2.71	5.37
2013	5	149.27	146	3.27	9,767.54	112.66	219	0.41	5.37
2014	6	133.36	73	60.36	4,883.77	56.33	4,038	7.59	2.69
2015	7	119.15	73	46.15	4,883.77	56.33	3,088	5.80	2.69
2016	8	106.73	73	33.73	4,883.77	56.33	2,257	4.24	2.69
2017	9	95.08	73	22.08	4,883.77	56.33	1,477	2.78	2.69
2018	10	84.95	73	11.95	4,883.77	56.33	799	1.50	2.69
2019	11	75.90	73	2.90	4,883.77	56.33	194	0.36	2.69
2020	12	67.99	0	67.99	0	0	4,548	8.55	0
2021	13	60.57	0	60.57	0	0	4,052	7.61	0
2022	14	54.11	0	54.11	0	0	3,620	6.80	0
2023	15	48.35	0	48.35	0	0	3,234	6.08	0
2024	16	43.31	0	43.31	0	0	2,897	5.44	0
2025	17	38.58	0	38.58	0	0	2,581	4.85	0
2026	18	34.47	0	34.47	0	0	2,306	4.33	0
2027	19	30.80	0	30.80	0	0	2,060	3.87	0
2028	20	27.58	0	27.58	0	0	1,845	3.47	0
2029	21	24.57	0	24.57	0	0	1,644	3.09	0
2030	22	21.87	0	21.87	0	0	1,463	2.75	0
	Total	2,278	1,314	964.00	87,907.82	1,013.98	64,492.54	121.20	48.37

## - Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	688.56	146	542.56	9,767.54	112.66	36,298	68.21	5.37
2009	1	693.88	146	547.88	9,767.54	112.66	36,653	68.88	5.37
2010	2	684.07	146	538.07	9,767.54	112.66	35,997	67.65	5.37
2011	3	662.37	146	516.37	9,767.54	112.66	34,546	64.92	5.37
2012	4	634.34	146	488.34	9,767.54	112.66	32,670	61.40	5.37
2013	5	597.76	146	451.76	9,767.54	112.66	30,223	56.80	5.37
2014	6	560.08	146	414.08	9,767.54	112.66	27,702	52.06	5.37
2015	7	521.17	146	375.17	9,767.54	112.66	25,099	47.17	5.37
2016	8	483.48	146	337.48	9,767.54	112.66	22,578	42.43	5.37
2017	9	443.96	146	297.96	9,767.54	112.66	19,934	37.46	5.37
2018	10	407.21	146	261.21	9,767.54	112.66	17,475	32.84	5.37
2019	11	372.25	146	226.25	9,767.54	112.66	15,136	28.45	5.37
2020	12	340.20	146	194.20	9,767.54	112.66	12,992	24.42	5.37
2021	13	308.44	146	162.44	9,767.54	112.66	10,867	20.42	5.37
2022	14	279.86	146	133.86	9,767.54	112.66	8,955	16.83	5.37
2023	15	253.46	146	107.46	9,767.54	112.66	7,189	13.51	5.37
2024	16	229.77	146	83.77	9,767.54	112.66	5,605	10.53	5.37
2025	17	206.88	146	60.88	9,767.54	112.66	4,073	7.65	5.37
2026	18	186.57	146	40.57	9,767.54	112.66	2,714	5.10	5.37
2027	19	168.08	146	22.08	9,767.54	112.66	1,477	2.78	5.37
2028	20	151.67	146	5.67	9,767.54	112.66	379	0.71	5.37
2029	21	136.00	73	63.00	4,883.77	56.33	4,215	7.92	2.69
2030	22	121.72	73	48.72	4,883.77	56.33	3,259	6.13	2.69
	Total	9,131.77	3,212	5,919.77	214,885.78	2,478.62	396,038.23	744.28	118.25

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## - Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	675.08	146	529	9,767.54	112.66	35,396	66.52	5.37
2009	1	676.41	146	530	9,767.54	112.66	35,485	66.69	5.37
2010	2	671.68	146	526	9,767.54	112.66	35,169	66.09	5.37
2011	3	662.46	146	516	9,767.54	112.66	34,552	64.93	5.37
2012	4	652.47	146	506	9,767.54	112.66	33,884	63.68	5.37
2013	5	637.56	146	492	9,767.54	112.66	32,886	61.80	5.37
2014	6	623.81	146	478	9,767.54	112.66	31,966	60.07	5.37
2015	7	609.87	146	464	9,767.54	112.66	31,033	58.32	5.37
2016	8	597.63	146	452	9,767.54	112.66	30,214	56.78	5.37
2017	9	582.38	146	436	9,767.54	112.66	29,194	54.87	5.37
2018	10	569.15	146	423	9,767.54	112.66	28,309	53.20	5.37
2019	11	556.34	146	410	9,767.54	112.66	27,452	51.59	5.37
2020	12	545.46	146	399	9,767.54	112.66	26,724	50.22	5.37
2021	13	532.05	146	386	9,767.54	112.66	25,827	48.54	5.37
2022	14	520.62	146	375	9,767.54	112.66	25,063	47.10	5.37
2023	15	509.65	146	364	9,767.54	112.66	24,328	45.72	5.37
2024	16	500.47	146	354	9,767.54	112.66	23,714	44.57	5.37
2025	17	488.98	146	343	9,767.54	112.66	22,946	43.12	5.37
2026	18	479.28	146	333	9,767.54	112.66	22,297	41.90	5.37
2027	19	469.97	146	324	9,767.54	112.66	21,674	40.73	5.37
2028	20	462.28	146	316	9,767.54	112.66	21,159	39.77	5.37
2029	21	452.42	146	306	9,767.54	112.66	20,500	38.52	5.37
2030	22	444.16	146	298	9,767.54	112.66	19,947	37.49	5.37
	Total	12,920	3,358	9,562	224,653.32	2,591.29	639,718.68	1,202.23	123.62

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- Optimization 6 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	675.08	438	237	29,302.61	337.99	15,861	29.81	16.12
2009	1	676.41	438	238	29,302.61	337.99	15,950	29.97	16.12
2010	2	671.68	438	234	29,302.61	337.99	15,634	29.38	16.12
2011	3	662.46	438	224	29,302.61	337.99	15,017	28.22	16.12
2012	4	652.47	438	214	29,302.61	337.99	14,348	26.97	16.12
2013	5	637.56	438	200	29,302.61	337.99	13,351	25.09	16.12
2014	6	623.81	438	186	29,302.61	337.99	12,431	23.36	16.12
2015	7	609.87	438	172	29,302.61	337.99	11,498	21.61	16.12
2016	8	597.63	438	160	29,302.61	337.99	10,679	20.07	16.12
2017	9	582.38	438	144	29,302.61	337.99	9,659	18.15	16.12
2018	10	569.15	438	131	29,302.61	337.99	8,774	16.49	16.12
2019	11	556.34	438	118	29,302.61	337.99	7,917	14.88	16.12
2020	12	545.46	438	107	29,302.61	337.99	7,189	13.51	16.12
2021	13	532.05	438	94	29,302.61	337.99	6,292	11.83	16.12
2022	14	520.62	438	83	29,302.61	337.99	5,528	10.39	16.12
2023	15	509.65	438	72	29,302.61	337.99	4,793	9.01	16.12
2024	16	500.47	438	62	29,302.61	337.99	4,179	7.85	16.12
2025	17	488.98	438	51	29,302.61	337.99	3,411	6.41	16.12
2026	18	479.28	438	41	29,302.61	337.99	2,762	5.19	16.12
2027	19	469.97	365	105	24,418.84	281.66	7,022	13.20	13.44
2028	20	462.28	365	97	24,418.84	281.66	6,508	12.23	13.44
2029	21	452.42	365	87	24,418.84	281.66	5,848	10.99	13.44
2030	22	444.16	365	79	24,418.84	281.66	5,296	9.95	13.44
	Total	12,920.18	9,782	3,138	654,424.88	7,548.53	209,947.12	394.56	360.12

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**Field Y****- Case 1 Oil reserve from MCS with constant cumulative GOR**

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	691.11	146	545	9,767.54	112.66	36,468	68.54	5.37
2009	1	387.47	146	241	9,767.54	112.66	16,155	30.36	5.37
2010	2	228.80	146	83	9,767.54	112.66	5,539	10.41	5.37
2011	3	139.12	73	66	4,883.77	56.33	4,423	8.31	2.69
2012	4	81.39	73	8	4,883.77	56.33	561	1.05	2.69
2013	5	54.64	0	55	0	0	3,655	6.87	0
2014	6	35.21	0	35	0	0	2,355	4.43	0
2015	7	16.47	0	16	0	0	1,102	2.07	0
2016	8	12.70	0	13	0	0	850	1.60	0
2017	9	10.07	0	10	0	0	673	1.27	0
2018	10	2.82	0	3	0	0	189	0.35	0
2019	11	0.94	0	1	0	0	63	0.12	0
	Total	1,660.73	584	1,077	39,070	451	72,034	135.37	21.50

**- Case 2 Oil reserve from MCS with increasing cumulative GOR**

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1,411.12	146	1,265	9,767.54	112.66	84,638	159.06	5.37
2009	1	974.33	146	828	9,767.54	112.66	55,416	104.14	5.37
2010	2	693.58	146	548	9,767.54	112.66	36,633	68.85	5.37
2011	3	502.00	146	356	9,767.54	112.66	23,817	44.76	5.37
2012	4	364.30	146	218	9,767.54	112.66	14,604	27.45	5.37
2013	5	272.65	146	127	9,767.54	112.66	8,473	15.92	5.37
2014	6	182.55	0	183	0	0	12,213	22.95	0
2015	7	44.36	0	44	0	0	2,968	5.58	0
2016	8	35.08	0	35	0	0	2,347	4.41	0
2017	9	28.00	0	28	0	0	1,873	3.52	0
2018	10	9.26	0	9	0	0	619	1.16	0
2019	11	3.53	0	4	0	0	236	0.44	0
	Total	4,521	876	3,645	58,605.21	675.99	243,837	458.25	32.25

## - Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1283.15	146	1,137	9,767.54	112.66	76,076	142.97	5.37
2009	1	1036.52	146	891	9,767.54	112.66	59,576	111.96	5.37
2010	2	899.23	146	753	9,767.54	112.66	50,392	94.70	5.37
2011	3	804.54	146	659	9,767.54	112.66	44,057	82.80	5.37
2012	4	721.91	146	576	9,767.54	112.66	38,529	72.41	5.37
2013	5	664.46	146	518	9,767.54	112.66	34,685	65.18	5.37
2014	6	618.70	146	473	9,767.54	112.66	31,624	59.43	5.37
2015	7	579.99	146	434	9,767.54	112.66	29,034	54.56	5.37
2016	8	548.12	146	402	9,767.54	112.66	26,902	50.56	5.37
2017	9	517.51	146	372	9,767.54	112.66	24,854	46.71	5.37
2018	10	490.40	146	344	9,767.54	112.66	23,041	43.30	5.37
2019	11	467.39	146	321	9,767.54	112.66	21,501	40.41	5.37
2020	12	448.19	146	302	9,767.54	112.66	20,217	37.99	5.37
2021	13	428.49	146	282	9,767.54	112.66	18,899	35.52	5.37
2022	14	411.71	146	266	9,767.54	112.66	17,777	33.41	5.37
2023	15	396.38	146	250	9,767.54	112.66	16,751	31.48	5.37
2024	16	383.32	146	237	9,767.54	112.66	15,877	29.84	5.37
2025	17	369.27	146	223	9,767.54	112.66	14,937	28.07	5.37
2026	18	357.25	146	211	9,767.54	112.66	14,133	26.56	5.37
2027	19	346.09	146	200	9,767.54	112.66	13,386	25.16	5.37
2028	20	336.59	146	191	9,767.54	112.66	12,751	23.96	5.37
2029	21	325.94	146	180	9,767.54	112.66	12,038	22.62	5.37
2030	22	316.84	146	171	9,767.54	112.66	11,430	21.48	5.37
	Total	12,751.98	3,358	9,394	224,653.32	2,591.29	628,466.31	1,181.08	123.62

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- Optimization 6 MW of case 3: Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Annual Gas Available (MMSCF/Year)	Gas Sale (MMSCF/Year)	Gas Flared (MMSCF/Year)	4-Stoke lean burn engines		Flaring		Oil Saved (Mil lit/year)
					CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1283.15	292	991	19,535.07	225.33	66,309	124.61	10.75
2009	1	1036.52	292	745	19,535.07	225.33	49,809	93.61	10.75
2010	2	899.23	292	607	19,535.07	225.33	40,624	76.35	10.75
2011	3	804.54	292	513	19,535.07	225.33	34,289	64.44	10.75
2012	4	721.91	292	430	19,535.07	225.33	28,761	54.05	10.75
2013	5	664.46	292	372	19,535.07	225.33	24,918	46.83	10.75
2014	6	618.70	292	327	19,535.07	225.33	21,856	41.07	10.75
2015	7	579.99	292	288	19,535.07	225.33	19,267	36.21	10.75
2016	8	548.12	292	256	19,535.07	225.33	17,135	32.20	10.75
2017	9	517.51	292	226	19,535.07	225.33	15,087	28.35	10.75
2018	10	490.40	292	198	19,535.07	225.33	13,273	24.94	10.75
2019	11	467.39	292	175	19,535.07	225.33	11,734	22.05	10.75
2020	12	448.19	292	156	19,535.07	225.33	10,449	19.64	10.75
2021	13	428.49	292	136	19,535.07	225.33	9,131	17.16	10.75
2022	14	411.71	292	120	19,535.07	225.33	8,009	15.05	10.75
2023	15	396.38	292	104	19,535.07	225.33	6,983	13.12	10.75
2024	16	383.32	292	91	19,535.07	225.33	6,110	11.48	10.75
2025	17	369.27	292	77	19,535.07	225.33	5,170	9.72	10.75
2026	18	357.25	219	138	14,651.30	169.00	9,249	17.38	8.06
2027	19	346.09	219	127	14,651.30	169.00	8,502	15.98	8.06
2028	20	336.59	219	118	14,651.30	169.00	7,867	14.78	8.06
2029	21	325.94	219	107	14,651.30	169.00	7,155	13.45	8.06
2030	22	316.84	219	98	14,651.30	169.00	6,546	12.30	8.06
	Total	12,751.98	6,351	6,401	424,887.80	4,900.91	428,231.83	804.78	233.81

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## C-2) LNG option

### Field X

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/year)	LPG Saved (Mil kg/year)	Oil Saved (Mil lit/year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	718.71	263.05	263.05	0	17,598	33.07	0	0	2,630	1,578.29	111,796	2.57	0.24	0.14
2009	1	642.02	234.34	234.34	0	15,677	29.46	0	0	2,343	1,406.03	99,594	2.29	0.21	0.12
2010	2	573.61	209.37	209.37	0	14,007	26.32	0	0	2,094	1,256.21	88,981	2.05	0.19	0.11
2011	3	512.49	187.06	187.06	0	12,514	23.52	0	0	1,871	1,122.35	79,499	1.83	0.17	0.10
2012	4	457.81	167.56	167.56	0	11,210	21.07	0	0	1,676	1,005.34	71,212	1.64	0.15	0.09
2013	5	408.96	149.27	149.27	0	9,986	18.77	0	0	1,493	895.62	63,440	1.46	0.14	0.08
2014	6	365.38	133.36	133.36	0	8,922	16.77	0	0	1,334	800.18	56,680	1.31	0.12	0.07
2015	7	326.44	119.15	119.15	0	7,971	14.98	0	0	1,192	714.91	50,640	1.17	0.11	0.06
2016	8	291.61	106.73	106.73	0	7,140	13.42	0	0	1,067	640.39	45,361	1.04	0.10	0.06
2017	9	260.50	95.08	95.08	0	6,361	11.95	0	0	951	570.49	40,410	0.93	0.09	0.05
2018	10	232.74	84.95	84.95	0	5,683	10.68	0	0	850	509.70	36,104	0.83	0.08	0.05
2019	11	207.94	75.90	75.90	0	5,078	9.54	0	0	759	455.39	32,257	0.74	0.07	0.04
2020	12	185.75	67.99	67.99	0	4,548	8.55	0	0	680	407.91	28,894	0.67	0.06	0.04
2021	13	165.93	60.57	60.57	0	4,052	7.61	0	0	606	363.39	25,740	0.59	0.06	0.03
2022	14	148.25	54.11	54.11	0	3,620	6.80	0	0	541	324.67	22,997	0.53	0.05	0.03
2023	15	132.45	48.35	0	48.35	0	0	3,234.36	6.08	0	0	0	0	0	0
2024	16	118.32	43.31	0	43.31	0	0	2,897.19	5.44	0	0	0	0	0	0
2025	17	105.70	38.58	0	38.58	0	0	2,580.99	4.85	0	0	0	0	0	0
2026	18	94.43	34.47	0	34.47	0	0	2,305.96	4.33	0	0	0	0	0	0
2027	19	84.37	30.80	0	30.80	0	0	2,060.23	3.87	0	0	0	0	0	0
2028	20	75.37	27.58	0	27.58	0	0	1,845.46	3.47	0	0	0	0	0	0
2029	21	67.33	24.57	0	24.57	0	0	1,644.04	3.09	0	0	0	0	0	0
2030	22	59.91	21.87	0	21.87	0	0	1,462.97	2.75	0	0	0	0	0	0
	Total		2,278	2,008.48	269.52	134,369	252.52	18,031.19	33.89	22,780.01	13,668.00	968,150	19.66	1.83	1.07

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/ year)	LPG Saved (Mil kg/ year)	Oil Saved (Mil lit/ year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	1,881.31	688.56	688.56	0	46,065	86.57	0	0	6,886	4,131.35	292,637	6.74	0.63	0.37
2009	1	1,901.03	693.88	693.88	0	46,421	87.24	0	0	6,939	4,163.26	294,897	6.79	0.63	0.37
2010	2	1,874.17	684.07	684.07	0	45,765	86.01	0	0	6,841	4,104.42	290,730	6.70	0.62	0.36
2011	3	1,814.71	662.37	662.37	0	44,313	83.28	0	0	6,624	3,974.22	281,507	6.48	0.60	0.35
2012	4	1,733.17	634.34	634.34	0	42,438	79.75	0	0	6,343	3,806.04	269,595	6.21	0.58	0.34
2013	5	1,637.69	597.76	597.76	0	39,991	75.15	0	0	5,978	3,586.54	254,047	5.85	0.54	0.32
2014	6	1,534.47	560.08	560.08	0	37,470	70.42	0	0	5,601	3,360.49	238,035	5.48	0.51	0.30
2015	7	1,427.87	521.17	521.17	0	34,867	65.53	0	0	5,212	3,127.03	221,498	5.10	0.47	0.28
2016	8	1,321.00	483.48	483.48	0	32,346	60.79	0	0	4,835	2,900.91	205,481	4.73	0.44	0.26
2017	9	1,216.34	443.96	443.96	0	29,702	55.82	0	0	4,440	2,663.78	188,685	4.35	0.40	0.24
2018	10	1,115.65	407.21	407.21	0	27,243	51.20	0	0	4,072	2,443.28	173,066	3.99	0.37	0.22
2019	11	1,019.86	372.25	372.25	0	24,904	46.80	0	0	4,082	2,449.28	173,491	4.00	0.37	0.22
2020	12	929.50	340.20	340.20	0	22,759	42.77	0	0	4,092	2,455.28	173,916	4.01	0.37	0.22
2021	13	845.05	308.44	308.44	0	20,635	38.78	0	0	4,102	2,461.28	174,341	4.02	0.37	0.22
2022	14	766.73	279.86	279.86	0	18,723	35.19	0	0	4,112	2,467.28	174,766	4.03	0.37	0.22
2023	15	694.40	253.46	253.46	0	16,956	31.87	0	0	4,122	2,473.28	175,191	4.04	0.38	0.22
2024	16	627.80	229.77	229.77	0	15,372	28.89	0	0	4,132	2,479.28	175,616	4.04	0.38	0.22
2025	17	566.79	206.88	206.88	0	13,840	26.01	0	0	4,142	2,485.28	176,041	4.05	0.38	0.22
2026	18	511.15	186.57	186.57	0	12,482	23.46	0	0	4,152	2,491.28	176,466	4.06	0.38	0.22
2027	19	460.48	168.08	168.08	0	11,244	21.13	0	0	4,162	2,497.28	176,891	4.07	0.38	0.22
2028	20	414.39	151.67	151.67	0	10,147	19.07	0	0	4,172	2,503.28	177,316	4.08	0.38	0.22
2029	21	372.60	136.00	136.00	0	9,098	17.10	0	0	4,182	2,509.28	177,741	4.09	0.38	0.22
2030	22	333.48	121.72	121.72	0	8,143	15.30	0	0	4,192	2,515.28	178,166	4.10	0.38	0.22
	Total		9,132	9,132	0	610,924	1,148.12	0	0	67,851.01	40,711	2,883,668	111.02	10.32	6.02

- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/ year)	LPG Saved (Mil kg/ year)	Oil Saved (Mil lit/ year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	1,844.48	675.08	675.08	0	45,163	84.88	0	0	6,751	4,050	286,909	6.61	0.61	0.36
2009	1	1,853.17	676.41	676.41	0	45,252	85.04	0	0	6,764	4,058	287,473	6.62	0.62	0.36
2010	2	1,840.23	671.68	671.68	0	44,936	84.45	0	0	6,717	4,030	285,466	6.58	0.61	0.36
2011	3	1,814.97	662.46	662.46	0	44,319	83.29	0	0	6,625	3,975	281,547	6.48	0.60	0.35
2012	4	1,782.71	652.47	652.47	0	43,651	82.03	0	0	6,525	3,915	277,301	6.39	0.59	0.35
2013	5	1,746.74	637.56	637.56	0	42,653	80.16	0	0	6,376	3,825	270,962	6.24	0.58	0.34
2014	6	1,709.06	623.81	623.81	0	41,733	78.43	0	0	6,238	3,743	265,118	6.11	0.57	0.33
2015	7	1,670.87	609.87	609.87	0	40,801	76.68	0	0	6,099	3,659	259,194	5.97	0.56	0.32
2016	8	1,632.86	597.63	597.63	0	39,982	75.14	0	0	5,976	3,586	253,992	5.85	0.54	0.32
2017	9	1,595.57	582.38	582.38	0	38,962	73.22	0	0	5,824	3,494	247,513	5.70	0.53	0.31
2018	10	1,559.32	569.15	569.15	0	38,077	71.56	0	0	5,692	3,415	241,889	5.57	0.52	0.30
2019	11	1,524.22	556.34	556.34	0	37,220	69.95	0	0	5,563	3,338	236,445	5.45	0.51	0.30
2020	12	1,490.32	545.46	545.46	0	36,491	68.58	0	0	5,455	3,273	231,819	5.34	0.50	0.29
2021	13	1,457.68	532.05	532.05	0	35,595	66.89	0	0	5,321	3,192	226,123	5.21	0.48	0.28
2022	14	1,426.37	520.62	520.62	0	34,830	65.46	0	0	5,206	3,124	221,265	5.10	0.47	0.28
2023	15	1,396.30	509.65	509.65	0	34,096	64.08	0	0	5,096	3,058	216,601	4.99	0.46	0.27
2024	16	1,367.40	500.47	500.47	0	33,482	62.92	0	0	5,005	3,003	212,699	4.90	0.46	0.27
2025	17	1,339.67	488.98	488.98	0	32,713	61.48	0	0	4,890	2,934	207,816	4.79	0.45	0.26
2026	18	1,313.09	479.28	479.28	0	32,064	60.26	0	0	4,793	2,876	203,694	4.69	0.44	0.25
2027	19	1,287.59	469.97	469.97	0	31,441	59.09	0	0	4,700	2,820	199,737	4.60	0.43	0.25
2028	20	1,263.06	462.28	462.28	0	30,927	58.12	0	0	4,623	2,774	196,469	4.53	0.42	0.25
2029	21	1,239.50	452.42	452.42	0	30,267	56.88	0	0	4,524	2,714	192,277	4.43	0.41	0.24
2030	22	1,216.88	444.16	444.16	0	29,715	55.84	0	0	4,442	2,665	188,769	4.35	0.40	0.24
	Total		12,920.18	12,920.18	0	864,372	1,624.42	0	0	129,202	77,521	5,491,076	126.48	11.76	6.85



## Field Y

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/year)	LPG Saved (Mil kg/year)	Oil Saved (Mil lit/year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	1,446.10	691.11	691.11	0	46,236	86.89	0	0	6,911	4,146.65	293,721	6.77	0.63	0.37
2009	1	832.54	387.47	387.47	0	25,922	48.72	0	0	3,875	2,324.84	164,676	3.79	0.35	0.21
2010	2	505.05	228.80	228.80	0	15,307	28.77	0	0	2,288	1,372.80	97,240	2.24	0.21	0.12
2011	3	277.54	139.12	139.12	0	9,307	17.49	0	0	1,391	834.69	59,124	1.36	0.13	0.07
2012	4	190.07	81.39	81.39	0	5,445	10.23	0	0	814	488.32	34,589	0.80	0.07	0.04
2013	5	122.24	54.64	54.64	0	3,655	6.87	0	0	546	327.82	23,220	0.53	0.05	0.03
2014	6	57.10	35.21	0	35	0	0.00	2,355	4.43	0	0	0	0	0	0
2015	7	40.00	16.47	0	16	0	0	1,102	2.07	0	0	0	0	0	0
2016	8	31.78	12.70	0	13	0	0	850	1.60	0	0	0	0	0	0
2017	9	25.27	10.07	0	10	0	0	673	1.27	0	0	0	0	0	0
2018	10	4.30	2.82	0	3	0	0	189	0.35	0	0	0	0	0	0
2019	11	3.58	0.94	0	1	0	0	63	0.12	0	0	0	0	0	0
	Total		1,661	1,583	78	105,872	198.97	5,232	9.83	16,607	9,964	705,809	15.49	1.44	0.84

- Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/ year)	LPG Saved (Mil kg/ year)	Oil Saved (Mil lit/ year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	3,279.87	1,411.12	700.00	711	46,831	88.01	47,574	89.41	7,000	4,200.00	297,500	6.85	0.64	0.37
2009	1	2,308.79	974.33	700.00	274	46,831	88.01	18,353	34.49	7,000	4,200.00	297,500	6.85	0.64	0.37
2010	2	1,662.89	693.58	693.58	0	46,401	87.20	0	0	6,936	4,161.47	294,771	6.79	0.63	0.37
2011	3	1,179.14	502.00	502.00	0	33,584	63.12	0	0	5,020	3,012.01	213,350	4.91	0.46	0.27
2012	4	890.29	364.30	364.30	0	24,372	45.80	0	0	3,643	2,185.80	154,828	3.57	0.33	0.19
2013	5	655.32	272.65	272.65	0	18,240	34.28	0	0	2,726	1,635.89	115,876	2.67	0.25	0.14
2014	6	146.30	182.55	182.55	0	12,213	22.95	0	0	1,825	1,095.29	77,583	1.79	0.17	0.10
2015	7	110.00	44.36	0	44	0	0	2,968	5.58	0	0	0	0	0	0
2016	8	88.09	35.08	0	35	0	0	2,347	4.41	0	0	0	0	0	0
2017	9	70.46	28.00	0	28	0	0	1,873	3.52	0	0	0	0	0	0
2018	10	16.22	9.26	0	9	0	0	619	1.16	0	0	0	0	0	0
2019	11	13.52	3.53	0	4	0	0	236	0.44	0	0	0	0	0	0
	Total		4,520.75	3,415.08	1,105.68	228,472	429.37	73,970.79	139.01	35,353	21,212	1,502,504	33.43	3.11	1.81

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- Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Supplied to LNG (MMSCF /Year)	Gas Flared (MMSCF /Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		Annual LNG Sale (ton/Year)	Annual C2+ Production & Sale (ton/year)	Annual NGL Production & Sale (kg/year)	Diesel Save (Mil lit/ year)	LPG Saved (Mil kg/ year)	Oil Saved (Mil lit/ year)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)						
2008	0	3,183.64	1283.15	700.00	583	46,831	96.40	39,013	73.32	7,000	4,200.00	297,500	6.85	0.64	0.37
2009	1	2,692.75	1036.52	700.00	337	46,831	96.40	22,513	42.31	7,000	4,200.00	297,500	6.85	0.64	0.37
2010	2	2,377.45	899.23	700.00	199	46,831	96.40	13,329	25.05	7,000	4,200.00	297,500	6.85	0.64	0.37
2011	3	2,147.96	804.54	700.00	105	46,831	96.40	6,993	13.14	7,000	4,200.00	297,500	6.85	0.64	0.37
2012	4	1,935.04	721.91	721.91	0	48,296	99.41	0	0	7,219	4,331.43	306,810	7.07	0.66	0.38
2013	5	1,794.10	664.46	664.46	0	44,453	91.50	0	0	6,645	3,986.76	282,395	6.50	0.60	0.35
2014	6	1,676.20	618.70	618.70	0	41,391	85.20	0	0	6,187	3,712.18	262,946	6.06	0.56	0.33
2015	7	1,575.58	579.99	579.99	0	38,802	79.87	0	0	5,800	3,479.93	246,495	5.68	0.53	0.31
2016	8	1,488.12	548.12	548.12	0	36,670	75.48	0	0	5,481	3,288.73	232,951	5.37	0.50	0.29
2017	9	1,411.58	517.51	517.51	0	34,622	71.27	0	0	5,175	3,105.04	219,940	5.07	0.47	0.27
2018	10	1,339.06	490.40	490.40	0	32,808	67.53	0	0	4,904	2,942.42	208,421	4.80	0.45	0.26
2019	11	1,278.73	467.39	467.39	0	31,269	64.36	0	0	4,674	2,804.35	198,642	4.58	0.43	0.25
2020	12	1,224.23	448.19	448.19	0	29,984	61.72	0	0	4,482	2,689	190,479	4.39	0.41	0.24
2021	13	1,174.96	428.49	428.49	0	28,666	59.01	0	0	4,285	2,571	182,108	4.19	0.39	0.23
2022	14	1,130.02	411.71	411.71	0	27,544	56.70	0	0	4,117	2,470	174,979	4.03	0.37	0.22
2023	15	1,088.86	396.38	396.38	0	26,518	54.59	0	0	3,964	2,378	168,461	3.88	0.36	0.21
2024	16	1,050.88	383.32	383.32	0	25,645	52.79	0	0	3,833	2,300	162,912	3.75	0.35	0.20
2025	17	1,015.89	369.27	369.27	0	24,705	50.85	0	0	3,693	2,216	156,940	3.61	0.34	0.20
2026	18	983.44	357.25	357.25	0	23,900	49.20	0	0	3,573	2,144	151,832	3.50	0.33	0.19
2027	19	953.27	346.09	346.09	0	23,154	47.66	0	0	3,461	2,077	147,087	3.39	0.32	0.18
2028	20	925.05	336.59	336.59	0	22,518	46.35	0	0	3,366	2,020	143,052	3.29	0.31	0.18
2029	21	898.72	325.94	325.94	0	21,806	44.89	0	0	3,259	1,956	138,526	3.19	0.30	0.17
2030	22	874.03	316.84	316.84	0	21,197	43.63	0	0	3,168	1,901	134,658	3.10	0.29	0.17
	Total		12,751.98	11,528.55	1,223	771,271	1,587.60	81,849	153.82	115,286	69,171	4,899,636	112.85	10.50	6.12

**C-3) Gas to community option****Field X**

- Case 1 Oil reserve from MCS with constant cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	718.71	263.05	20.58	242.46	1,377.13	2.59	16,221	30.48	0.63
2009	1	642.02	234.34	20.58	213.75	1,377.13	2.59	14,300	26.87	0.63
2010	2	573.61	209.37	20.58	188.78	1,377.13	2.59	12,630	23.74	0.63
2011	3	512.49	187.06	20.58	166.47	1,377.13	2.59	11,137	20.93	0.63
2012	4	457.81	167.56	20.58	146.97	1,377.13	2.59	9,833	18.48	0.63
2013	5	408.96	149.27	20.58	128.69	1,377.13	2.59	8,609	16.18	0.63
2014	6	365.38	133.36	20.58	112.78	1,377.13	2.59	7,545	14.18	0.63
2015	7	326.44	119.15	20.58	98.57	1,377.13	2.59	6,594	12.39	0.63
2016	8	291.61	106.73	20.58	86.15	1,377.13	2.59	5,763	10.83	0.63
2017	9	260.50	95.08	20.58	74.50	1,377.13	2.59	4,984	9.37	0.63
2018	10	232.74	84.95	20.58	64.37	1,377.13	2.59	4,306	8.09	0.63
2019	11	207.94	75.90	20.58	55.31	1,377.13	2.59	3,701	6.95	0.63
2020	12	185.75	67.99	20.58	47.40	1,377.13	2.59	3,171	5.96	0.63
2021	13	165.93	60.57	20.58	39.98	1,377.13	2.59	2,675	5.03	0.63
2022	14	148.25	54.11	20.58	33.53	1,377.13	2.59	2,243	4.22	0.63
2023	15	132.45	48.35	20.58	27.76	1,377.13	2.59	1,857	3.49	0.63
2024	16	118.32	43.31	20.58	22.72	1,377.13	2.59	1,520	2.86	0.63
2025	17	105.70	38.58	20.58	17.99	1,377.13	2.59	1,204	2.26	0.63
2026	18	94.43	34.47	20.58	13.88	1,377.13	2.59	929	1.75	0.63
2027	19	84.37	30.80	20.58	10.21	1,377.13	2.59	683	1.28	0.63
2028	20	75.37	27.58	20.58	7.00	1,377.13	2.59	468	0.88	0.63
2029	21	67.33	24.57	20.58	3.99	1,377.13	2.59	267	0.50	0.63
2030	22	59.91	21.87	20.58	1.28	1,377.13	2.59	86	0.16	0.63
	Total		2,278	473.45	1,804.56	31,673.92	59.53	120,726	226.88	14.43

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## - Case 2 Oil reserve from MCS with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1,881.31	688.56	20.58	667.97	1,377.13	2.59	44,688	83.98	0.63
2009	1	1,901.03	693.88	20.58	673.29	1,377.13	2.59	45,044	84.65	0.63
2010	2	1,874.17	684.07	20.58	663.49	1,377.13	2.59	44,388	83.42	0.63
2011	3	1,814.71	662.37	20.58	641.79	1,377.13	2.59	42,936	80.69	0.63
2012	4	1,733.17	634.34	20.58	613.76	1,377.13	2.59	41,061	77.17	0.63
2013	5	1,637.69	597.76	20.58	577.17	1,377.13	2.59	38,613	72.57	0.63
2014	6	1,534.47	560.08	20.58	539.50	1,377.13	2.59	36,093	67.83	0.63
2015	7	1,427.87	521.17	20.58	500.59	1,377.13	2.59	33,490	62.94	0.63
2016	8	1,321.00	483.48	20.58	462.90	1,377.13	2.59	30,968	58.20	0.63
2017	9	1,216.34	443.96	20.58	423.38	1,377.13	2.59	28,324	53.23	0.63
2018	10	1,115.65	407.21	20.58	386.63	1,377.13	2.59	25,866	48.61	0.63
2019	11	1,019.86	372.25	20.58	351.66	1,377.13	2.59	23,527	44.21	0.63
2020	12	929.50	340.20	20.58	319.61	1,377.13	2.59	21,382	40.18	0.63
2021	13	845.05	308.44	20.58	287.86	1,377.13	2.59	19,258	36.19	0.63
2022	14	766.73	279.86	20.58	259.27	1,377.13	2.59	17,346	32.60	0.63
2023	15	694.40	253.46	20.58	232.87	1,377.13	2.59	15,579	29.28	0.63
2024	16	627.80	229.77	20.58	209.19	1,377.13	2.59	13,995	26.30	0.63
2025	17	566.79	206.88	20.58	186.29	1,377.13	2.59	12,463	23.42	0.63
2026	18	511.15	186.57	20.58	165.99	1,377.13	2.59	11,105	20.87	0.63
2027	19	460.48	168.08	20.58	147.49	1,377.13	2.59	9,867	18.54	0.63
2028	20	414.39	151.67	20.58	131.08	1,377.13	2.59	8,770	16.48	0.63
2029	21	372.60	136.00	20.58	115.41	1,377.13	2.59	7,721	14.51	0.63
2030	22	333.48	121.72	20.58	101.14	1,377.13	2.59	6,766	12.72	0.63
	Total		9,132	473	8,658.33	31,673.92	59.53	579,250	1,088.59	14.43

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## - Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1,844.48	675.08	20.58	654.50	1,377.13	2.59	43,786	82.29	0.63
2009	1	1,853.17	676.41	20.58	655.82	1,377.13	2.59	43,875	82.45	0.63
2010	2	1,840.23	671.68	20.58	651.10	1,377.13	2.59	43,559	81.86	0.63
2011	3	1,814.97	662.46	20.58	641.88	1,377.13	2.59	42,942	80.70	0.63
2012	4	1,782.71	652.47	20.58	631.89	1,377.13	2.59	42,274	79.45	0.63
2013	5	1,746.74	637.56	20.58	616.97	1,377.13	2.59	41,276	77.57	0.63
2014	6	1,709.06	623.81	20.58	603.22	1,377.13	2.59	40,356	75.84	0.63
2015	7	1,670.87	609.87	20.58	589.28	1,377.13	2.59	39,424	74.09	0.63
2016	8	1,632.86	597.63	20.58	577.04	1,377.13	2.59	38,605	72.55	0.63
2017	9	1,595.57	582.38	20.58	561.80	1,377.13	2.59	37,585	70.63	0.63
2018	10	1,559.32	569.15	20.58	548.57	1,377.13	2.59	36,700	68.97	0.63
2019	11	1,524.22	556.34	20.58	535.76	1,377.13	2.59	35,843	67.36	0.63
2020	12	1,490.32	545.46	20.58	524.87	1,377.13	2.59	35,114	65.99	0.63
2021	13	1,457.68	532.05	20.58	511.47	1,377.13	2.59	34,218	64.31	0.63
2022	14	1,426.37	520.62	20.58	500.04	1,377.13	2.59	33,453	62.87	0.63
2023	15	1,396.30	509.65	20.58	489.06	1,377.13	2.59	32,719	61.49	0.63
2024	16	1,367.40	500.47	20.58	479.88	1,377.13	2.59	32,105	60.33	0.63
2025	17	1,339.67	488.98	20.58	468.39	1,377.13	2.59	31,336	58.89	0.63
2026	18	1,313.09	479.28	20.58	458.69	1,377.13	2.59	30,687	57.67	0.63
2027	19	1,287.59	469.97	20.58	449.38	1,377.13	2.59	30,064	56.50	0.63
2028	20	1,263.06	462.28	20.58	441.69	1,377.13	2.59	29,550	55.53	0.63
2029	21	1,239.50	452.42	20.58	431.83	1,377.13	2.59	28,890	54.29	0.63
2030	22	1,216.88	444.16	20.58	423.58	1,377.13	2.59	28,338	53.26	0.63
	Total		12,920.18	473.45	12,446.73	31,673.92	59.53	832,698	1,564.90	14.43

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**Field Y****- Case 1 Oil reserve from MCS with constant cumulative GOR**

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	1,446.10	691.11	20.58	670.52	1,377.13	2.59	44,859	84.30	0.63
2009	1	832.54	387.47	20.58	366.89	1,377.13	2.59	24,545	46.13	0.63
2010	2	505.05	228.80	20.58	208.22	1,377.13	2.59	13,930	26.18	0.63
2011	3	277.54	139.12	20.58	118.53	1,377.13	2.59	7,930	14.90	0.63
2012	4	190.07	81.39	20.58	60.80	1,377.13	2.59	4,068	7.64	0.63
2013	5	122.24	54.64	20.58	34.05	1,377.13	2.59	2,278	4.28	0.63
2014	6	57.10	35.21	14.90	20.30	997.11	1.87	1,358	2.55	0.45
2015	7	40.00	16.47	10.44	6.03	698.40	1.31	404	0.76	0.32
2016	8	31.78	12.70	8.29	4.41	554.92	1.04	295	0.55	0.25
2017	9	25.27	10.07	6.59	3.47	441.21	0.83	232	0.44	0.20
2018	10	4.30	2.82	1.12	1.70	75.12	0.14	114	0.21	0.03
2019	11	3.58	0.94	0.93	0.00	62.45	0.12	0	0.00	0.03
	Total		1,660.73	165.80	1,494.93	11,091.98	20.85	100,012	187.95	5.05

**- Case 2 Oil reserve from MCS with increasing cumulative GOR**

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	3,279.87	1,411.12	20.58	1,390.53	1,377.13	2.59	93,027.98	174.83	0.63
2009	1	2,308.79	974.33	20.58	953.75	1,377.13	2.59	63,806.60	119.91	0.63
2010	2	1,662.89	693.58	20.58	672.99	1,377.13	2.59	45,023.87	84.61	0.63
2011	3	1,179.14	502.00	20.58	481.42	1,377.13	2.59	32,207.20	60.53	0.63
2012	4	890.29	364.30	20.58	343.72	1,377.13	2.59	22,994.88	43.21	0.63
2013	5	655.32	272.65	20.58	252.06	1,377.13	2.59	16,863.33	31.69	0.63
2014	6	146.30	182.55	20.58	161.96	1,377.13	2.59	10,835.54	20.36	0.63
2015	7	110.00	44.36	20.58	23.78	1,377.13	2.59	1,590.79	2.99	0.63
2016	8	88.09	35.08	20.58	14.49	1,377.13	2.59	969.64	1.82	0.63
2017	9	70.46	28.00	18.39	9.60	1,230.38	2.31	642.58	1.21	0.56
2018	10	16.22	9.26	4.23	5.02	283.23	0.53	336.04	0.63	0.13
2019	11	13.52	3.53	3.53	0.00	236.13	0.44	0.22	0.00	0.11
	Total		4,520.75	211.42	4,309.34	14,143.89	26.58	288,298.66	541.80	6.44

## - Case 3 Oil reserve from harmonic decline with increasing cumulative GOR

Year	Year No.	Gas Daily Production @ the end of the year (MSCFD)	Annual Gas Available (MMSCF /Year)	Annual Gas Sale (MMSCF /Year)	Gas Flared (MMSCF/ Year)	CO <sub>2</sub> Emission Reduced (ton/year)	NO <sub>x</sub> Emission Reduced (ton/year)	Flaring		LPG saved (Mil kg)
								CO <sub>2</sub> Emission (ton/year)	NO <sub>x</sub> Emission (ton/year)	
2008	0	3,183.64	1,283.15	20.58	1,262.56	1,377.13	2.59	84,467	158.74	0.63
2009	1	2,692.75	1,036.52	20.58	1,015.93	1,377.13	2.59	67,967	127.73	0.63
2010	2	2,377.45	899.23	20.58	878.65	1,377.13	2.59	58,782	110.47	0.63
2011	3	2,147.96	804.54	20.58	783.95	1,377.13	2.59	52,447	98.56	0.63
2012	4	1,935.04	721.91	20.58	701.32	1,377.13	2.59	46,919	88.18	0.63
2013	5	1,794.10	664.46	20.58	643.87	1,377.13	2.59	43,076	80.95	0.63
2014	6	1,676.20	618.70	20.58	598.11	1,377.13	2.59	40,014	75.20	0.63
2015	7	1,575.58	579.99	20.58	559.40	1,377.13	2.59	37,425	70.33	0.63
2016	8	1,488.12	548.12	20.58	527.54	1,377.13	2.59	35,293	66.33	0.63
2017	9	1,411.58	517.51	20.58	496.92	1,377.13	2.59	33,245	62.48	0.63
2018	10	1,339.06	490.40	20.58	469.82	1,377.13	2.59	31,431	59.07	0.63
2019	11	1,278.73	467.39	20.58	446.81	1,377.13	2.59	29,892	56.18	0.63
2020	12	1,224.23	448.19	20.58	427.60	1,377.13	2.59	28,607	53.76	0.63
2021	13	1,174.96	428.49	20.58	407.91	1,377.13	2.59	27,289	51.28	0.63
2022	14	1,130.02	411.71	20.58	391.13	1,377.13	2.59	26,167	49.18	0.63
2023	15	1,088.86	396.38	20.58	375.79	1,377.13	2.59	25,141	47.25	0.63
2024	16	1,050.88	383.32	20.58	362.74	1,377.13	2.59	24,268	45.61	0.63
2025	17	1,015.89	369.27	20.58	348.69	1,377.13	2.59	23,327	43.84	0.63
2026	18	983.44	357.25	20.58	336.67	1,377.13	2.59	22,523	42.33	0.63
2027	19	953.27	346.09	20.58	325.50	1,377.13	2.59	21,776	40.92	0.63
2028	20	925.05	336.59	20.58	316.01	1,377.13	2.59	21,141	39.73	0.63
2029	21	898.72	325.94	20.58	305.36	1,377.13	2.59	20,429	38.39	0.63
2030	22	874.03	316.84	20.58	296.26	1,377.13	2.59	19,820	37.25	0.63
	Total		12,751.98	473.45	12,278.54	31,673.92	59.53	821,446	1,543.75	14.43

สถาบันวิทยบริการ  
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## VITAE

Noppanan Nopsiri was born on September 21, 1981 in Phrae, Thailand. He received his B.Eng. in Mechanical Engineering from the faculty of Engineering, Chulalongkorn University in 2004. After graduating, he worked for York Industrial Thailand for a year and then continued his study in the Master of Petroleum Engineering program at the Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn University.



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