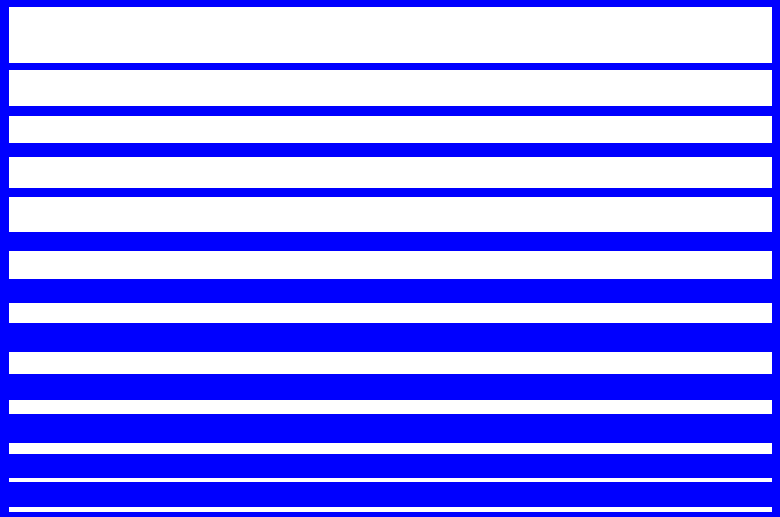
BALANCING THE SUPPLY AND DEMAND FOR NATURAL GAS



The Texas Institute for Advancement of Chemical Technology (TIACT)
Texas A&M University, 3125 TAMU
College Station, Texas 77843-3125
Phone: 979-845-3372, Fax: 979-862-4202
Email: cms5701@tamu.edu
Website: http://www-chen.tamu.edu/tiact
The Institute is a nonprofit charitable corporation
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INTRODUCTION

An analysis of the imbalance in the supply and demand of natural gas and the actions that are being taken or need to be taken to decrease demand and increase supply follows.

This analysis is presented in three parts:

1. **Causes of the imbalance in supply and demand for natural gas**
2. **Decreasing the demand for natural gas**
3. **Increasing the supply of natural gas by**
   - **Drilling more gas wells**
   - **Importing by pipelines**
   - **Importing as liquefied natural gas (LNG)**

ABSTRACT

DEMAND FOR NATURAL GAS AND HOW TO DECREASE BY 2010

- **Demand: 28.13[2] tcf/y***

  Decrease by conservation and use of more nuclear energy and alternate energy sources to generate electricity

SUPPLY OF NATURAL GAS AND HOW TO INCREASE BY 2010

- **Production: 19 tcf/y**

  Increase by drilling more wells in old, new and restricted fields

- **Supply by pipeline from Canada: 3.5 tcf/y**
- **LNG from existing terminals: 1.43 tcf/y**
- **LNG needed from new terminals to balance supply and demand:**

  28.13 tcf/y – 19 tcf/y – 3.5 tcf/y – 1.43 tcf/y = 4.2 tcf/y

* tcf/y = trillion cubic feet per year.

WHAT HAS CAUSED THE PRESENT HIGH PRICES OF NATURAL GAS SHOWN IN SLIDE 5?

A demand that exceeds supply has caused the increase in natural gas prices as shown in Slide 5.

In an effort to reduce pollution, power companies have been encouraged to use natural gas to generate electricity while potentially productive gas fields have remained restricted for drilling. Thus demand was increased while supply was restricted.

In 2001, over 95% of all the new power plants that went on line used natural gas.

PRICE OF NATURAL GAS

(Taken From: American Chemistry Council, www.accnewsmedia.com, 2003)

	Per million BTU
 **USA**	$ 5.50
 **Russia**	$ 0.80
 **Venezuela**	$ 0.70
 **Kuwait**	$ 0.60
 **Algeria**	$ 0.40

WHAT IS THE PROJECTED ELECTRICAL POWER REQUIRMENTS FOR THE UNITED STATES?

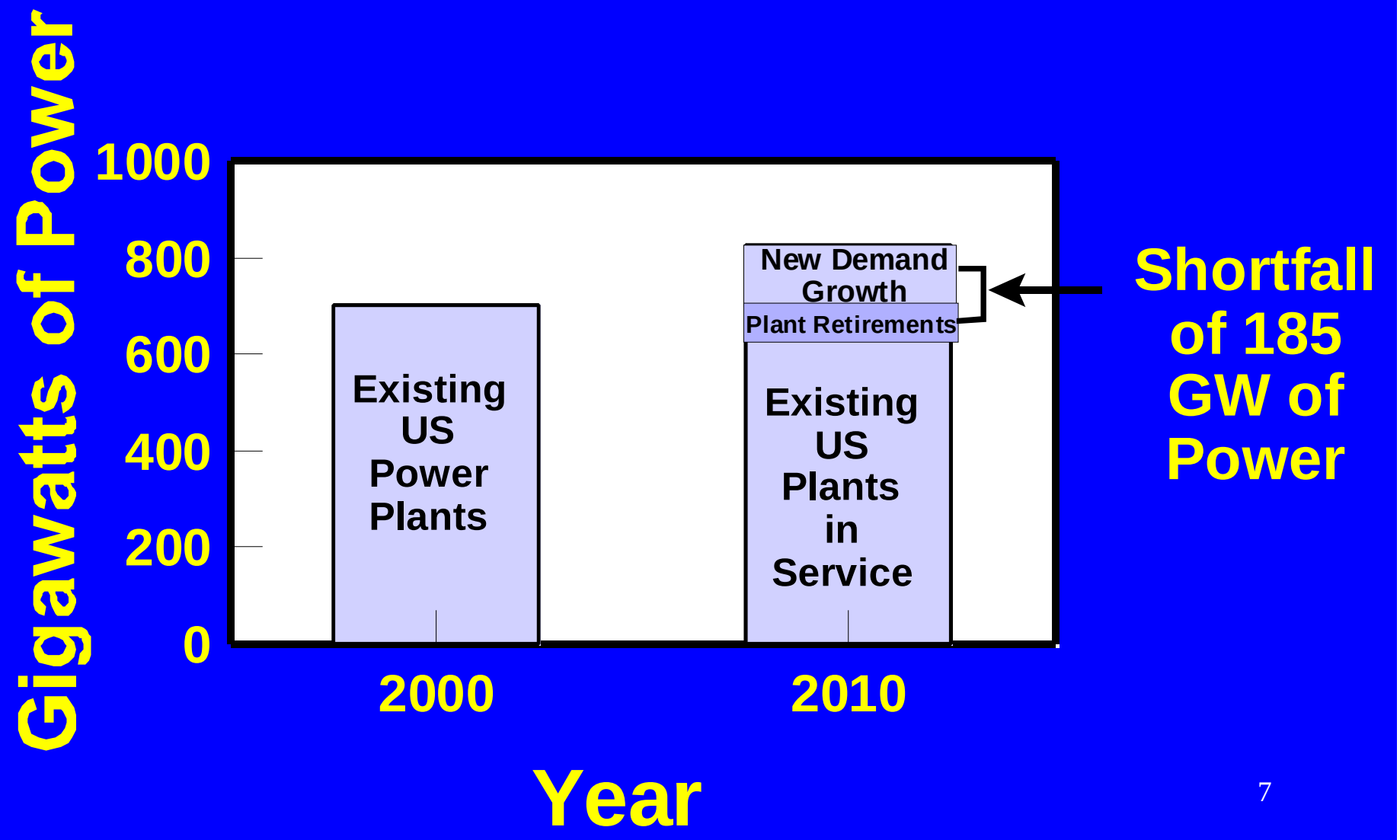
As shown in Slide 7, 185,000 MW of electric power will be needed by 2010. This would correspond to 185 power plants, each having a rating of 1,000 MW. [2]

The estimates of natural gas needs that follow are based on the assumption by the *Energy Information Administration (EIA)* that most of future power plants will fueled by natural gas.[3]

The EIA estimates of natural gas requirements will be reduced if some highly needed new nuclear power plants are constructed.

PROJECTED U.S. POWER NEEDS IN 2010

(Taken from : *Energy Information Administration (EIA); see Ref. 2*)



HOW CAN THE DEMAND FOR NATURAL GAS BE DECREASED?

The demand may be decreased by increasing the conservation of energy and by using alternate energy sources to generate electricity instead of natural gas. Of the alternate energy sources (nuclear, geothermal, biomass, wind, and solar), only nuclear has the capacity to satisfy our future energy needs while reducing emissions.

These alternate energy sources were described in two TIACT reports, *Alternate Energy Sources* and *Alternate Energy sources, Solution of Major Problems*, and two Symposia, all on the TIACT website: www-chen.tamu.edu/tiact .

Since the use of nuclear energy to decrease the demand for natural gas has been discussed in considerable detail previously (see TIACT website), it is not discussed further here.

HOW CAN THE SUPPLY OF NATURAL GAS BE BROUGHT INTO BALANCE WITH DEMAND?

The supply and demand of natural gas may be brought into balance by drilling more gas wells in existing fields, new fields, restricted areas, and by importing by pipelines and importing as liquefied natural gas (LNG).[4]

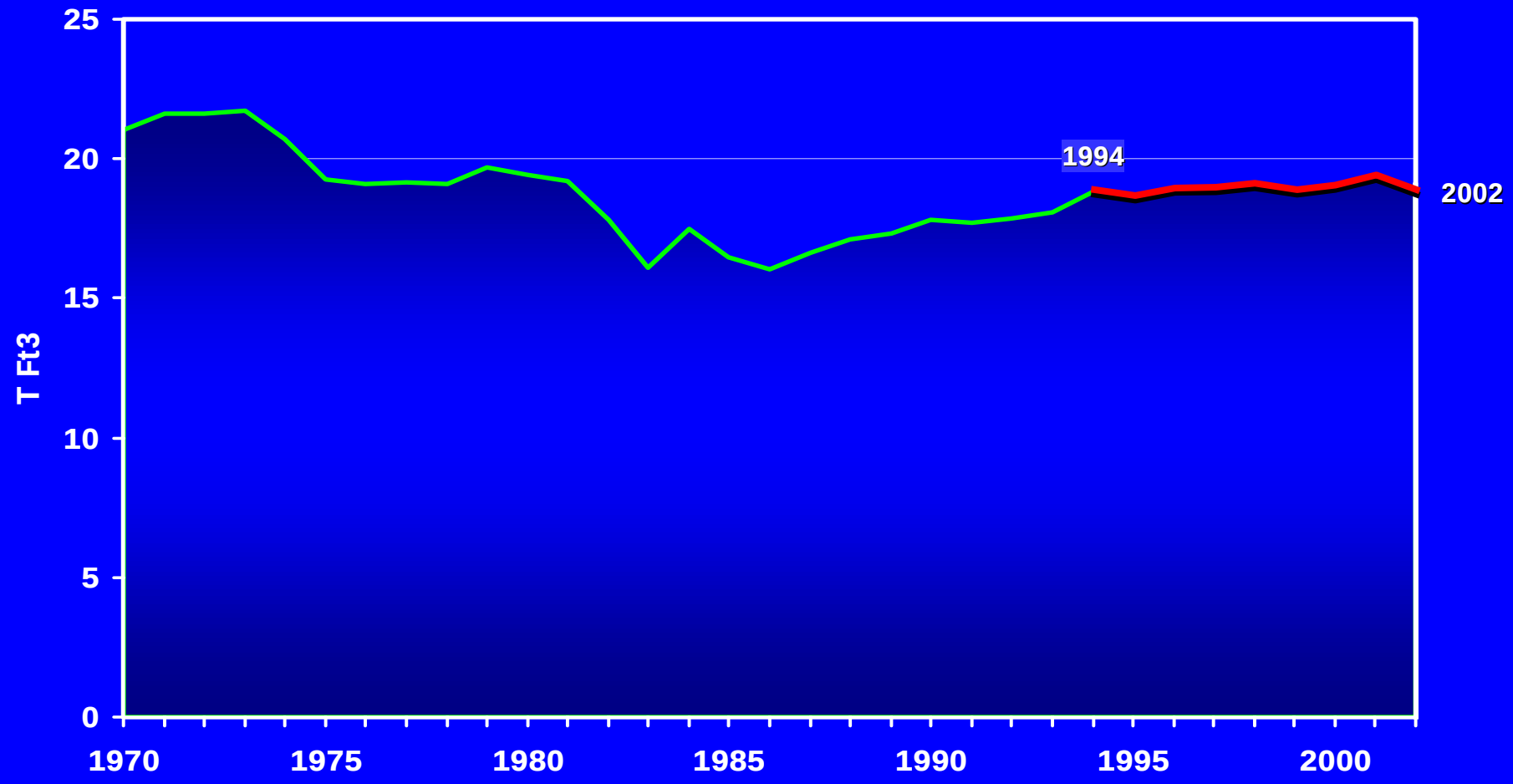
WHAT IS THE HISTORY OF NATURAL GAS PRODUCTION SINCE 1970?

As shown in Slide 11, natural gas production has remained at approximately 19 trillion cubic feet per year (tcf/y) since 1974.[5]

To maintain this level of 19 tcf/y, approximately three times as many wells are now required as were required in 1970, as shown in Slide 12.

U.S. Dry Natural Gas Production, 1970-2002

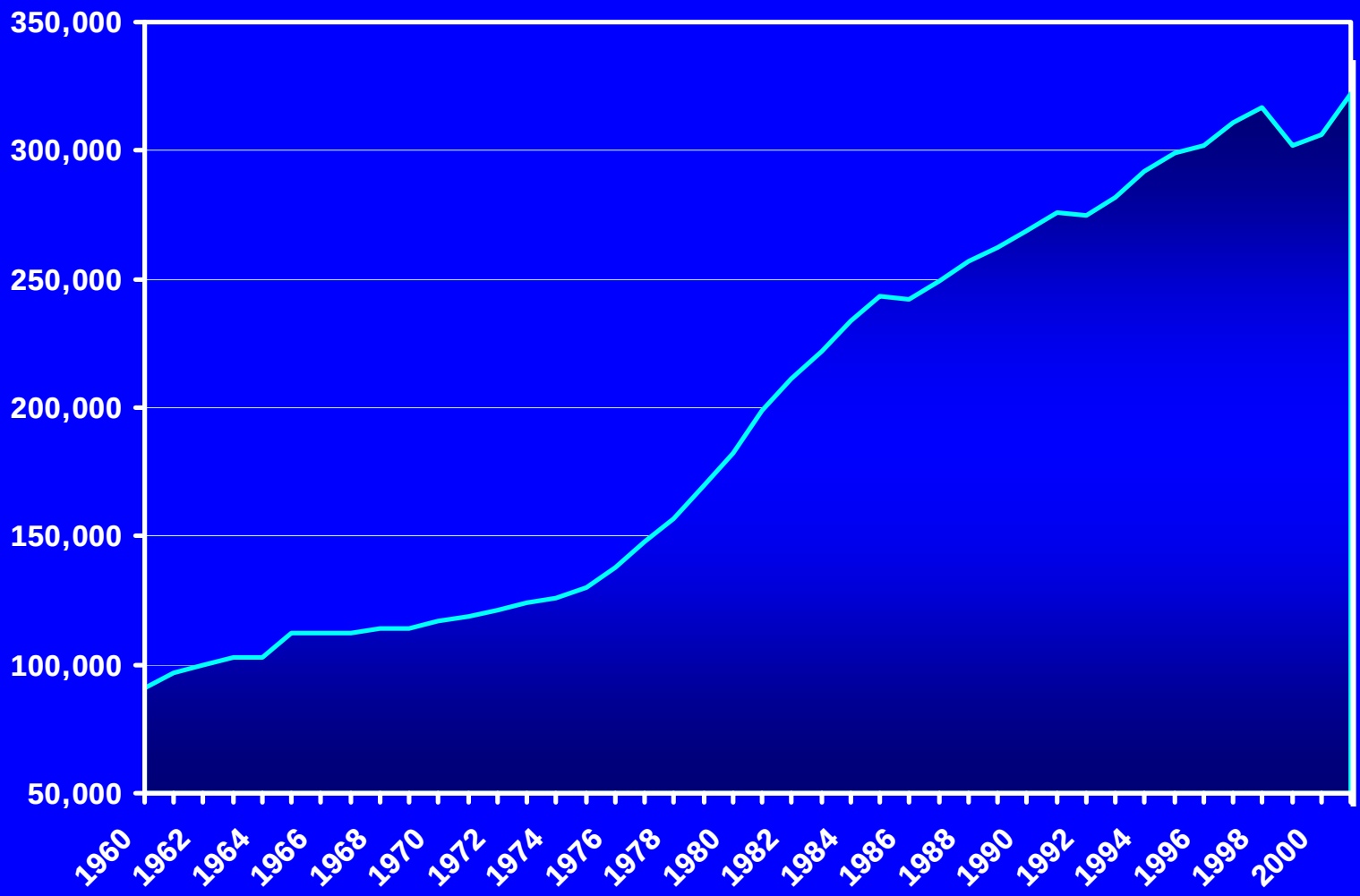
(Taken from: *Presentation by R.W. Jewell; see Ref. 5, and EIA, 2003*)



Source: EIA

Number of Gas Producing Wells in the United States

(Taken from: *Presentation of R.W. Jewell; see Ref. 5, and EIA, 2003*)

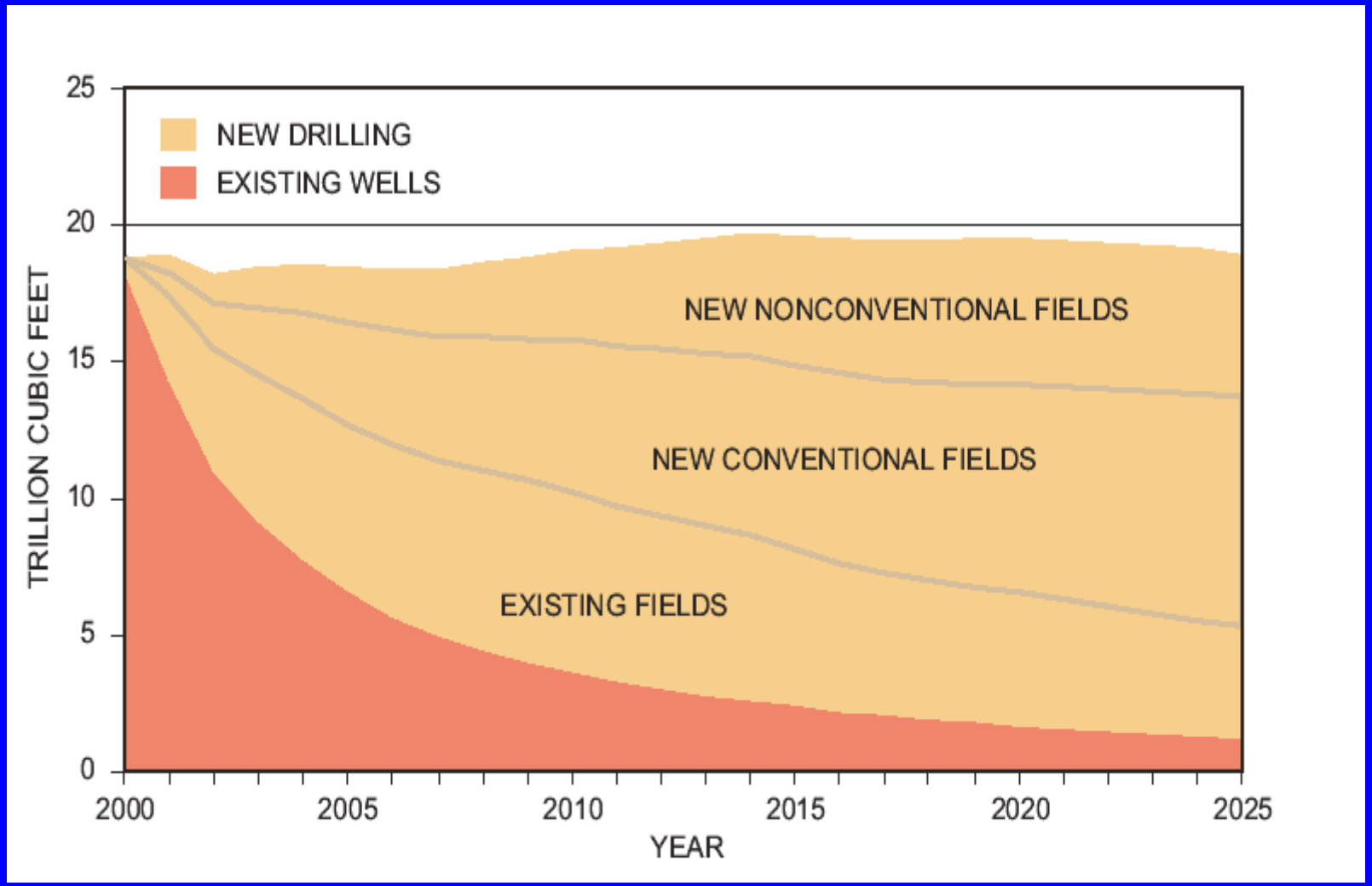


HOW CAN THE PRESENT NATURAL GAS PRODUCTION RATE BE MAINTAINED AT 19 tcf/y?

As shown in Slide 14 drilling needs to be increased in existing fields, new conventional fields and new non-conventional fields.[4] Non-conventional fields denotes those from which gas is produced from tight formations, shales, and coal seams. These non-conventional fields are scattered over the United States.

Lower-48 Production and Future Wells

(Taken from: *National Petroleum Council Report*; see Ref. 4)



HOW MUCH OF THE TOTAL U.S. SUPPLY OF NATURAL GAS PROJECTED FOR 2010 CAN BE EXPECTED TO COME FROM INCREASED DRILLING IN THE U.S.?

Even with the projected drilling in the unrestricted areas shown in Slide 14, production may fall below the 19 tcf/y.

Production from the Rocky Mountain Region could make up some of the shortfall. This region has a potential of 2.7 tcf/y, but production at this rate is unlikely to be realized until the next decade. According to the *Wall Street Journal* (August 26, 2003), the effort to explore and drill in this area is being held up by activists.

Thus, drilling can be expected to produce,

19±tcf/y

where the + or – indicates that production rate could go up or down from 19 tcf/y, depending on how all of the above sources play out.

HOW MUCH NATURAL GAS IS EXPECTED TO BE AVAILABLE BY PIPELINE IN 2010?

Imports from Canada to the U.S. by pipeline total 3.5 tcf/y of natural gas, and this is not expected to increase because Canada is using natural gas in the development of its tar sands.[6]

The next largest source is the projected 2.9 tcf/y from Alaska. However, the pipeline for transporting this gas is not expected to be completed until around 2025. Thus, pipelines are expected to contribute:

3.5 tcf/y

WHAT IS THE PROJECTED SUPPLY OF NATURAL GAS BY PRODUCTION AND PIPELINE FOR 2010?

The following summary of Slides 15 and 16, shows the supply of natural gas that can be expected from the conventional sources of production and imports by pipeline in 2010[6] are:

Source of Supply	2010
U.S. Production	19± tcf/y
Imports by pipeline	3.5 tcf/y
Total Supply	22.5 tcf/y

WHAT IS THE BEST ESTIMATE OF THE DEMAND FOR NATURAL GAS IN 2010, AND HOW MUCH LNG (LIQUEFIED NATURAL GAS) WILL NEED TO BE IMPORTED?

According to the *Energy Information Administration (EIA),*[2] it is estimated that demand for natural gas will be 28.13 tcf/y* in 2010.[6] Thus, the LNG needed to balance supply and demand for natural gas is:

28.13 tcf/y – 22.5 tcf/y = 5.63 tcf/y of LNG

***The estimate of 28.13 tcf/y is based on the assumption that most new power plants will use natural gas.**

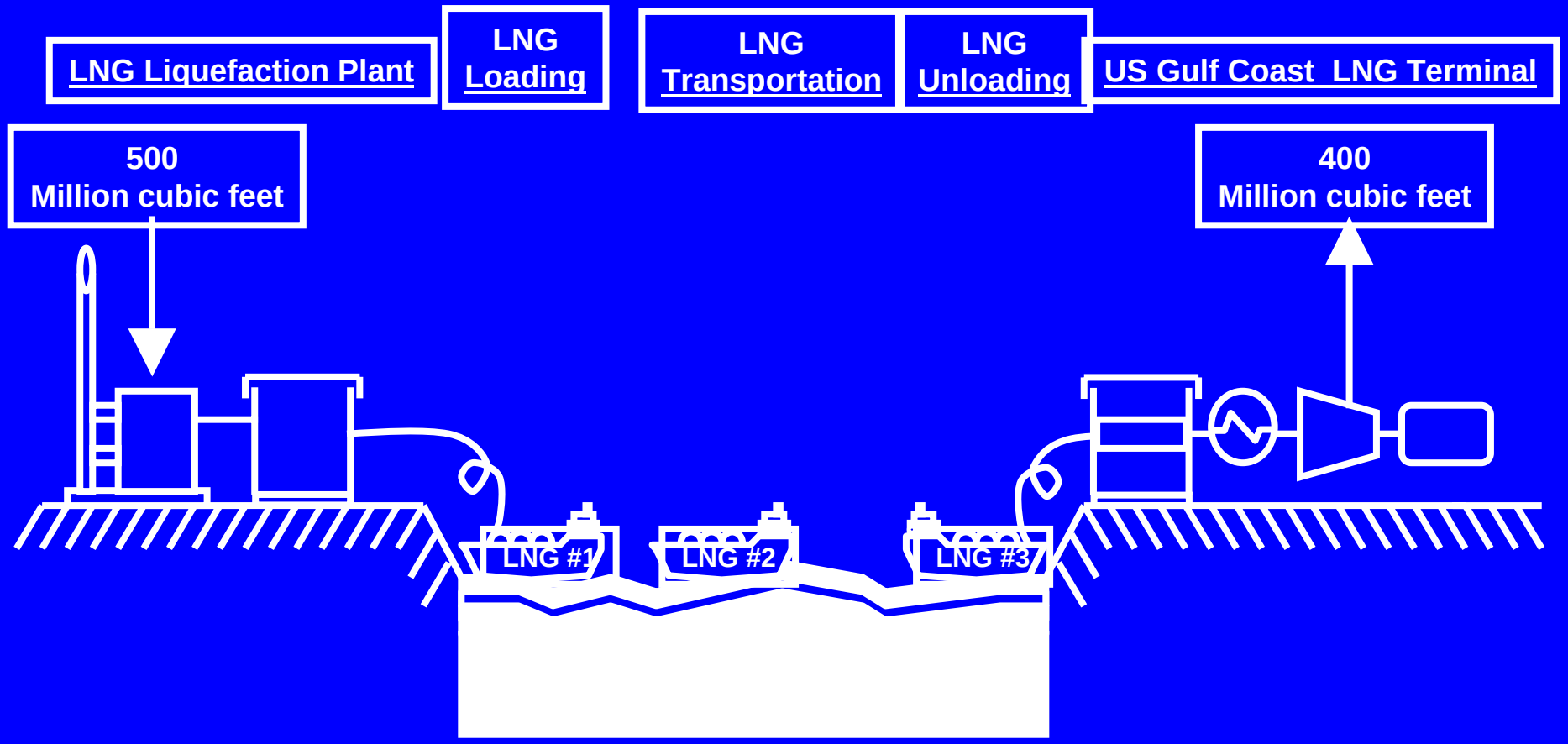
WHAT IS INVOLVED IN IMPORTING NATURAL GAS FROM FOREIGN SOURCES SUCH AS QATAR?

Importing LNG involves the steps shown in Slide 20.[1]

The steps consist of liquefaction of the natural gas to form LNG, transportation of the LNG by ship to an LNG terminal, unloading the LNG at the terminal, storing and/or revaporizing for distribution through pipelines.

STEPS INVOLVED IN IMPORTING NATURAL GAS FROM FOREIGN SHORES

(Taken from: *Barnes and Click, Inc. See Ref. 1*)



West Africa to U.S. and return

WHY IS IT NECESSARY TO LIQUEFY NATURAL GAS TO IMPORT IT FROM A FOREIGN COUNTRY SUCH AS QATAR?

At -260°F and atmospheric pressure, natural gas condenses to a liquid. When the gas is condensed to a liquid (LNG), the volume is reduced to 1/600 of its initial value. The reduced volume makes it economically feasible to transport natural gas as LNG.

WHEN WERE THE FIRST LNG TERMINALS IN THE UNITED STATES CONSTRUCTED?

The first marine terminal in the United States was built in Kenai, Alaska in 1969. This terminal is still in the operation of supplying Japan with LNG. Between 1971 and 1980. LNG terminals were constructed in Everett, Massachusetts; Coves Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana. Operations for all except for one were ceased in 1980, but all of them are now back in operation.[2,7]

The capacity of these terminals is in the process of being increased to 1.43 tcf/y. By 2010, the terminals are expected to have a capacity to supply:

1.43 tcf/y

HOW MANY TERMINALS HAVE BEEN PROPOSED FOR THE GULF COAST?

The following terminals have been proposed, but some of the may not be built.[7,8] The first three Cheniere sites shown in Slide 25 have been leased, and Cheniere has an option to lease a site at Brownsville.[9] A Typical salt dome which has been proposed for LNG storage by McCall[10] is shown in Slide 26.

Location	Company	Capacity (tcf/y)
Freeport, TX	Freeport LNG and Cheniere	0.55
Sabine Pass, TX	ExxonMobil	0.37
Sabine Pass, LA	Cheniere	0.95
Corpus Christi, TX	Cheniere	0.95

Continued on next slide

SLIDE 22 CONTINUED

Location	Company	Capacity (tcf/y)
Corpus Christi, TX	ExxonMobil	0.37
Theodore, LA	ExxonMobil	0.37
West Cameron, Block 182, LA	Shell	0.37
Port Pilican, LA	Chevron	0.37
Onshore or Offshore	Conversion Imports*	_____
Total Proposed Terminal Capacity		4.30

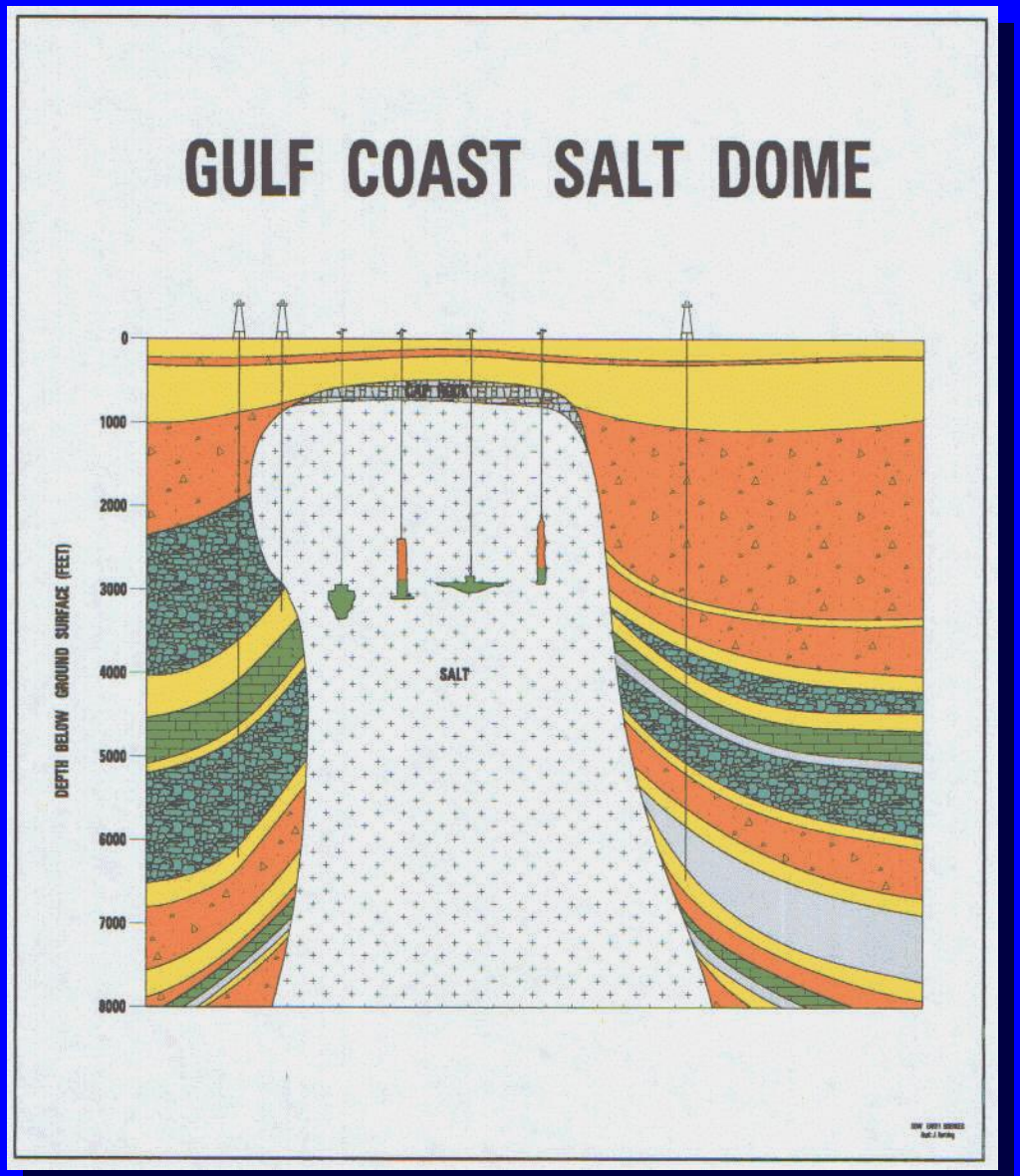
*Storage in salt domes with twice the volume of conventional terminals at half the cost – still in experimental development.

CHENIERE LNG SITES

(Taken from: *Cheniere LNG Brochure*; see Ref. 9)

GULF COAST SALT DOME LNG STORAGE

(Taken From: *McCall*, Ref. 10)



WHY IS THE GULF COAST A FAVORED LOCATION FOR LNG TERMINALS?

Pipelines originating on the Gulf Coast directly or indirectly serve all major U.S. markets; see Slide 28.

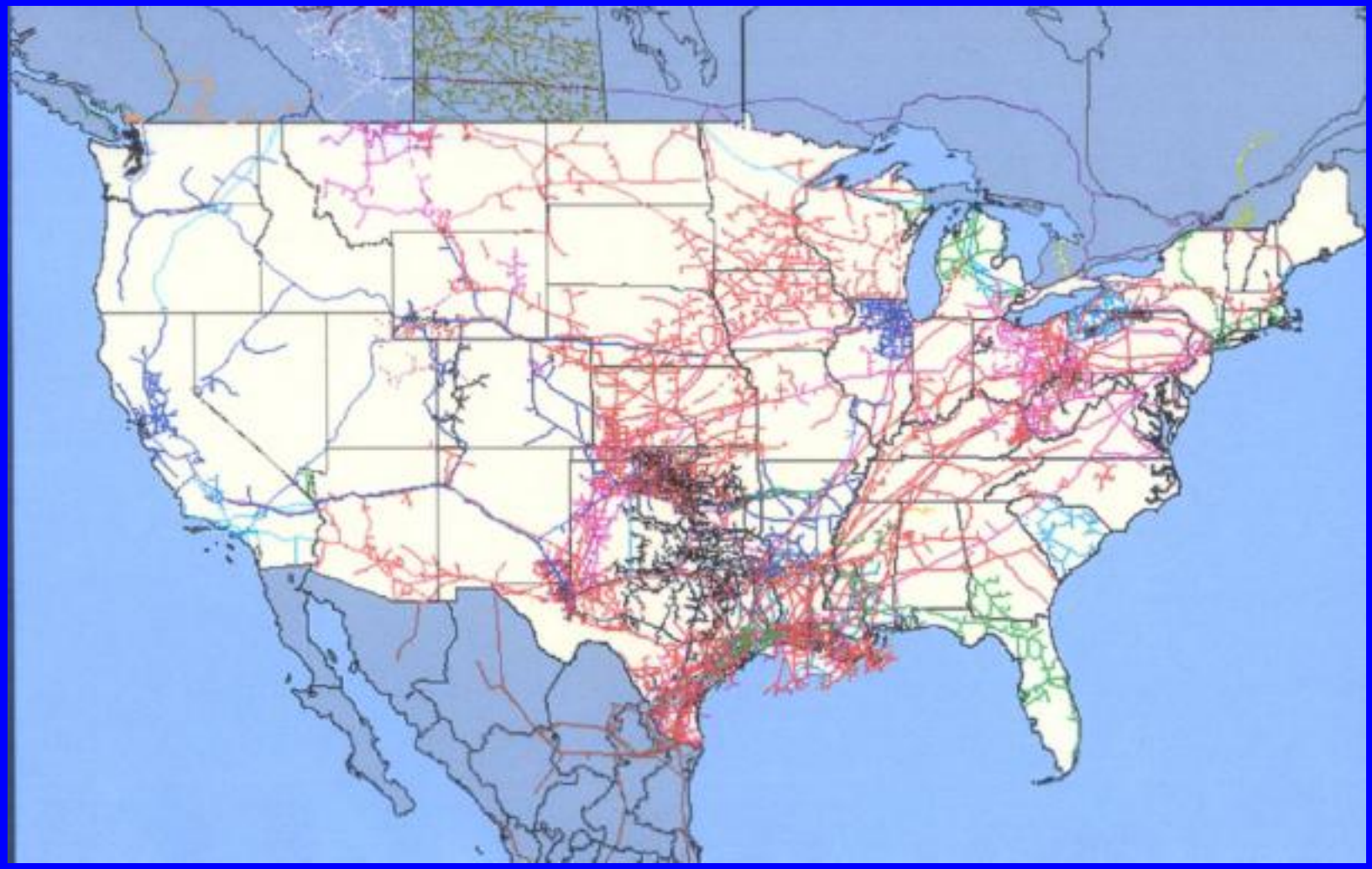
Deep water ports permit tankers to unload at the LNG terminals.

An ExxonMobil spokesman said they intended to develop terminals along the Gulf Coast to avoid the hotbeds of environmentalists on the East Coast and West Coast.

Because of the small likelihood that proposed LNG terminals will ever be built on the East and West Coasts, they were not included in this analysis.

GULF COAST-CENTERED US GAS PIPELINE GRID

(Taken from: Cheniere Brochure; see Ref. 9)



HOW DOES THE POTENTIAL SUPPLY OF LNG COMPARE WITH THE PRPOSED TERMINAL CAPACITY?

According to Barbara Shook, [7] all of the terminal capacity available today and all of the proposed expansion capacity are fully booked. However, only one of the four existing mainland terminals is anywhere close to being fully utilized.

The liquefaction plants and ships have to come on stream before all of the capacity can be utilized.[7]

HOW DO THE NEEDED AND PROPOSED LNG STORAGE CAPACITIES COMPARE?

The results of Slides 18, 22, and 24 show that

Storage Needed		Existing Storage	Proposed Storage
5.63 tcf/y	–	[1.43 tcf/y	+ 4.30 tcf/y]
	=	-0.1 tcf/y	

The imbalance in the needed and proposed storage of (-0.1) is within accuracy of the other numbers.

HOW MANY LIQUEFACTION PLANTS ARE IN THE PLANNING OR CONSTRUCTION STAGE?

Both ExxonMobil and ConocoPhillips have similar contracts with Qatar Petroleum to develop liquefaction plants in Qatar and transport the LNG to the United States.[11,12]

ExxonMobil plans to spend $12 billion on their project. The LNG will be transported to the U.S. in 25 to 30 large tankers.

ExxonMobil plan to supply U.S. terminals with 0.73 tcf/y and ConocoPhillips expects to supply 0.37 tcf/y for a total of:

1.1 tcf/y

AT WHAT LEVEL WILL THE SUPPLY OF LNG TO THE UNITED STATES BE BY 2010?

According to Barbara Shook,[7] numerous liquefaction plants are being developed. However, few of these sources will be available before 2008 or 2009. Expansion of existing liquefaction plants in Australia, Nigeria, Qatar, and Trinidad will be the first to become available.

By 2010, and thereafter, supplies can be expected from new ventures in Angola, Abu Dhabi, Alaska, Algeria, Australia, Brunei, Egypt, Equatorial Guinea, Indonesia, Malaysia, Nigeria, Norway, Oman, Sakkalin, the Timor Sea, Venezuela, and other possible locations. The LNG available from all existing and new sources is expected to be in the neighborhood of:[1,7]

9 tcf/y

WHAT IS THE STATUS OF IDENTIFIED SUPPLY SOURCES NEEDED TO PROVIDE 5.63 TCF/Y OF LNG?

Most of the supply sources needed to provide the 5.63 tcf/y of LNG have not been precisely identified. The remaining sources to be identified are as follows:

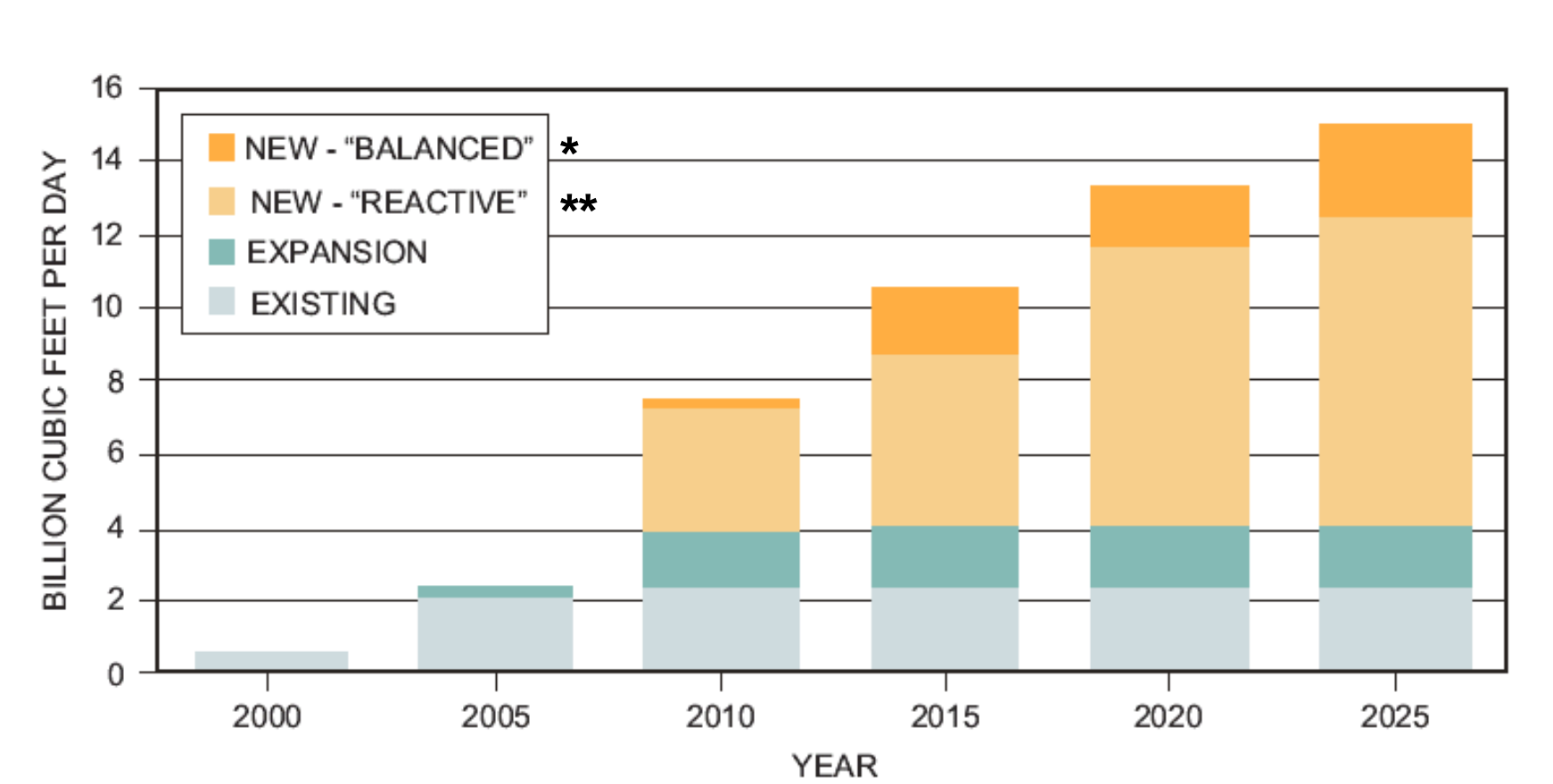
LNG demand	**5.63 tcf/y**
ExxonMobil and ConocoPhillips	**1.1 tcf/y**
	4.53 tcf/y

If it is assumed that supply sources for the existing terminals of 1.43 tcf/y have been identified, then the sources to be identified reduce to:

4.53 tcf/y – 1.43 tcf/y = 3.1 tcf/y

PROJECTED NORTH AMERICAN IMPORTS

(Taken from: *National Petroleum Council*; see Ref. 4)



***Supportive policies for supply and development**

**** Continued conflict between supply and demand policies.**

WHAT ARE THE CAPITAL REQUIREMENTS FOR A TYPICAL LNG DEVELOPMENT FROM THE SOURCE TO AN INTERCONNECTION TO AN EXISTING PIPELINE OR GRID; AND WHAT DOES A TYPICAL TERMINAL AND UNLOADING FACILITY LOOK LIKE?

The cost of an LNG system is $5 - $10 billion per billion cubic feet per day (or $13.7 - $27.4 billion per trillion cubic feet per year).[4]

The proposed Cheniere LNG terminal in Sabine Pass with two LNG ships being unloaded is shown in Slide 36.

SABINE PASS LNG (ARTIST RENDITION)

(Taken from: *Cheniere LNG Brochure*, 2003)

WHAT TYPE OF PURCHASING ARRANGEMENT COULD BE USED TO PREVENT THE SMALLER USERS FROM BEING PLACED AT A DISADVANTAGE BECAUSE OF THEIR SIZE?

Keith Meyer, President, Cheniere LNG, has suggested that a consortium of companies could be formed with a purchasing branch, which would purchase the LNG at the best possible price, from various sources on behalf of the consortium. A large consortium could accommodate purchasing arrangements which best suited the respective members.

AN LNG TANKER HAS BEEN DESCRIBED AS A FLOATING BOMB; TRUE OR FALSE?[13]

FALSE. LNG tankers have run aground, developed leaks, damaged by weather conditions, had engine room fires, and collided with other vessels and

NO CARGO EXPLOSIONS HAVE BEEN REPORTED.

HOW DOES THE BEHAVIOR OF NATURAL GAS IN THE GASEOUS FORM DIFFER FROM ITS BEHAVIOR IN THE LIQUID FORM (LNG)?

In the gaseous form in open space, natural gas will burn when mixed with 5% to 15 % air.

In a closed space, mixtures of natural gas in the gaseous form with 5% to 15% air will burn explosively.

However, natural gas in the liquid form of

LNG DOES NOT EXPLODE OR BURN.

IF AN IGNITION SOURCE IS CLOSE TO THE ORIGIN OF A SPILL OF LNG, WHAT WILL BE THE RESULT?[13]

A rapid burn off of the natural gas vapors will occur.

WHAT ARE SOME OF THE CONCLUSIONS REACHED IN LLOYD'S REPORT?[13]

Historically, for all types of LNG, there has been no loss of life, land based property damage or environmental damage.

The inherent strength of the LNG carriers prevents leaks.

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13 U.S. Department of Energy, www.doe.gov .