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Report on Issues Regarding the Existing New York Liquefied Natural Gas Moratorium

New York State Energy Planning Board

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November 1998

George E. Pataki, Governor

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This report examines the laws and regulations that would affect new LNG plants in New York and government initiatives in other states. It reviews existing use of LNG in NewYork, including safety issues and potential public concerncthat may arise with lifting the moratorium. It also discusses the economic and environmental effects of increased LNG usage for New York State and makes recommendations regarding the existing State moratorium on the use and transport of LNG in New York State.

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November 1998

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ABSTRACT

The New York Energy Planning Board has prepared this study to provide the Governor and the Legislature with information necessary to determine the need for further extension or modification of the existing State moratorium on the siting of new liquefied natural gas (LNG) facilities and intrastate transportation routes as required by Chapter 385 of the laws of 1997. The report examines existing laws and regulations that would affect new LNG facilities in New York and government initiatives in other states. It reviews existing use of LNG in New York, including safety issues and potential public concerns that may arise with lifting the moratorium. It also discusses the economic and environmental effects of increased LNG usage for New York State.

The study concludes that there are economic and environmental advantages for allowing the construction of new LNG facilities as well as the intrastate transportation of LNG over new routes. Additionally, it concludes that safety concerns associated with these facilities are adequately addressed by existing Federal, State and local statutes and regulations. For these reasons, the study recommends: that the Legislature discontinue the existing State moratorium by allowing the statute to lapse; and that Title 17, Article 23 of the Environmental Conservation Law, which imposes regulatory responsibilities on DEC, be repealed. In proposing these recommendations, the report recognizes the appropriate role of applicable local zoning and building permit laws and regulations to govern where such plants may be located in the same manner as local zoning and building codes currently apply to the siting of other fuel storage facilities, including petroleum products and propane.

KEY WORDS

Moratorium, Cryogenic liquid, Peakshaving, Regulations, Standards, Safety, Tank, Alternative Fuel, Job Creation, Air Emissions

CONTENTS

Section		Page
	EXECUTIVE SUMMARY	S-1
	Study Findings	S-6
	Recommendation	S-8
1	**INTRODUCTION**	1-1
	Purpose	1-1
	Background	1-2
	Current Practices	1-4
2	**REGULATORY ASSESSMENT**	2-1
	Federal	2-1
	National Fire Protection Association	2-4
	New York State	2-6
	New York City	2-11
	New York Regulatory Summary	2-11
3	**LNG REGULATIONS AND POLICIES IN OTHER STATES**	3-1
	California	3-2
	Connecticut	3-2
	Iowa	3-3
	Louisiana	3-3
	Maryland	3-4
	Massachusetts	3-4
	Rhode Island	3-5
	Texas	3-5
4	**PUBLIC CONCERNS**	4-1
5	**CURRENT LNG STATUS IN NEW YORK**	5-1
	Existing Peakshaving Plants	5-1
	Other Uses	5-6
	Transportation Restrictions	5-6
6	**SAFETY**	6-1
	Staten Island Accident	6-2
	Potential LNG Hazards and Causes	6-4
	Storage Safety	6-5
	Transportation Safety	6-6
	LNG Fueled Vehicle Safety	6-8
	Safety Training	6-9

7 **OUTLOOK FOR EXPANDED LNG USE IN NEW YORK** 7-1
Potential Demand By Economic Sector 7-1
Local Gas Distribution Companies 7-1
Future Role of Imported LNG 7-3
Industrial Outlook 7-5
Light- and Heavy-Duty Vehicles 7-7

8 **ECONOMIC AND ENVIRONMENTAL CONSEQUENCES OF EXPANDED LNG USE** 8-1
Job Creation Potential 8-1
LNG Environmental Impacts 8-3

9 **RECOMMENDATIONS** 9-1

10 **REFERENCES** 10-1

Appendices

A **LNG RESOURCE GROUP MEMBERS** A-1
B **MAJOR SAFETY FEATURES OF THE EXISTING NEW YORK STATE LNG PLANTS** B-1

EXECUTIVE SUMMARY

New York State has imposed a moratorium on the siting of new liquefied natural gas (LNG) facilities and intrastate transportation routes since 1978. New York is the only state that has a LNG moratorium in effect. Two pieces of LNG-related legislation were adopted in the summer of 1997. One extended the existing moratorium through April 1, 1999 (Chapter 235 of the Laws of 1997). The other instructed New York's Energy Planning Board to review the activities and initiatives of the Federal government and other states regarding the regulation of LNG, evaluate safety concerns and the potential markets for LNG, and make recommendations for policies on the production, transportation, storage, and use of LNG (Chapter 385 of the Laws of 1997).

This report has been prepared to meet the requirements of Chapter 385. To help the EPB agency staffs to meet the legislation's intent in an unbiased manner, a LNG Resource Group, consisting of private and public sector representatives knowledgeable of existing regulatory authorities, safety and public concern issues, and the use and environmental aspects associated with LNG, was established (See Appendix A). The LNG Resource Group served as an information source to the study team, reviewed draft documents, and critiqued the findings and recommendations contained in the study. Additionally, the Energy Planning Board retained the services of Project Technical Liaison Associates Inc. of Spring Texas (PTL), experts in the LNG field, to conduct a study of LNG safety issues. This PTL work is the basis for the safety analysis component of the report.

The report examines existing laws and regulations that would affect new LNG plants in New York and government initiatives in other states. It reviews existing use of LNG in New York, including safety issues and potential public concerns that may arise with lifting the moratorium. It also discusses the economic and environmental effects of increased LNG usage for New York State and makes recommendations regarding the existing State moratorium on the use and transport of LNG in New York State (see page S-8).

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[1] The-five member Energy Planning Board is chaired by the President of the New York State Energy Research and Development Authority and includes the Chairman of the Public Service Commission and the Commissioners of the Departments of Environmental Conservation, Economic Development, and Transportation. An interagency working group comprising representatives of the Planning Board agencies was chaired by NYSERDA.

LNG is a clear, odorless, cryogenic liquid at a temperature of -260°F at atmospheric pressure. As a liquid, it is a highly concentrated form of natural gas containing nearly 100% methane[2]. While, as with other fuels, there are risks associated with mishandling LNG, the physical properties of LNG tend to mitigate some of those risks as compared with other fuels. For example, LNG's high lower-flammability limit, high autoignition temperature, and weight make it less likely than other fuels to ignite in a well-ventilated area. LNG has a flammability range of 5% and 15%, which means that LNG vapors will burn only when its fuel-to-air concentrations are within this range. The lower LNG flammability limit is higher than that of most petroleum and alcohol-based fuels currently in use and, consequently, less air is required to dilute LNG vapors below flammability.

Another measure of LNG's flammability is its "autoignition temperature," which is closely related to the lowest temperature that a fuel's vapors will ignite. A 10% LNG mixture has an autoignition temperature of 1000°F, which is higher than most other fuels. For example, gasoline's autoignition temperature is 495°F. Moreover, LNG, in its cryogenic form, is heavier than air and is approximately one-half the weight of water on a volumetric basis. Therefore, if LNG is spilled on land or water, its temperature rises and it will vaporize into the atmosphere forming a cloud. As the cloud drifts downwind, additional air mixes and dilutes the vapors. If no ignition sources are encountered, the cloud will eventually dissipate.

An accidental release of LNG associated with its transport or use at a stationary facility in the presence of an ignition source raises two potential hazards to public safety: direct exposure to a fire and thermal radiation generated from a fire. Government and industry recognize these potential risks and have adopted regulatory requirements and operating practices to ensure that LNG facilities are located on sites with suitable topography, size, and configuration to minimize any hazard to individuals or property. LNG tanks are required to be surrounded by an impoundment area or dike large enough to contain the entire contents of the tank. Additionally a LNG site must have a thermal exclusion zone, which is an area sufficient in size to prevent the heat from a fire within the LNG facility from causing harm beyond the plant's property line. Another potential risk is a vapor cloud. However, LNG's slow flame speed (i.e., the time it takes

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[2] Like natural gas, the composition of LNG varies depending on its source. Unless otherwise stated, LNG is assumed to contain near 100% methane compared to the 90% typical of natural gas consumed in New York.

for the flame to move through a LNG/air mixture) prevents a significant pressure buildup in an unconfined area, which diminishes the potential for an explosion associated with an LNG accident.

Three LNG peakshaving plants, (facilities that augment natural gas supply when demand levels exceed a utility's access to pipeline supplies) currently operate in New York. These plants liquefy pipeline natural gas and regasify the LNG to provide an assured, timely natural gas supply to supplement seasonal pipeline deliveries of natural gas during high-demand winter periods. Two of these plants are owned by Brooklyn Union, a KeySpan Corporation company, and are located in Greenpoint, New York City, and on Long Island at Holtsville. The third plant is owned by Consolidated Edison and is located in Astoria, New York City. These three LNG peakshaving plants entered service between 1968 and 1974 and co-exist with other businesses and residents without disrupting normal activities in their respective communities. During this nearly 30-year period, these facilities have not experienced a single LNG incident involving any personal injuries, fatalities, or significant spills of LNG.

The PTL study shows that LNG has had an excellent safety record over the past 20 years. Since 1980, there were seven LNG facilities or tanker accidents worldwide, and an additional four accidents in the United States related to vehicles fueled with LNG[3]. None of the accidents involved any fatalities.

Furthermore, despite the moratorium on approval of new intrastate transportation routes, LNG has been and continues to be transported safely along dedicated interstate highway routes across New York. While the existing LNG moratorium has prevented LNG use in new applications in New York, industries in New England, commercial companies in California, several metropolitan transit bus authorities, including those in Dallas, Houston, and El Paso, Texas, and Phoenix and Tempe, Arizona, and the Los Angeles International Airport, rely on LNG to partially satisfy their energy requirements.

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[3] *Evaluation of Liquefied Natural Gas Safety Issues*, Project Technical Liaison Associates, Inc, pg. 8.1-3, 8.9 September 1998.

New York is the only state that has adopted a moratorium on constructing new LNG facilities and approving new transportation routes. A 1973 fire at the Texas Eastern Transmission Company Staten Island LNG peakshaving plant, which caused the death of 40 workers, was the primary motivating factor in the adoption of the current LNG moratorium in 1978. Testimony concerning the cause of the accident at the July 1973 U.S. House Of Representatives hearing[4] indicated that analysis of the tank insulation revealed nitrogen, freon 11, and oxygen, rather than LNG vapors, were absorbed in the insulation and contributed to the fire. However, the cause of the accident was never conclusively determined.

The Staten Island LNG facility, which was built to unique design standards for its time, included a 575,000-barrel internally insulated tank with a mylar/aluminum membrane. Following an abnormally high boil-off rate during the test period, when a large amount of LNG vaporized and had to be used as an off-peak supply of natural gas, the tank was emptied and purged. An inspection revealed tears in the membrane; while repairs were in progress a fire occurred. The widely accepted plausible explanation for the fire is that a spark from some source ignited a flammable solvent, which ignited the mylar lining and the polyurethane foam insulation. The fire created enough internal pressure to lift the tank roof. Once this pressure was vented, the roof collapsed back into the tank. The combination of asphyxiation related to the fire and the weight of the collapsed roof killed 40 workers inside the tank. There was no damage outside the tank structure. A repeat of the 1973 Staten Island accident could not occur in any new facility because that accident involved combustible materials and tank design that are now prohibited.

Since 1980, a wide range of Federal laws, New York State and New York City regulations, and national industry standards have been adopted that affect all aspects of LNG production, transportation, and use. At the national level, the Federal Energy Regulatory Commission, the Departments of Energy and Transportation, and the United States Coast Guard are the primary agencies with specific responsibilities regarding LNG facilities. In New York, the principal State agencies with LNG regulatory jurisdiction are the Public Service Commission and the departments of Environmental Conservation, State, and Transportation. Additionally, New York City has local

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[4] Record of the Staten Island Explosion: Safety Issues Concerning LNG Storage Facilities July 10, 11, and 12, 1973 hearings before the Special Subcommittee on Investigations of the Committee On Interstate And Foreign Commerce of the U. S. House Of Representatives.

oversight of LNG facilities administered primarily through its Fire and Buildings Departments. Finally, the National Fire Protection Association (NFPA) has developed extensive and comprehensive technical safety codes and standards that address all aspects of the LNG industry, including vehicles fueled with LNG. While NFPA itself can not enforce these codes and standards, New York State and New York City generally have adopted them by reference into law and regulation.[5]

LNG has the potential to expand in-state natural gas availability, create economic gains, and foster environmental benefits for New York residents and businesses. As natural gas continues to capture market share, the demand for natural gas is projected to increase significantly in the future. LNG can offer local distribution companies an alternative for meeting peak daily supply economically, especially for companies serving large temperature-sensitive loads. Small temporary peakshaving stations also may supply new remote customers with natural gas, allowing the local distribution company to expand or extend its system.

New York businesses currently manufacture equipment components for LNG systems and facilities for use in other states. In the future, the demand for advanced energy equipment and engines that operate on alternative fuels is expected to escalate, a trend that could increase interest in LNG and create jobs in New York. Domestic manufacturers are offering a wide range of heavy- and medium-duty vehicle engines that operate on LNG with the expectation that LNG can play a larger role in the transportation sector in the future. Additionally, developing new technologies that can economically recover stranded natural gas (supplies without access to a pipeline gathering system) and remote gas reserves has the potential to increase natural gas production in the Southern Tier of New York.

LNG could also contribute to reducing transportation-related air pollution levels. Programs in other states have demonstrated that LNG can power vehicles, maintain customer service levels, and lower transportation sector pollution. In New York's newly competitive electricity industry, LNG would be unlikely to play a role as a primary fuel for electric generation.

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[5] 16 NYCRR section 259.2 requires all LNG facilities in New York State to conform to Title 49 CFR Part 193, which discusses the applicability of NFPA 59A and other industry standards. With regard to New York City, 3 RCNY Chapter 23, Section 2303 (a) covers the applicability of these standards.

If the moratorium were lifted, job growth in New York would initially be related to employment gains as a result of the construction of new LNG liquefaction, storage, and dispensing facilities. In the longer term, however, manufacturing jobs could expand as the demand for LNG-related equipment and new LNG facilities increase and as LNG becomes another fuel option available to New York businesses.

Expanded LNG use either as a vehicle fuel or as a supplemental source of natural gas also would have positive environmental effects in New York. LNG contains virtually no sulfur; therefore, emissions of sulfur oxide are nearly eliminated. Furthermore, combustion of LNG would produce significantly less particulate matter, carbon monoxide, nitrogen compounds, and non-methane hydrocarbons as compared to conventional transportation fuels. Finally, LNG's emissions of CO_2 and heavy metals are lower than other conventional fuels.

STUDY FINDINGS

The major findings of this report are summarized below:

- Given its physical and chemical properties, LNG is as safe as other currently available fuels. LNG facilities have an excellent safety record. Since 1980, there have been seven plant or ocean tanker accidents worldwide and four vehicle-related accidents in the United States, with no fatalities, which compares favorably with the safety record of facilities for competing fuels.

- LNG is clean-burning compared to other fossil fuels. Using LNG in mobile and stationary applications would virtually eliminate sulfur oxide emissions, significantly reduce particulate matter emissions, and decrease carbon monoxide, carbon dioxide, and nitrogen oxide emissions.

- The Staten Island accident, which was the motivating factor in New York adopting the existing LNG moratorium, occurred after the tank was fully purged of all LNG. The combustion of the mylar liner and polyurethane insulation caused the fire that led to the death of 40 workers. A similar incident at a new LNG facility could not occur because the construction materials and tank design used at the Staten Island LNG facility now are prohibited.

- Current federal regulations, combined with adoption of the NFPA standards, adequately address safety concerns regarding the siting, construction, and operation of new LNG facilities and activities.

- The operation of the existing LNG facilities in New York are subject to comprehensive Federal, State, local, and NFPA regulations, codes and standards.

- New York's three existing downstate LNG peakshaving plants provide local natural gas distribution companies with the flexibility to serve unexpected or seasonal increases in hourly or daily consumer gas demand at a cost that is estimated to be approximately one-third the expense of existing firm long-line interstate pipeline capacity. These facilities co-exist with their business and residential neighbors without opposition or disruption to normal daily activities and have never experienced an accident involving personal injuries or fatalities since beginning operation in 1968.

- LNG supplies currently are transported over highways across New York from New Jersey to destinations in New England and from New England to the south in compliance with the Interstate Commerce Clause of the United States Constitution and New York State Department of Transportation regulations.

- No state, other than New York, has instituted a moratorium on new LNG facilities or transportation routes. In addition to the Federal statutes that govern the LNG industry, many states have promulgated regulations concerning safety, storage, use or transport of LNG and the construction of LNG facilities.

- While the existing moratorium on siting LNG facilities and certifying new transportation routes has restricted LNG use in the State over the past 20 years, industrial businesses in New England and metropolitan transit bus systems in Texas and Arizona have selected LNG to satisfy a significant part of their vehicle fuel requirements.

- Currently, there are several New York companies that manufacture components for LNG systems and the transport of cryogenic liquids. New York companies also transport LNG for out-of-state customers. The economic benefits of LNG use in New York would initially be in jobs related to the production of LNG from conventional pipeline gas facilities, development of new remote gas gathering technologies, and the transportation of LNG to small scale storage and dispensing sites. Initially, new jobs would begin with the construction of liquefaction, storage, and dispensing plants, followed by manufacturing and servicing of such equipment. As LNG competes with other fuels, it may satisfy a portion of the State's energy requirements and help achieve compliance with national and statewide environmental standards.

- More than 700 vehicles, ranging from light-duty passenger cars to full-size locomotives now operate on LNG worldwide. In the United States several medium- and heavy-duty LNG vehicle demonstration programs are underway. These programs, such as public mass transit testing of LNG operated buses, are encouraging manufacturers to advance LNG technologies in the transportation sector.

RECOMMENDATIONS

There are economic and environmental advantages for allowing the construction of new LNG facilities as well as the intrastate transportation of LNG over new routes. Allowing LNG to compete for markets with other energy resources can have positive economic and environmental consequences for New York constituencies. As discussed fully in the Regulatory Assessment section, safety concerns are adequately addressed by existing Federal and State statutes and regulations. The industry has an excellent safety record over the last 20 years and the current regulatory framework is more extensive than the one that was in effect in 1978 when the moratorium was originally imposed. The regulatory role assigned to DEC under Title 17, Article 23 of the Environmental Conservation Law, which was passed just prior to the moratorium but never implemented, would duplicate the roles played by other agencies under existing statutes and regulations. For these reasons, the Legislature should:

- Discontinue the existing moratorium by allowing the statute to lapse effective April 1, 1999.
- Repeal Title 17, Article 23 of the Environmental Conservation Law, which imposes duplicative regulatory responsibilities on DEC.

The New York City Fire Department participated in the Resource Group that assisted the Energy Planning Board staff in developing this Report. The Fire Department indicated that it had some concerns about extensive new use of LNG in the densely populated City limits. If the moratorium is lifted, the Fire Department requested that the legislative findings or memorandum in support of any legislation ending the moratorium contain the following language:

> The City of New York will retain its authority to regulate the storage, transportation, and use of LNG within City limits, including its authority to restrict or prohibit such activities as it determines appropriate in the interest of public safety. Such restrictions and prohibitions could be applied to existing and new LNG transportation routes, as well as to the construction of bulk LNG plants and vehicle fueling stations.

It is noted that there is a possibility that the moratorium could be allowed to expire without any further legislation. In such case, the Legislature could consider other methods of recognizing the Fire Department's concerns.

Applicable local zoning and building permit laws and regulations should govern where such plants may be located in the same manner as local zoning and building codes currently apply to the siting of other fuel storage facilities, including petroleum products and propane. The Public Service Commission has regulations (16 NYCRR Part 259) that address the safety aspects of any proposed LNG plant where the facility would supply a distribution company in New York State. New plants constructed to serve end use or vehicle fuel applications would be regulated by the New York State Uniform Fire Prevention and Building Code, maintained by the Department of State, and any local provisions that are stricter than comparable requirements of that Code. A developer proposing to build a new LNG facility would have to apply to the local governing jurisdiction and proceed through the State Environmental Quality Review Act (SEQRA) process, complying with all applicable environmental requirements before any facility could be constructed and operated.

SECTION 1
INTRODUCTION

PURPOSE

Chapter 385 of the Laws of 1997 directed the State Energy Planning Board to conduct a study to evaluate issues relating to liquified natural gas (LNG). Use of LNG in New York has been limited since 1978 as a result of legislation that suspended further activities involving the siting of new LNG facilities and intrastate transportation routes (Chapter 395 of the Laws of 1978). The moratorium was intended to continue until accurate and reliable information concerning the safe transportation and storage of LNG became available. It was most recently extended through April 1, 1999 (Chapter 235 of the Legislation of 1997).

The objective of this report is to provide information necessary to evaluate the need for extension or modification of the State's moratorium affecting the use and transport of LNG. To fulfill this charge in an unbiased manner, an LNG Resource Group, consisting of private and public sector representatives knowledgeable of existing regulatory authorities, safety and public concern issues, and the use and environmental aspects associated with LNG, was established (See Appendix A). The LNG Resource Group served as an informational source to the study team, reviewed draft documents, and critiqued the findings and recommendations contained in the study. Additionally, the Energy Planning Board retained the services of Project Technical Liaison Associates Inc., Spring, Texas (PTL), experts in the LNG field, to conduct a study of LNG safety issues. The PTL study underlies the safety analysis component of this report.

The report reviews regulatory authorities of federal, state, and New York City agencies governing current LNG use and transportation in New York. It examines the LNG industry's recent safety record; potential safety and local public concerns; future markets for LNG use within New York and elsewhere, including its potential use as a viable alternative fuel; and economic and environmental effects associated with LNG consumption and with the prohibition of its use.

BACKGROUND

Liquefying natural gas can be an effective method to store natural gas for use at a later time or to transport natural gas over long distances for use at another site. LNG is a cryogenic liquid, existing only at very low temperatures. Liquefaction is the process by which natural gas is converted to LNG. The process removes impurities from the feedstock natural gas, which contains 85% to 99% methane depending on its source, resulting in LNG that is colorless and odorless. LNG is a clean, high energy content liquid fuel that is stored in double-walled tanks. Similar to other cryogenic substances, such as liquid hydrogen, nitrogen, and oxygen, LNG is routinely transported, stored, and used in applications throughout the country. LNG will maintain its liquid state, without changing its temperature or pressure, provided that tanks are designed properly, built using approved materials, and allow for venting of vapor "boil off."

The most common use of LNG in the U.S. is for "peakshaving" (i.e. to augment the supply of natural gas at those times of the year when the demand for natural gas from a local utility company exceeds its access to pipeline supply). Natural gas utilities liquefy pipeline gas at times when it is abundant and available at off-peak prices or they purchase LNG from import terminals supplied from overseas liquefaction facilities. When gas demand increases, and pipeline gas is physically or economically constrained, LNG is converted back to its gaseous state to supplement the utility's pipeline supplies. Liquefaction and storage of LNG allows companies to increase system throughput during high demand periods without having to build additional pipelines or other upstream facilities. Other LNG applications include using it to generate electricity (such as in Asian counties), fuel vehicles, supplement compressed natural gas systems, and fuel industrial applications. LNG is a common fuel in many other countries, particularly those without a plentiful indigenous natural gas supply, or those with energy demands in remote areas not readily serviced by a comprehensive distribution infrastructure or without access to other energy sources.

Properties of LNG

LNG is a clear, odorless, cryogenic liquid, at a temperature of -260°F, at atmospheric pressure. It floats on water because it weighs about 3.5 pounds per gallon, compared to 8.3 pounds for water. Methane is its major component with small amounts of ethane and trace quantities of propane, butane, and nitrogen. Examples of LNG composition are shown in Table 1.

Source	LNG COMPOSITION (Mole Percent)				
	Methane	Ethane	Propane	Butane	Nitrogen
New York City	98.00	1.40	0.40	0.10	0.10
San Diego Gas & Electric	92.00	6.00	1.00	0.00	1.00
Baltimore Gas & Electric	93.32	4.65	0.84	0.18	1.01
Algeria	86.98	9.35	2.33	0.63	0.71
Venezuelan	87.30	10.10	2.10	0.20	.30
Alaska	99.72	0.06	0.005	0.005	0.20

Table 1 [6]

As a liquid, LNG is a highly concentrated form of natural gas -- one cubic foot of LNG is equal to approximately 618 cubic feet of natural gas. The primary reason for its liquefaction is to allow a large volume of gas to be stored in a small space, making transportation and storage much easier. The properties of fuels, including LNG, that have safety implications are its flammability limit, its autoignition[7] (and ignition) temperatures, vaporization rate, and weight. Table 2 shows selected properties of LNG compared to other fuels.

Flammability limits, or the concentration of fuel (by volume) that must be present in air for ignition to occur, has a bearing on safety. The upper and lower flammability limits of methane (a surrogate for LNG vapor) are 5% and 15% by volume, respectively. In a closed storage tank, where the concentration of LNG is 100%, the fuel can not ignite because of lack of oxygen. A leak from the tank to a ventilated area would cause rapid mixing and dissipation to below a 5% level, limiting the potential for ignition in the area directly near the leak. However, the potential for an accumulation of a significant amount of vapor that could result in ignition becomes more likely when a leak occurs in a closed, poorly ventilated area.

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[6] *Liquid Methane Fuel Characterization and Safety Assessment Report*, Cryogenic Fuels, Inc., Report No. CFI-16000, Dec. 16 1991, page 2.

[7] Autoignition is the temperature at which a gas will ignite when adiabatically compressed. The autoignition temperature of LNG is about 1000° F (540° C). Ignition level is anything greater than the autoignition temperature.

FUEL	FLAMMABILITY (VOLUME % GAS MIXTURE)	AUTOIGNITION TEMPERATURE (° F)
LNG (primarily methane)	5.3-15	1004
LPG	2.2-9.5	850-950
Ethanol	4.3-19	793
Methanol	7.3-36	867
Gasoline	1.4-7.6	495
Diesel Fuel	1-6	approx. 600

Table 2[8] [9]

Table 2 shows that LNG has one of the highest lower flammability limits of the fuels shown. This means that less air is needed to dilute an LNG leak to below flammability than for most other fuels.

Autoignition temperature is closely related to the minimum temperature required to ignite a given fuel. LNG has an autoignition temperature of over 1000°F, which is more than 500°F and 400°F higher than gasoline and diesel fuel, respectively. The significance of LNG's autoignition temperature is that a higher temperature ignition source is necessary to ignite LNG vapor than for most other fuels.

If LNG spills on the ground or on water and does not encounter an ignition source, it will vaporize into the atmosphere. The LNG vapor that enters the atmosphere is at a boiling point of -260° F and is denser than air. As the cloud drifts downwind, the vapor mixed with air reducing both the cloud density and the methane concentration and eventually the cloud dissipates.

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[8] *Alternatives To Traditional Transportation Fuels: An Overview*, Energy Information Administration, U.S. Department of Energy, 1994.

[9] Coward, H.F., and Jones, G.W., *Limits of Flammability of Gases and Vapors*. Bureau of Mines Bull. 503, 1952.

CURRENT PRACTICES

Japan and South Korea are the largest consumers of LNG, with their natural gas demands almost entirely met by LNG. The U.S. is a relatively small LNG user, with its liquefaction plants accounting for less than 2% of the existing 4.0 trillion cubic feet (tcf) estimated annual worldwide LNG capacity. The U.S. imports LNG from Algeria and more recently from the United Arab Emirates and Australia to Everett, MA, and Lake Charles, LA, and exports LNG from Alaska to Japan. In the near term, new Trinidad LNG plants will supplement imports to Everett, MA. The combined annual operating capacity of the Everett and Lake Charles import-terminals is 341.5 billion cubic feet (bcf). Two other operable import facilities exist in Cove Point, MD, and Elba Island, GA, but are not actively importing LNG because of the current lack of a market for LNG. These two plants have a combined annual import capacity of 533.9 bcf. The Cove Point facility currently is liquefying pipeline gas and is being used as a peakshaving plant. The U.S. Department of Energy's Energy Information Administration (EIA) projects imports to the two currently operating U.S. import-terminals should increase at an annual average 11% rate from 65.6 bcf in 1997 to 132.0 bcf by 2002.[10]

In addition to imports, another source of LNG is pipeline gas that is liquefied by gas utilities and stored. In 1996, gas utilities in 29 states used LNG storage to supplement pipeline gas supplies, withdrawing 69.3 bcf from and adding 73.1 bcf to LNG storage. Although still not a significant factor in other applications, LNG use in the U.S. is increasing. Bus and heavy-duty vehicle fleets are fueled by LNG in several cities and there are some remote LNG baseload natural gas distribution systems serving municipalities and industrial sites. [11]

Comprehensive industry standards and national regulations and codes are in place to govern how LNG is used, stored, and transported. The National Fire Prevention Association (NFPA), consisting of representatives of industry, government, and academia, has adopted safety standards

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[10] Projection based on Department of Energy *Natural Gas Import and Export* quarterly reports presented in Oil & Gas Journal, January 19, 1998, p.53, Table 2.

[11] Foss Manufacturing Company in Hampton, NH and Pratt and Whitney in East Hartford, CT are two examples of industrial companies relying primarily on LNG.

relating to a wide range of LNG operations. Four Federal and three New York State agencies and New York City have adopted extensive regulations that apply to the LNG industry.

New York has three LNG peakshaving facilities. These plants were built prior to the 1978 moratorium and help meet the energy demands of customers in the service territories of Brooklyn Union, including portions of New York City and the region formerly served by Long Island Lighting Company and the Consolidated Edison Company. The moratorium prevented any expansion of these facilities, construction of additional peakshaving facilities, authorization of new transportation routes, or growth of other LNG applications in New York State.

Recently, the regulatory, economic, and competitive forces affecting energy uses and choices have changed dramatically. These forces will continue to change in the future as industries, consumers, and government entities respond to evolving energy markets. The need for a moratorium on LNG use and transportation to protect the health and safety of New Yorkers should be evaluated and considered within the context of these changing forces.

SECTION 2
REGULATORY ASSESSMENT

The production, storage, transportation and use of LNG is governed by regulations at the Federal, state, and, in some cases, local levels. The Department of Energy (DOE), the Federal Energy Regulatory Commission (FERC), the Department of Transportation (DOT), and the United States Coast Guard all have specific regulatory responsibilities with regard to LNG. The National Fire Protection Association (NFPA) has developed standards for LNG that have been adopted by various federal, state and local regulatory or political entities. In New York State, the Public Service Commission (PSC), and the departments of Environmental Conservation (DEC), Transportation (NYSDOT), and State (DOS) also have regulatory jurisdiction over certain aspects of the production, storage, transportation, and use of LNG within the State. Additionally, New York City exercises even stricter regulatory jurisdiction over LNG facilities located within in that city.

FEDERAL

Four Federal agencies have jurisdiction over issues involving the safety, construction, and transportation of LNG and LNG facilities.

Department of Energy

The 1977 Department of Energy Organization Act transferred approval powers for international gas trade from the former Federal Power Commission to the Secretary of Energy (Public Law 95-91, Section 402F and 42 U.S.C. 7101, et. seq.). The DOE issues certificates for the import or export of LNG or other forms of methane natural gas.[12] When natural gas and LNG are imported from, or exported to, a free trade nation, (e.g., Mexico or Canada), approval is generally automatic. In other cases, the DOE does a study before granting approval. Although DOE

[12] In 1989, the U.S. Department of Energy Delegation Order No. 0204-127, transferred approval authority for natural gas imports and exports to the Assistant Secretary for Fossil Energy. From 1977 to 1989, this authority was the responsibility of the Administrator of the Economic Regulatory Administration (ERA).

monitors the amount of LNG being imported and exported, it has no role in either the construction or safety of LNG facilities.

Federal Energy Regulatory Commission (FERC)

In 1984, the Secretary of Energy delegated certain powers to the FERC.[13] As a result, the FERC has the power to approve or disapprove the site at which an LNG import/export facility is constructed.[14] Section 7 of the Federal Natural Gas Act also authorizes the FERC to approve the construction, replacement, or abandonment of, among other things, LNG peakshaving facilities used in interstate service. The FERC issues a certificate for public convenience and necessity authorizing operation of a respective LNG facility (15 U.S.C. Section 717f (c)). There are about 20 such import/export terminals and major interstate peakshaving plants.[15]

FERC prepares an Environmental Assessment (EA) or an Environmental Impact Statement (EIS), depending on the issues identified, in accordance with the provisions of the National Environmental Policy Act of 1969 (NEPA) as part of the certification process to construct or operate an LNG facility.[16] In addition to evaluating environmental concerns, the FERC reviews the engineering design of the facility and monitors construction of the project.

Department of Transportation

The Federal Department of Transportation (DOT) plays a major role in ensuring the safe operation of LNG facilities. Section 60103 of the Pipeline Safety Laws (49 U.S.C. 60101 et seq.) authorizes the Secretary of Transportation to prescribe minimum safety standards concerning the location,

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[13] DOE Delegation Order No. 0204-112

[14] Actions taken by the FERC in its proceedings must be consistent with the determinations of the Assistant Secretary for Fossil Energy.

[15] There are about 60 to 70 intrastate plants, which fall under state regulatory commissions. Three of these are in New York State.

[16] The federal regulations developed to comply with NEPA are contained in 18 CFR Part 380.

design, installation, construction, initial inspection, and testing of a new LNG facility.[17] Specifically, DOT's Research and Special Programs Administration (RSPA), Office of Pipeline Safety (OPS) is responsible for overseeing Federal safety standards for LNG facilities (contained in 49 CFR Part 193).[18] These standards include requirements for siting, design, construction, equipment, operations, maintenance, personnel qualifications and training, fire protection, and security.

For interstate LNG facilities there appears to be some jurisdictional overlap in the review of the siting and design and in monitoring the construction of the facility. Although the FERC approves the site, OPS and/or a state agency authorized to act as OPS's agent can complement the FERC's efforts in reviewing the design and monitoring the construction of a LNG facility[19]. The certificate issued by the FERC may contain conditions that reflect input from OPS or could attach conditions that would be in addition to the requirements of Part 193 but could not be in conflict with those requirements (15 U.S.C. 717f[e]).

Coast Guard

The United States Coast Guard has regulatory authority over the design, construction, manning, and operation of ships and barges that would transport LNG, as well as the duties of their officers and crew (Sec.46 CFR Part 30 - Shipping.) At LNG export or import terminal facilities, the Coast Guard has jurisdiction over the marine transfer area which is that part of a waterfront facility handling LNG between the vessel or where it moors and the last manifold or valve immediately before the receiving tanks (33 CFR Part 127, Subpart B - Waterfront Facilities Handling Liquefied Natural Gas.) There are currently no import/export terminal facilities operating in New York State.

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[17] The laws define an existing LNG facility (as distinguished from a new one) as one for which an application for approval of the site, construction, or operation of the facility was filed before March 1, 1978 with FERC or the appropriate state or local authority but not including one on which construction is begun after Nov. 29, 1979, without approval. However, if such a facility is replaced, relocated, or significantly altered after February 11, 1980, it must comply with the applicable requirements of the federal safety standards.

[18] These standards were originally enacted February 11, 1980, and most recently amended May 4, 1998.

[19] 49 U.S.C. 60101 et. Seq. authorizes the OPS to have a state agency act as its agent.

NATIONAL FIRE PROTECTION ASSOCIATION

The National Fire Protection Association (NFPA) describes itself as "an international, nonprofit, membership organization founded in 1896 to protect people, their property and the environment from destructive fire."[20] To further this goal, NFPA develops fire safety codes and standards drawing upon the technical expertise of persons from diverse professional backgrounds who form technical committees that address specific activities/conditions having fire-related safety concerns. The members of these committees use an open consensus process to develop standards for "minimizing the possibility and effects of fire," which balance the various affected interests in the subject areas being addressed.[21] NFPA has adopted two comprehensive standards, NFPA 59A and NFPA 57, that relate to LNG.

For LNG facilities and its use, the basic methods of equipment fabrication as well as LNG installation and operating practices that provide for protection of persons and property are contained in NFPA 59A Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG) 1996 Edition. It also "provides guidance to all persons concerned with the construction and operation of equipment for the production, storage, and handling of liquefied natural gas." This standard is quite comprehensive and contains detailed technical requirements to ensure safety across all aspects of LNG industry operations, including general plant considerations, process systems, stationary LNG storage containers, vaporization facilities, piping systems and components, instrumentation and electrical services, transfer of LNG and refrigerants, fire protection, safety and security, and alternate requirements for vehicle fueling for industrial and commercial facilities using containers built to American Society of Mechanical Engineers (ASME) standards. The standard also incorporates by reference technical standards developed by a number of other professional organizations, such as ASME, the American Society of Civil Engineers, the American Petroleum Institute, the American Concrete Institute, and the American Society for Testing and Materials. (A complete list of these organizations appears in the last chapter of the NFPA standard.)

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[20] From NFPA informational bulletin Bringing people together in a safer world.

[21] Ibid.

It is important to note that NFPA is not empowered to enforce compliance with its codes and standards. Regulatory bodies or political entities having such enforcement powers can best ensure their implementation by adopting or incorporating the NFPA standards by reference into their appropriate codes. The National Fire Prevention Association (NFPA) does have regional offices and an international department that provides support services to assist state and local officials with code adoption, training and certification of personnel, and code advisory services.

The Office of Pipeline Safety has asked the National Association of Pipeline Safety Representatives (NAPSR)[22] to form a committee to explore the feasibility of merging the NFPA 59A standards into Part 193 of the DOT standards. The committee has made recommendations to OPS. A probable result will be to update the standards in Part 193 by adopting appropriate standards in NFPA 59A while retaining the scope and applicability provisions of Part 193. This will significantly strengthen OPS's safety standard.

Effective February 1996, NFPA also has revised and adopted NFPA 57 Standard for Liquefied Natural Gas (LNG) Vehicular Fuel Systems. NFPA 57 "...applies to the design, installation, operation and maintenance of liquefied natural gas (LNG) engine fuel systems on vehicles of all types, and to their associated fueling (dispensing) facilities, and to LNG and CNG facilities, with LNG storage in ASME containers of 70,000 gallons...or less", and it "...includes marine, highway, rail, off-road, and industrial vehicles.[23] NFPA 57 is comprehensive and contains detailed technical requirements for vehicle fuel systems, LNG fueling facilities, installation of ASME approved tanks, and fire protection, safety and security. It also incorporates other NFPA publications and an American Gas Association LNG Information Book by reference.

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[22] This group comprises state government personnel, specifically the safety program managers of each of the states. Representatives from OPS also frequently participate in the group's deliberations. Its mission is to manage their respective programs and identify and address matters affecting pipeline safety across the nation.

[23] NFPA 57 Standard for Liquefied Natural Gas (LNG) Vehicular Fuel Systems, 1996 Edition, p.4

NEW YORK STATE

Public Service Commission[24]

The Federal DOT RSPA Administrator has certified the Department of Public Service (DPS) to carry out a pipeline safety program for intrastate facilities and to act as the Administrator's agent for interstate facilities located within the State (49 U.S.C. 60101 et. Seq.).[25] The DPS Gas and Water Division Safety Section personnel who meet OPS training and qualification requirements perform safety audits of the three LNG plants within the State and witness fire safety drills and tests of safety systems.

Section 66 of Public Service Law articulates the general powers of the Commission with respect to gas and electricity. Pursuant to the statute, the Commission has promulgated rules and regulations, 16 NYCRR, which enable it to carry out its responsibilities in this regard. Part 259 of 16 NYCRR[26] deals with LNG and prescribes safety standards for all LNG facilities within the State except for those facilities subject to the jurisdiction of the FERC or which are otherwise exempted under 49 CFR 193.2001(b).[27]

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[24] The Public Service Commission derives its authority from the Public Service Law, Article 1, Section 5.1 and Article 4, Section 65.1. Article 1, Section 5.1 states: "the jurisdiction, supervision, powers and duties of the Public Service Commission shall extend under this chapter: b) to the manufacture, conveying, transportation, sale or distribution of gas (natural or manufactured or both) and electricity for light, heat or power, to gas plants and to electric plants and to the persons or corporations owning, leasing or operating the same." Also, Article 4, Section 65.1 states: "Every gas corporation, electric corporation and every municipality shall furnish and provide such service, instrumentalities and facilities as shall be safe and adequate and in all respects just and reasonable."

[25] The OPS administers a program whereby a state agency can receive grant-in-aid funds from the Federal Government of up to half of its cost for carrying out a pipeline safety program for intrastate pipeline facilities under a certification or agreement with the RSPA Administrator. A state agency can also act as an agent of the Administrator with respect to the safety aspects of interstate pipeline facilities within its jurisdictional area.

[26] Part 259, Sections 259.0 through 259.12, was initially filed Jan. 31, 1973. The latest revisions were effective May 1, 1982.

[27] This exception includes LNG facilities used by ultimate consumers of LNG or natural gas; LNG facilities used in the course of natural gas treatment or hydrocarbon extraction that do not store LNG; any matter other than siting pertaining to a marine cargo transfer system and associated facilities between the marine vessel and the last manifold or valve located immediately before a storage tank; and any LNG facility located in navigable waters.

The primary provision of Part 259 is its requirement of adherence to Part 193 of 49 CFR (Federal DOT). Part 259 also contains provisions that require a gas corporation to file with the DPS's Gas Division[28] a letter of intent providing design data and specifications for the facility at least 90 days[29] prior to the construction or reconstruction of any LNG facility. Prior to operating a facility, a report must be filed with the Gas Division certifying that the facility has been constructed and tested in accordance with the requirements of Part 259 (which means it must also meet the standards in 49 CFR 193 and any other standards such as NFPA 59A referenced in Part 193). Part 259 requires each gas corporation to file with the Gas Division the operating procedures, emergency procedures, transfer procedures, and maintenance procedures it has established in compliance with 49 CFR 193.

The regulations in Part 259 of 16 NYCRR contain a provision requiring that the Gas Division must be notified immediately of any accidents, spills, or leaks involving LNG facilities that cause injury, death, property, or plant damage, or would cause public concern if reported in the news media. The facility must also submit a written report of an accident to the Division within 30 days. Any spills or leaks that requires taking a segment of pipeline or process area out of service must also be reported immediately.

The regulations in Part 259 also require that any LNG tank temporarily taken out of service and purged to atmosphere must meet various federal requirements regarding penetrations[30] before being returned to service.

Primary enforcement rests with Safety staff of DPS's Gas and Water Division. If staff is unable to effect an operator's compliance with the regulations, it can recommend that the Public Service Commission (PSC) order the operator to take specific actions. The PSC would normally institute a proceeding to allow the company due process before it ordered an action. However, in cases

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[28] This would be the Gas and Water Division in the DPS's current organizational structure.

[29] This length of time is not intended to imply anything about the actual time required to assess the proposal before permission to begin construction or reconstruction is granted or denied.

[30] Penetrations used in this context refers to the piping systems through which the LNG tank is filled or emptied.

where the safety of persons or property is imperiled, the PSC could order that an action be taken on an emergency basis.

Section 25 of Public Service Law, subdivision 2, provides for substantial civil penalties for failure to obey or comply with, or for neglect of, a PSC order or regulation or a provision of Public Service Law. Subdivision 2 of that section provides that the penalty shall not exceed $100,000 for each offense, with each day of a continuing violation deemed a separate offense. Subdivision 3 of Section 25 provides that if the order, regulation, or provision in question was "...adopted specifically for the protection of human safety, including but not limited to the commission's code of gas safety regulations..." and "...it is determined by the commission that such safety violation caused or constituted a contributing factor in bringing about a death or personal injury..." the penalty shall not exceed the greater of (a) $250,000 for each separate offense, although each day of a continuing violation is not deemed a separate offense or (b) the maximum penalty determined in accordance with Section 25, subdivision 2.

Department of Environmental Conservation

In the absence of the moratorium, the DEC has the authority to issue environmental safety permits related to the preparation of a site, or for the construction of a liquefied natural or cryogenic petroleum gas storage or conversion facilities under Title 17, Section 23 of New York State Environmental Conservation Law, titled Liquefied Natural and Petroleum Gas Act (the Act). An exception was made for such facilities in actual use and operation as of September 1, 1976, which was applicable to the three existing New York State LNG plants. The legislation also provided that the DEC was to adopt regulations establishing criteria for the siting of LNG and LPG facilities and to prescribe the form and content of the environmental safety permits for construction of these facilities. While DEC has not been promulgated such regulations, the criteria have been established in regulations of other Federal and State agencies.

Other provisions in the Act require the New York State Department of Transportation (NYSDOT), in consultation with the DEC, to establish criteria for the safe transportation of LNG and LPG. The DEC consults with the PSC on a continuing basis in the administration of its

responsibilities under this Act. Except as specifically provided with regard to public safety, the Act states that it shall not affect the jurisdiction of the PSC.

The three existing LNG plants (in Brooklyn, Queens, and Suffolk Counties) were subject to the legislation's provisions for non-conforming facilities. Following public hearings, the Commissioner of DEC issued orders permitting the plants to continue operation subject to certain conditions, which included each plant filing an annual report to the DEC and additional training of the fire department personnel who would respond to a major LNG fire at the facilities[31].

Department of Transportation

The Commissioner of Transportation is authorized in Section 14-f of New York State Transportation Law to promote safety in all modes of hazardous materials transportation (which includes LNG). Liquid natural gas transport is regulated in New York State through the same set of regulations used nationally for this commodity. New York has adopted the Federal regulations contained in 49 CFR that deal with proper shipping name, registration of transporter, financial responsibility of motor carriers, authorized packaging, material identification, emergency response information, placards, controlled substance and alcohol use testing, driver training, and loading and unloading. The reference to adoption of these regulations and some additional provisions have been codified in 17 NYCRR Sections 507.4[32] and 819.10. These include the regulations governing financial responsibility ($1 million of insurance is required for the transportation of hazardous materials); material identification (the shipping papers must contain proper shipping name, hazard class, identification number, packing group number, total quantity, shipper's certification, emergency response telephone); emergency response information (monitoring the emergency response phone number at all times while the hazardous material is in transportation); placards and driver training. If the vehicle should fail a random inspection, meaning it fails to meet all the appropriate code provisions, it may immediately be removed from service and the driver may be fined.

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[31] Orders signed by Commissioner Robert F. Flacke dated January 19, 1979.

[32] Section 507.4 Transportation of hazardous materials was originally filed February 11, 1977 and most recently amended March 24, 1993.

Department of State

Article 18, Sections 371 through 379, of New York State Executive Law designates the basic procedures for development and maintenance of a New York State Uniform Fire Prevention and Building Code, interpretation of the code's applicability, and variance from its provisions. The code covers all political subdivisions with a population of less than 1,000,000 (which exempts New York City). The provisions of the code are set out in 9 NYCRR, Subtitle S, Subchapters B (Building Construction) and C (Fire Prevention). Part 1003, Hazardous Gases, requires that storage tanks for LNG be in accordance with generally accepted standards. Part 1250.5 lists that standard as NFPA 59A (1991).[33] The Uniform Fire and Building Code covers the construction and maintenance of an LNG facility outside of New York City where the PSC and Federal jurisdiction do not apply.

In addition, the Disaster Preparedness Commission has a Comprehensive Emergency Response Plan that has as an annex to it, a Hazardous Materials Emergency Contingency Plan. This contingency plan designates the Office of Fire Prevention and Control as the lead state agency when fire or the threat of fire is the primary concern. Under the DOT's classification system, LNG would be considered a flammable gas, making the primary threat fire-related.

When a proposal to construct a building, systems, or equipment is submitted, the code enforcement official for the community in which the respective facility would be located issues a building permit and performs inspections as construction progresses. If the structure or equipment conforms to the prescribed standard, a certificate of occupancy is issued. If it fails to conform, the certificate of occupancy presumably would be denied. If a local jurisdiction does not wish to enforce the uniform fire prevention and building code, it can opt to move the enforcement to the next level of government. In such cases, either the county or New York State could become the enforcement agency.

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[33] Although the current reference is to the 1991 edition, The Codes Division is in the process of updating this to the 1996 edition.

NEW YORK CITY

Title 3, Chapter 23, Section 23-03 of the Rules of the City of New York (RCNY) contains extensive provisions governing the manufacture, storage, transportation, delivery, and processing of LNG. These regulations apply to all liquefied natural gas installations connected to a natural gas pipeline constructed and operated after the date of promulgation (April 1977). They also extend to the safety of operation, alterations, or redesign of existing facilities not covered by existing criteria. The regulations state that they are also applicable to the waterborne transportation and delivery of LNG as it relates to land-based facilities. No permit or permission to operate an LNG facility or to load or unload a container or vessel will be granted until the New York City Fire Department (NYCFD) is satisfied that the regulations have been complied with and no undue hazard exists.

Additionally, Section 27-4100 (e) of the New York City Administrative Code specifies that filling a container with LNG is illegal unless the NYCFD adopts regulations permitting such activity. Currently, no applicable regulations exist. With respect to matters not specifically addressed in these rules, the regulations of NYSDOT, the PSC and NFPA 59A (1975) apply (see 3 RCNY 23-2303[a]). If the moratorium were to be lifted, existing New York City regulations would continue to govern and restrict the use and transport of LNG within City limits. In addition, the City would have the ability to promulgate additional regulations, as appropriate, to regulate LNG within the City.

NEW YORK REGULATORY SUMMARY

The existing statutes and regulations that have been promulgated since the passage of the New York LNG moratorium provide a comprehensive framework to regulate LNG facilities and transport of LNG in New York State. If the moratorium is lifted, Federal, State, and local agencies would regulate the various types of LNG facilities and operations under their existing statutory and regulatory authorities.

Facilities connected to interstate pipelines would be regulated by FERC and the Federal Department of Transportation or their authorized delegated agency at the State level. Facilities operated by gas corporations that connect to intrastate distribution pipelines would be regulated by the PSC. Other facilities, outside New York City, would be regulated under the Uniform Fire Prevention and Building Code, which has adopted the NFPA 59A and 57 standards, by the Department of State or the locality with jurisdiction. Regulation of smaller LNG facilities by localities would be analogous to local regulation of propane or petroleum facilities. The Department of State would be available to provide training or assistance to local employees or officials, as necessary. Facilities within New York City are presently and would be regulated by the City under its existing regulatory framework.

Transportation of LNG within New York would continue to be regulated by the State Department of Transportation (DOT) under its hazardous materials program. Maritime transportation of LNG would remain regulated by the United States Coast Guard.

Title 17, Article 23 of the Environmental Conservation Law gives certain responsibilities for regulating LNG to the Department of Environmental Conservation (DEC) and DOT. The statute requires DEC to promulgate siting criteria and to issue environmental safety permits for LNG facilities. It also requires DEC to approve routes for transportation of LNG in accordance with criteria to be promulgated by DOT. Largely due to the moratorium, the provisions of Article 23, which was passed in 1976, have never been implemented and the regulations to implement this statute were never promulgated. In the interim, the regulatory system described above has been put in place. Accordingly, implementation of Article 23, if the moratorium were lifted, would duplicate and potentially conflict with existing regulations.

SECTION 3

LNG REGULATION AND POLICIES IN OTHER STATES

In addition to the Federal statutes that regulate the liquefied natural gas (LNG) industry in the United States, many states have promulgated regulations regarding the safety, storage, use, or transport of LNG, or the construction of LNG facilities. These regulations specifically address such issues as: the classification of LNG as a hazardous substance (with regard to spills and handling); vehicle identification sign specifications (with regard to transportation); inclusion of LNG as an "alternative fuel" or "low-energy fuel" (with regard to taxation issues, ranging from imposition of a tax, to tax exemptions, or tax credits for its use); and regulations governing the construction of LNG facilities.

A basic search of state regulations using WESTLAW®[34], resulted in no LNG references in approximately one dozen states (including the District of Columbia). However, the remaining states showed at least some reference to LNG in its annotated statutes. Search results for a sampling of the states are discussed below to characterize the regulation of LNG in different geographic regions of the country and are not intended as an exhaustive assessment of state-level LNG regulations.

This cross-section of LNG statutes and regulations is indicative of the large variety of ways that states have addressed the issue of LNG. Only a few states have provisions specific to LNG and theses typically are modeled after the existing Federal requirements and industry standards. Other states include references to LNG when referring to CNG or LPG, with amendments (generally since the 1990's) adding LNG. The most common references to LNG are in the context of alternative fuels and alternative fuel vehicles and tax credits or exemptions for the use of alternative fuels, including the use of LNG. For example:

[34] WESTLAW® is a computer-based legal research tool containing over 9,000 databases. The search used in this exercise consisted of the query "liquefied /s natural /s gas" in the annotated statutes database for each of the 50 U.S. states and the District of Columbia.

CALIFORNIA

Currently, California has statutory provisions governing developments for the storage, transmission, and processing of LNG within ports, [35] and with respect to fuel containers and fuel systems on vehicles using compressed or LNG and LPG (used in conjunction with a propulsion system certified by the State Air Resources Board). [36]

Formerly, California under Chapter 10, of Division 2, of the Public Utilities Code, Division 2, "Locating, Constructing and Operating a Liquefied Natural Gas Terminal California had extensive regulations governing LNG facilities under the Public Utilities Code. The law had authorized the California Public Utilities Commission to issue a permit for the construction and operation of a LNG terminal, pursuant to a prescribed permit procedure and within a specified time, which had expired.[37] In 1987, the California legislature repealed Chapter 10 (commencing with § 5550), of Division 2 of, the Public Utilities Code".[38]

CONNECTICUT

Connecticut's statutes allow for a 10% tax credit for investments in vehicles powered by clean alternative fuels, including LNG, for construction of or improvements to alternative fuel filling stations, and for converting motor vehicles to use alternative fuels.[39] All of the fuels included in this statute must also meet the generally accepted standards of the American Gas Association (AGA), National Fire Protection Association (NFPA), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM) or American Society of Mechanical

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[35] CA PUB RES §30715.

[36] CA VEHICLE §2402.6.

[37] 1987-1988 Cal. Legis. Serv. Chapter 182 (West).

[38] Repealed by Stats. 1987, c. 182 §2.

[39] C.G.S.A. §12-217 (i).

Engineers (ASME). Connecticut also exempts LNG from the Motor Vehicle Fuels Tax after 1 July 1994 until 1 July 2001.[40]

Connecticut's Fire Safety Code[41] was amended in 1979 to include LNG, and also contains general provisions regarding LNG and LPG, inspections, report of leak or discharge, etc. Title 29 also gives the Commissioner of Public Safety the authority to promulgate regulations concerning the safe storage of LNG, although such regulations do not apply to either electric or gas companies.

IOWA

Iowa statutes contain rules for the Fire Marshall for handling flammable liquids and liquefied petroleum gases, including LNG,[42] including vehicle marking and LNG dispensing regulations.[43] Iowa statutes also provide that various Iowa State agencies'[44] vehicle fleets comprised a minimum of 10% of alternative fuel vehicles, including but not limited to LNG.

LOUISIANA

Louisiana statutes provide dozens of references to liquefied petroleum gas (LPG) and compressed natural gas (CNG), but only a few with regard to LNG. LNG is specifically exempted from the "hazardous liquid" definition under the Hazardous Liquid Pipeline Law.[45] However, LNG is defined as an "alternative fuel" under LSA-R.S. 47:38, Tax Credit for Conversion of Vehicles to

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[40] C.G.S.A.§12-458f.

[41] C.G.S.A. tit. 29 §§330-332.

[42] I.C.A. § 101.1.

[43] I.C.A. §101.11.

[44] The agencies include the Department of the Blind, Community Colleges, the Board of Regents, and the Department of Transportation.

[45] LSA- R.S. 30:702.

Alternative Fuel Usage. This provision provides for a tax credit of 20% for the cost of the qualified clean-burning motor vehicle fuel property.

MARYLAND

Article 78 of Maryland's Public Service Commission law contains the functions, duties, and powers of the Commission for LNG regulation.[46] An LNG facility is defined therein, as any facility used for the production, storage, or regasification of LNG. Other Maryland statutes include LNG in the definition of "clean burning fuel"[47] and explicitly exclude LNG under the definition of "oil" when referring to water pollution control and abatement.[48]

MASSACHUSETTS

Massachusetts addresses the manufacture and sale of gas and electricity, electric power facilities, energy needs, and environmental protection, and includes a definition of LNG.[49] Definitions of LNG and other substances were added in 1974.

Under the Code of Massachusetts Regulations, 980 C.M.R. 10.00 implements the Energy Facilities Siting Council's statutory mandate under M.G.L. c. 164, §69H and sets forth regulatory standards for the siting of intrastate LNG facilities proposed for construction in Massachusetts. The purpose of these regulations is to ensure systematic review of information that is necessary for the Council's determination of need, cost, and acceptable environmental impact.[50]

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46 MD CODE 1957, Art. 78, §64D.

47 MD TAX GENERAL §9-101.

48 MD ENVIR §4-401.

49 MA ST 164 §69G.

50 908 CMR 10.00

RHODE ISLAND

Under the General Laws of Rhode Island Annotated, Title 23. Health and Safety, Rhode Island has developed a comprehensive set of provisions addressing the storage and handling of LNG, including references to standards advisory, enforcement, the regulation of LNG facilities and the power of the Public Service Commission to develop regulations with regard to safety and welfare. Title 23, Chapter 28.33 et seq. address the storage and handling of LNG specifically.

Under the General Law of Rhode Island Annotated, Title 39. Public Utilities and Carriers, provisions address the powers of the Public Utilities Commission with regard to LNG, thereby including LNG under the purview of the Commission. Title 39-1-2.1 specifically provides for the presumption of in-state use or intrastate commerce upon the use or transportation of LNG within Rhode Island. Regulations promulgated pursuant to this section and concerning applications and permits for the transportation of liquefied natural and petroleum gases, a curfew on the hours of transportation and subsequent written notice of accidents were preempted by the Hazardous Materials Transportation Act, 49 U.S.C. §1801 et seq.

Title 45. Towns and Cities, Chapter 2-17 addresses the localities authority to regulate LNG facilities, and Title 46. Waters and Navigation, Chapter 12-6, Tank Vessel Safety Act, includes LNG under the definition of "oil".

TEXAS

Similar to Rhode Island, Texas provides for comprehensive specific LNG regulations. In Texas statutes, references to LNG are found in three major areas: Government Code, Health and Safety Code, and the Natural Resources Code. The Government Code provisions of the Texas statutes allow state agencies to purchase vehicles beyond certain wheelbase specifications, if the vehicle is capable of using LNG, CNG, LPG, or other defined fuels.[51] These provisions also provide that

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[51] V.T.C.A. Government Code §2158.003.

state agencies may obtain equipment or refueling facilities to operate vehicles using LNG;[52] the percentage requirements for vehicles capable of using alternative fuels and program review;[53] determination of alternative fuels program parameters;[54] compliance with applicable safety standards;[55] and when a vehicle is considered capable of using alternative fuels.[56]

The Health and Safety Code provisions specifically exclude LNG under Chapter 361. Solid Waste Disposal Act, Subchapter A. General Provisions. LNG is also specifically excluded under the definitions of "pollutant" and "contaminant".[57]

The Natural Resource Code provisions refer to LNG under Chapter 113 (LNG); Chapter 116 (CNG) and Chapter 117 (Hazardous Liquid or Carbon Dioxide Pipeline Transportation Industry).

Under the Natural Resources Code, Chapter 113.286, Subchapter J addresses the Alternative Fuels Council, and provides that the Council may use money in the Alternative Fuels Conversion Fund to finance activities supporting or encouraging the use of LNG, CNG, LPG and other fuels. A 1995 amendment to this subchapter listed specific fuels, replacing the more generic term "alternative fuels".

Chapter 116 addresses CNG, including LNG in most of its provisions. In Chapter 116.011, Subchapter B. Administrative Provisions, the Commission is provided the authority to administer and enforce the rules and standards adopted relating to CNG and LNG, with LNG added in 1993.

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52 V.T.C.A. Government Code §2158.004.

53 V.T.C.A. Government Code §2158.005.

54 V.T.C.A. Government Code §2158.006.

55 V.T.C.A. Government Code §2158.007.

56 V.T.C.A. Government Code §2158.008.

57 V.T.C.A. Government Code §361.401.

LNG is comprehensively addressed in Title 16 of the Texas Administrative Code, Part I. Railroad Commission of Texas, Chapter 13, Regulations for Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG). Chapter 117 exempts LNG as a hazardous liquid under its general provisions.[58]

[58] V.T.C.A. Natural Resource Code §117.001.

SECTION 4
PUBLIC CONCERNS

The three LNG facilities currently operating in New York State co-exist with their neighbors and in their respective communities without opposition or disruption of normal everyday activities. Consultation with the NYC Fire Department and with the operators of these facilities indicates that there is little or no public concern with or in opposition to these facilities. All are peakshaving facilities that are part of larger energy complexes and are generally not distinctly identifiable as LNG plants. All three of these facilities were sited before the accident at the Staten Island LNG facility in 1973. Moreover, the LNG that routinely is transported through the State has not generally been a cause for public concern.

Nonetheless, this does not mean that concerns will not be raised by citizens and governments of communities that are potential candidate sites for new LNG facilities. Some examples of concerns that could arise in such situations can be drawn from two LNG projects that recently received FERC certification.[59] The LNG peakshaving plant in Guilford County, NC has obtained the necessary Federal and State approvals and is under construction. A LNG storage facility in Wells, ME, has been proposed and is still under regulatory review. The public comment/hearing processes for these facilities reveal some consistent public concern themes. The following list illustrates typical concerns raised in these projects:

- Impact on property values and potential conflict with other community activities, land use plans or future development.
- Facility safety and potential accident consequences, fire hazards, emergency response.
- Potential for and impact of future expansion.
- Adequacy of the public notification and participation processes.
- Site suitability, including seismic hazard and evaluation of alternative sites.

[59] *Evaluation of Liquid Natural Gas Safety Issues*, Project Technical Liaison Associates, September, 1998, page 7-1.

- Impacts of construction activities, including increased traffic and blasting effects.
- Environmental impacts, including effects on water resources, wetlands, vegetation wildlife, and air quality.
- Visual impacts and impacts on cultural resources.

Many of these concerns are not unique to LNG facilities but are frequently raised in siting other large facilities, such as solid or hazardous waste management facilities and large industrial or commercial complexes.

For new LNG facilities, project sponsors will be challenged to satisfactorily address concerns of this nature if they are to achieve a sufficient level of community support or acceptance to allow the project to proceed. Experience with other facilities suggests that certain actions will enhance a project's chance for success. These include actions which are designed to:

- Involve the local community, citizens, citizen groups, government organizations, and other interested and potentially affected parties in the planning and development process as early as possible. Project sponsors should be willing to provide the necessary resources to facilitate active local participation.
- Prepare and explain facility safety programs with local concerned citizen groups.
- Be open and respond to local concerns and comments. Be willing to meet local needs whenever feasible.
- Work closely and cooperatively with local regulatory agencies and seek local oversight of construction and operation.
- Seek to identify and implement mitigation measures to balance real and perceived impacts of the proposed new facilities, including providing voluntary enhancements to local assets (i.e., parks, fire departments, schools).

SECTION 5
CURRENT LNG STATUS IN NEW YORK

EXISTING PEAKSHAVING PLANTS

The three existing LNG peakshaving plants are located in downstate New York State and provide added natural gas distribution system operational flexibility while reducing the need for additional pipeline capacity. These plants are a source of critical "needle peak"[60] gas supplies during high demand winter periods, typically when temperatures fall below 10°F or 15°F. During those times, LNG is removed from the storage tanks, vaporized, and sent out to supply system requirements, which results in costs savings compared to other alternatives to meet this same need.

Liquefied natural gas has been used as a needle peaking supply in the Greater New York City Metropolitan area since 1968. It represents approximately 23%, and 14% of the Design Day,[61] delivery capabilities for Brooklyn Union in its New York City and Long Island territories,[62] respectively, and 18% for Consolidated Edison of New York, Inc. However, in terms of annual volumes, these plants provide less than 1% of the winter season supplies available to these companies.[63]

Since needle peak loads occur during a small number of days per year, the annual cost of meeting this need with an LNG peakshaving plant is significantly lower than the annual cost of available alternatives. While an LNG plant provides a significant daily quantity of gas for a few days per year, the alternatives for providing the same daily volumes generally involve pipeline capacity

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60 The term "needle peak" refers to events that occur during only a small number of days per year (i.e., 5-10 days), as opposed to the general winter season demand increase, which is met through conventional storage services.

61 A "Design Day" is one during which the coldest temperatures and highest loads are expected to occur, based on planning criteria developed from historical patterns that vary from company to company.

62 LILCO and Brooklyn Union have merged and are now operating as KeySpan.

63 Typically, the LNG storage capacity of these plants will provide approximately five or six days of revaporized gas at the design send-out rate, the volume of gas scheduled for delivery to consumers for a given day.

commitments for the entire winter season or year. Thus, even though the unit cost (cost per volume of LNG) is higher than alternatives, the annual cost is lower.

Peakshaving Plant Characteristics

Brooklyn Union operates two LNG facilities. One is in Holtsville, NY in the center of Suffolk County and was formerly operated by LILCO. It occupies approximately 16 acres of an 85-acre site south of the Long Island Expressway and north of Union Avenue. A KeySpan generating facility and electric substation and a New York Power Authority generating facility are also located at the site. The LNG plant was constructed between 1969 and 1971, when it began commercial operation. It is designed to liquefy natural gas at a rate of 3 mtd/d thousand decatherms per day[64], and vaporize the gas for send-out to the system at a rate of 100 mtd/d.

The LNG storage tank at this facility has a design capacity of 600 mdt. It is a double-walled tank, with an inner cryogenic tank[65] constructed of 9% nickel steel and an outer tank shell of normal carbon steel. A four-foot insulated annular space between the inner and outer shells is filled with perlite and kept under a nitrogen atmosphere. The tank is surrounded by a containment dike that measures 550 feet by 550 feet (inside bottom wall dimensions) and is 20-feet high at the center of the dike wall[66].

Brooklyn Union also operates a dual-tank LNG facility in the Greenpoint section of Brooklyn, NY. The plant has a liquefaction capability of approximately 5 mdt/d and can vaporize gas for send out at a rate of 280 mdt/d. It is located within Brooklyn Union's 110-acre Greenpoint Energy Center, which also includes buildings and facilities for company personnel involved in various

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[64] A dekatherm (dh) has a heating value of 1,000,000 British Thermal Units (Btu); one thousand cubic feet (mcf) of natural gas contains approximately 1.03 dh.

[65] A cryogenic tank is constructed of material which is able to withstand very low temperatures such as the temperature of LNG, which can be as low as minus 260 degrees Fahrenheit, and still maintain its ductile and toughness properties.

[66] The purpose of a dike is to create an impounding area to minimize the possibility that an accidental discharge of LNG from the storage tank it surrounds would endanger adjoining property, facilities or waterways. In the dike the liquid would turn into a gas, the dispersion of which can be better controlled.

other operations, a meter operations shop, transportation garage, storeroom, and laboratory. The Energy Center is bounded on three sides by primarily industrial areas and by Newtown Creek on the east.

The initial Greenpoint LNG tank, with storage capacity of 600 mdt was constructed and commenced service in 1968. A second tank was built in 1971, with a storage capacity of 1000 mdt. Each of these tanks consists of an inner cryogenic tank of 9% nickel steel and an outer carbon steel shell. An insulating annular space is filled with perlite and kept under a nitrogen atmosphere. Each tank is surrounded by an inner and outer dike. Tank 1 has an inner dike measuring 305 feet square with a height of 21 feet and an outer dike, which measures 802 feet by 551 feet and is 5 feet high. Similarly Tank 2 has comparable spill protection. It has an inner dike measuring 329 feet square with a height of 32 feet and an outer dike that measures 645 feet by 678 feet and is 6 feet high. The facility also has a LNG truck loading/unloading station that is idle because the New York City Fire Department regulations prohibit the transportation of LNG within the City.

Con Edison operates an LNG facility in Astoria, Queens, NY. The plant occupies 22 acres within the company's 316-acre Astoria Plant complex and does not directly border any city streets. Also located at the site are three steam electric generating units, several electric substations, an oil storage depot, a central wastewater treatment facility, a chemical laboratory, a transformer shop, a transportation building, and storage facilities. The LNG plant was constructed between 1971 and 1974, when it began operation. It has a liquefaction capability of 5 mdt/d and can vaporize gas for send out at a rate of up to 240 mdt/d.

The Astoria LNG storage tank at this facility has a capacity of 1000 mdt. Both the inner and outer tank walls are constructed of cryogenic 9% nickel steel and the tank is protected by a 10 feet thick reinforced concrete wall. It is surrounded by a containment dike that measures 400 feet by 400 feet and is 20 feet higher than the base of the tank.

Safety and Operational Considerations

In addition to the safety design features of the cryogenic steel tank, emergency automatic shutdown capabilities, and dikes for containment of minor or major LNG losses, there are three major safety systems at each of the three LNG plants. Those systems address the areas of fire protection, gas detection, and plant security. Each of the plants also complies with the safety requirements of all applicable Federal, State, and municipal codes and safety requirements. The plants are audited by DPS safety staff to verify compliance with State and Federal safety codes. There are documented procedures for each operating, maintenance, and testing function, which are designed to ensure safe and reliable operation of the facility and to mitigate the consequences of equipment failure and human error. Those procedures and any subsequent modifications to them are submitted to the DPS for review and approval.

The three existing plants have an unblemished safety record over the 24 to 30 years that they have operated. No LNG-related incidents resulting in injuries, fatalities, or significant spills of LNG at New York facilities have occurred over this time period. Specific safety features of each of the three LNG plants are described in Appendix B.

Alternatives to LNG gas supply

The primary alternatives to the use of LNG are long-line interstate pipelines from the production area or natural gas storage service.[67] These options involve a variety of costs including the payment of demand and volumetric charges for long-line interstate pipeline capacity, or a demand charge for storage capacity, payment of variable costs for injecting gas into and withdrawing gas from storage, and the payment of demand and volumetric charges for pipeline capacity to deliver gas to and from storage. The cost of constructing and operating LNG peakshaving plants within the local distribution company's (LDC) service area is generally much less than these alternatives for equivalent daily volumes.

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[67] Another possible alternative is essentially a capacity-sharing arrangement with a large customer (e.g., a power generator) that has a contract for firm upstream capacity and is willing to make that capacity available during the winter to meet peak loads.

Since fixed costs for a peakshaving plant are substantial, ranging from $4 million to $12 million per year,[68] the unit cost of the facility varies significantly with the extent of plant use. For example, operating a LNG plant at full capacity for only one day during the winter would yield gas supply at approximately $40 to $50 per dt. However, if a LNG plant were used to the full extent of its winter output capacity, the unit costs would be in the range of approximately $7 to $8 per dt.[69]

In comparison, the unit cost of existing long line interstate pipeline capacity is in a range of approximately $0.50/dt at a 100% load factor[70], while the cost of new incremental pipeline capacity could exceed $1/dt. The unit costs of existing storage options (storage capacity and pipeline capacity to deliver gas to and from storage) are in the range of $1.50/dt (when fully utilized), while the cost of new storage capacity could be considerably higher.

Since unit costs of various supply sources vary directly with the extent that the respective facility is used, such comparisons can be misleading. For this reason it is reasonable and informative to compare alternative natural gas supply sources on a total cost basis.

The total annual cost of using a LNG peakshaving plant to supply its maximum annual capability (one cycle of the tank) ranges between $5 and $13 million. In comparison, the total annual cost of existing capacity on long-line gas transmission system (when sized to provide the same amount of daily capacity as the existing LNG plants) would be $19 to $48 million. The total annual cost of existing storage alternatives (when sized to provide the same amount of daily capacity as the existing LNG plants) is in the range of $17 to $43 million. [71]

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[68] These fixed costs include operations, maintenance, and depreciation expenses as well as return on and of equity, and taxes.

[69] These cost estimates are exclusive of the gas commodity itself and assume KeySpan LNG peakshaving plants represent a 6-day winter gas supply.

70 When used at full daily volumes throughout the year.

[71] It should be noted that these alternatives are only presented to give a general sense of the relative economic benefit of using LNG. While such alternatives can be sized to provide the same daily delivery capacity as an LNG plant, in reality they would not provide the same responsiveness and ability to meet hourly variations in load and, therefore, these cost comparisons understate the benefits of LNG plant use.

In addition to economic benefits, LNG peakshaving plants also provide system operational benefits. Since these plants are located within the local distribution company's (LDC) service territory they provide the flexibility to respond quickly to unexpected changes in hourly demand (e.g. caused by sudden changes in weather) or temporary disruptions in supply deliveries.
In limited circumstances, a LNG plant also may be operated to allow the LDC to maximize the value of upstream capacity assets. By relying on LNG to meet short term demand variations the LDC may be able -- if its need for, or ability to use the plant for its primary purpose is not impaired -- to release more upstream capacity on the secondary market or increase the use of upstream capacity to make off-system sales, thus achieving additional secondary economic benefits.

OTHER USES

Currently, consumers and businesses in New York do not consider LNG when selecting a fuel to satisfy their energy requirements. The existing moratorium on LNG activities effectively has deterred end-users from evaluating LNG as a energy resource to fulfill their energy needs. In New England, however, LNG has made some in-roads as a fuel in industrial applications at locations not near a natural gas pipeline. Since the late 1960s the Pratt and Whitney plant in East Hartford, CT has relied on LNG from the Distrigas import terminal in Massachusetts. In the second half 1997, Foss Manufacturing in Hampton, NH contracted with the same import terminal to add LNG to its energy resource mix.

TRANSPORTATION RESTRICTIONS

New York State and New York City laws currently restrict the interstate transportation of LNG. At the State level, the present LNG moratorium has discouraged the DOT and DEC from establishing approved dedicated routes for the highway transport of liquid natural and petroleum gas in a cryogenic state. Moreover, Sections 23-03, 40-04, and 40-07 of the Regulations of New York City impose a ban on the transportation of LNG within the City. [72]

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[72] Boston, MA is the only other municipality in the Northeast with a ban on LNG movement comparable to the New York City practice.

Even with these restrictions, LNG currently is transported on several Interstate Highways in New York, often by New York-based common carrier companies. LNG is carried from the Distrigas import terminal in Massachusetts to destinations in New Jersey, Pennsylvania, and other states as far south as South Carolina. LNG also is shipped in the opposite direction from the New Jersey Transco Carlstadt facility into New England. These LNG movements result in highway travel through New York and are authorized under provisions of the Federal Interstate Commerce Law. Typically, such movement of LNG involves U.S. Route 95, 84, 17, and 87, and the Tappan Zee Bridge.

SECTION 6

SAFETY

The discussion of LNG safety issues is based largely on the report *Evaluation of Liquefied Natural Gas Safety Issues* prepared by Project Technical Liaison (PTL) Associates. Project Technical Liaison Associates prepared this analysis for the New York State Energy Planning Board under contract with the New York State Energy Research and Development Authority. The findings contained in the PTL report are shown below:

- Given its physical and chemical properties, LNG is inherently no more dangerous than competing fuels.
- LNG facilities have an excellent safety record. Over the last 25 years, in the 100 facilities operating in the United States there have been less than 10 accidents, resulting in few injuries and one fatality. This compares favorably with the safety record of facilities for competing fuels.
- As with competing fuels, the possibility of a major accident exists where large amounts of LNG are produced, transported, or transferred.
- LNG shipping, notwithstanding an excellent worldwide safety record, represents the largest potential for accident. Industry history indicates that the probabilities of such an accident are low; however, the consequences could be severe.
- Third-party instigated risks are of significant concern. Terrorist-type activities are improbable but are of such consequences that prudent countermeasures are appropriate.
- Since the adoption of 49 CFR Part 193, a comprehensive and stringent regulatory regime has existed at the Federal level for covered facilities. These regulations, when carefully implemented and enforced, provide a sufficient basis for safe operation. Residual risk arises from human error and deviations from procedures.
- The 1971 development of the NFPA 59A Standards for the Production, Storage, and Handling of LNG, and their frequent revisions, further complement the. existing regulatory framework, particularly when states adopt these standards as in New York.

The LNG industry has a good safety record. The over 100 facilities operating in the United States have had less than 10 accidents, resulting in a few injuries and only one fatality, in the past 25

years.[73] This record compares favorably with the safety records of facilities for competing fuels. Two earlier accidents, which took place in Cleveland in 1944[74] and in Staten Island in 1973, greatly influenced the public's perception of LNG safety. The Staten Island accident was a major factor in the Legislature's decision to initiate the moratorium in 1978. Since those accidents, extensive new safety regulations have been developed and put in place in New York and nationwide. Both the Cleveland and Staten Island accidents could have been prevented if the facilities had used the specific materials and followed operating procedures that are required today.

STATEN ISLAND ACCIDENT[75]

The Staten Island facility was a peakshaving plant consisting of a 24-million gallon tank that was internally insulated and lined. Texas Eastern Transmission Company constructed the facility, which was near grade with an earthen berm that provided the safety features characteristic of in-ground storage. The design of this facility was the result of years of research and development as well as a tank experiment at Battelle Memorial Institute.

In February 1972, after experiencing high boil-off rates, the operators suspected that there was a possible leak in the tank and it was taken out of service. Over the next 12 months, the LNG tank was emptied and tears were found in the Mylar lining. During the repair stage in February 1973, a fire created enough internal pressure in the tank to lift the roof. As the roof lifted, which was consistent with engineering design specifications for the facility, the internal pressure vented and the roof fell back into the tank.[76] This accident resulted in the death of 40 workers caused by

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[73] One fatality occurred in the 1979 Cove Point, MD accident, which involved the ignition of LNG vapors that had traveled through electrical conduit and accumulated in an enclosed area after a leak in a pump.

[74] The most catastrophic of accidents was at the Cleveland peakshaving plant in 1944, which resulted in 133 employee and public casualties, when there was a failure in the inner tank. The failure of the inner tank was due to the industry's general inexperience with metals at cryogenic temperatures.

[75] *Evaluation of Liquefied Natural Gas Issues* report, PTL, September 1998, discussion of the Staten Island LNG plant accident description on page 8.5.

[76] Ibid, PTL, page 8.6.

asphyxiation and body crushing, but there was no damage outside of the tank. No explosion was involved in the accident.

Despite considerable investigation of this accident, including 1973 hearings in the House of Representatives,[77] information regarding the cause of the accident was inconclusive, in part because of litigation. Testimony at the hearing did indicated that analysis of the tank insulation revealed nitrogen, freon 11, and oxygen, and not LNG vapors, were absorbed in the insulation and contributed to the fire. What has been determined is that:

- The tank had been purged of any residual LNG vapors.
- The flame spread of the mylar/aluminum membrane had been tested on a horizontal surface, but not in a vertical configuration as installed in the tank.
- A highly volatile, low ignition temperature solvent, possibly methyl ethyl keytone (MEK), was being used to clean the membrane.
- Equipment that was capable of producing sparks was employed in the repair of the tank.

The most plausible explanation for the accident is that an unknown source ignited the cleaning vapors, which in turn ignited the mylar liner. The mylar in its upright position burned much faster than in the tested horizontal position and caused the polyurethane foam to ignite. The resultant fire caused the temperature in the tank to rise, generating enough pressure to dislodge the 6-inch-thick concrete roof, which then fell on the workers in the tank.

The government regulations and industry operating practices now in place would prevent a replication of this accident. The fire involved combustible construction materials and a tank design that are now prohibited. Although the exact causes may never be known, it is certain that LNG was not involved in the accident and the surrounding areas outside the facility were not exposed to risk.

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[77] Hearings were convened before the Special Subcommittee On Investigations of the Committee On Interstate And Foreign Commerce, House of Representatives during the July 10 to 12, 1973 period.

POTENTIAL LNG HAZARDS AND CAUSES

Potential hazards with LNG activities and facilities result from direct exposure to fire, the thermal radiation generated by a fire from an ignited release of LNG, or the formation of a cloud of vapor. An accidental release of LNG would need to occur before any of the hazards could be realized. Adherence to applicable regulations and accepted industry operating practices makes realization of these hazards extremely low.

Direct exposure to fire and thermal radiation from ignited LNG is the primary hazard. To address this hazard, specific Federal regulations (49 CFR Part 193.2057) and industry operating standards relating to the design and siting of new LNG facilities have been adopted to ensure that LNG facilities are located on sites with suitable topography, size, and configuration to minimize any hazard to individuals and property. Additionally, LNG tanks are required to be located within a dike or surrounded by an impoundment area large enough to hold the entire contents of the tank if a spill was to occur. A thermal exclusion zone, which is a specific distance (calculated from the Gas Research Institute's Thermal Radiation Model) from the impoundment area to the LNG facility property line, is also required. This zone must be large enough to prevent the heat of an LNG fire from adversely affecting conditions beyond the LNG plant property line.

Another potential hazard of an LNG spill is the formation of a vapor cloud that could be carried away from the site by wind. The vapor cloud could be an asphyxiant at concentrations above 50% and could become flammable when mixed with the proper amounts of air. A unique characteristic of an LNG vapor cloud is that they are generally visible under normal humidity conditions providing an indication of a hazardous area[78] and the direction of the LNG dispersion.

The final hazard is explosion: the sudden release or creation of pressure and generation of high temperature resulting from a change in the chemical nature of the fuel. A requirement for a methane explosion is either total confinement (as in a closed room) or partial confinement (as in a very dense field of obstructions). The inability of unconfined methane clouds to explode is due to the low laminar flame speed at which a flame will move through a mixture of methane and air.

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[78] PTL report, Section 9, page 3.

Flame speeds are too slow to produce the pressure needed for a significant over pressure in unconfined areas. However, in partial confinement, a flame front can accelerate, generating turbulence, and, ultimately, a dangerous pressure front and over pressure.[79]

There are actions operators of stationary facilities, which comply with government and industry regulations and standards, can practice to minimize the potential for a LNG explosion. Hazard detection equipment, such as vapor, fire, and low temperature, should be installed and monitored. Fire protection and suppression systems should be installed, maintained, and tested periodically. Also, emergency response plans and drills should be tailored to individual facilities and coordinated with local safety agencies.

Although some of the earlier accidents involving LNG were caused by using materials that were not appropriate for LNG storage (i.e., non-cryogenic resistant alloys), the primary cause of accidents is human error. In fact, human error is generally recognized as the major cause of industrial accidents.[80] A good training program coupled with strict enforcement and operating procedures are needed for accident prevention and to mitigate the consequences of an accident in the unlikely event that it occurs.

STORAGE SAFETY

Large storage tanks represent the greatest land-based hazard because of the large volume of LNG stored in them.[81] The primary safety issues regarding large storage tanks are the prevention of a catastrophic tank failure, minimizing the release of LNG, and the minimization of the consequences in the unlikely event of a LNG release. Large LNG storage tanks must be built to specific Federal requirements in the United States and situated in a manner that creates a buffer or exclusion zone around the facility. Smaller stationary facilities have a potential for lower volume

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[79] PTL report, Section 9, page 5.

[80] PTL report, page 9-10.

[81] Ibid. Section 4, page 3.

releases but the likelihood of a LNG spill is not necessarily less. Smaller facilities tend to have more activities such as truck unloading, which increases the possibility of a release.

Containment is a critical design consideration in storage systems. A double-containment system has been the mainstay of the LNG industry. This system involves an inner tank as the primary source of containment. The outer tank, which is generally constructed of carbon steel, serves no containment function but does provide insulation and a gas seal. Also, the outer tank is surrounded by low earthen dikes that serve to reduce thermal radiation and vapor dispersion if a leak were to occur.

Specific construction materials are an important safety consideration in the design of LNG equipment. Nickel and stainless steel are used for structural applications, such as LNG tanks, primarily because of their ability to function well at very low temperatures. Other cryogenic applications may use aluminum alloys that have a low fabrication cost, are lightweight, have a stable crystal structure, and good retention of strength and toughness at low temperatures.

TRANSPORTATION SAFETY

A major advantage of LNG's density is that it offers an alternative to non-pipeline distribution of natural gas. The major transportation modes of LNG are ocean-going ships, highway trucks, barges, and, to a limited extent, rail transport.

Though LNG is transported to the United States from Algeria and from the United States to Japan, there is no marine transportation of LNG within the Unites States.[82] Marine transport of LNG has advanced considerably since its inception in 1959 because of the increasing demand for LNG worldwide. Currently, there are 102 LNG ships in service and approximately 14 planned or under construction.[83] Ocean-going tankers can carry approximately 40 million gallons of LNG, or the equivalent of 3.32 billion cubic feet of natural gas, in one trip.

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[82] *LNG Vehicle Markets and Infrastructure*, Gas Research Institute, Contract No. 5096-940-4017, March 1998.

[83] *The 1997 World LNG Source Book: Encyclopedia of the World's LNG Infrastructure*, The Institute of Gas Technology, Chicago and Zeus Development Corporation, Houston.

From a public risk standpoint, the hazards of shipping fall within two categories, those that occur in the harbor and surrounding coastal areas and those that occur on the high seas. However, in New York the potential for increased shipping appears extremely low at this time. Coastal area and harbor hazards include grounding, collision with another ship, and collision with stationary objects, such as a bridge abutment. Marine transfer of LNG requires a Coast Guard permit issued by the Captain of the Port under provisions of 33 CFR Part 127. The likelihood of a LNG release on the high seas is unlikely given the double hull design of the vessel.

Overland transportation of natural gas in both the compressed and liquefied state, by commercial vehicle, is a mature and well-regulated practice. Typically, LNG is transported between LNG peakshaving liquefaction plants, from peakshaving plants to remote satellite LNG storage facilities for vaporization and local distribution, or from LNG import terminals to satellite storage or industrial customers. In New England alone, there are approximately 300 scheduled LNG deliveries per week to satellite storage or industrial customers. According to Federal DOT reports from 1970-1990, LNG had the best safety record involving the accidental release of a hazardous material.[84]

The technology and equipment for trucking LNG is derived from the same materials used in the truck transport of other cryogenic industrial gases such as liquid nitrogen and oxygen. The design of the trailer for LNG transport consists of an inner tank made of cryogenic material, such as nickel or stainless steel, with an outer shell of carbon steel. Between these shells, the insulation material serves to isolate the cold LNG from outside temperatures. Special tank supports allow for static loads, dynamic loads, and the expansion and contraction of the inner shell. The primary structural element of the LNG highway trailer is the outer shell. Stiffening rings are incorporated in the outer shell to improve its structural strength and prevent its collapse. The center of gravity on a LNG tanker is high, which results in a greater potential for vehicle rollover than for most other highway trucks. While there have been LNG trailer rollover accidents, the trailer's doubled walled vessel has proven quite resistant to damage and loss of product. The June 1971 Westbury,

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[84] *Liquid Methane Fuel Characterization and Safety Assessment Report*, Cryogenic Fuels, Inc., Report No. CFI-16000, Dec. 16 1991.

VT LNG tank truck accident is the only rollover incident that resulted in the release of product.[85] Despite the release of 20% of the vehicle's cargo, no fire occurred.

Other modes of transportation include barge and rail service. The safety concerns related to barging are similar to those of large-scale shipping, primarily collision and spillage, but to a lesser degree. Rail transport has low feasibility as an option for transport of LNG as it is a time-sensitive product. Delays in scheduled train departures may cause heat transfer to the LNG cargo, which could raise the cargo saturation temperature and tank pressure resulting in excessive LNG boil-off.

While LNG is moved short distances via pipeline from the liquefier to the storage tank at a LNG facility, this is not a mode used for transporting the fuel from a supplier to a user. LNG plant pipelines are designed with great care given to materials, insulation, and thermal expansion and contraction of the pipe.

LNG-FUELED VEHICLE SAFETY

Crash tests on LNG automotive fuel tanks showed that the probability of an explosion due to impact with an LNG fuel tank is very small and that the double-walled LNG fuel tank is stronger and safer than a standard automotive gasoline tank.[86] A well-designed, well-constructed and properly mounted LNG fuel tank is unlikely to burst. A rupture of a tank with operating pressure of 20 to 30 psig would result in a small fraction of LNG (less than 10%) flashing to vapor, which would be quickly diluted by the ventilation air.

A major tank failure due to internal pressure appears to be only remotely possible.[87] A possible cause for over pressure could be the malfunction of several safety valves that control LNG flow. It is unlikely that a rupture would occur.

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[85] *Evaluation of Liquid Natural Gas Safety Issues*, PTL, September, 1998, pages 5.8 and 8.8.

[86] *Social Benefits Versus Technological Risk* Science, 19 Sept. 1969.

[87] *Careful Accident Assessment Key to LNG Storage Safety.* John J. Closner and Dr. Robert Parker, The Oil and Gas Journal, Vol. 76, No. 6, February 6, 1978.

Tests on highway vehicle LNG tanks have shown that a 40-mph relative speed rear-end collision might result in failure of the fuel tank mountings and some damage to the tank; however, it is unlikely that the tank would rupture.[88] If the LNG tank did fail, it would spill and potentially lead to a fire hazard rather than an explosion.

SAFETY TRAINING

LNG facilities that fall under 49 CFR are required to implement a written plan of initial training and an additional plan for continuing education. Written records of training sessions must also be maintained by the facility. However, the training provisions do not require operator licensing or certification and there is currently no mandated LNG licensing or certification program except in the state of Texas. The training syllabus is left to the discretion of the facility operator, but in many instances is approved by the Federal DOT. Training at LNG facilities generally covers proper operating and emergency response procedures. Studies have recommended better, more consistent training of other groups who may be working or have contact with LNG such as local fire service personnel, truck drivers transporting LNG, consumers who use LNG, and possibly the public living near LNG facilities.[89] The existing three LNG facilities in New York are recognized throughout the industry as operating exemplary training programs that could serve as a standard for other LNG facilities.

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[88] *Dual Fuel Motor Vehicle Safety Impact Testing*, Report No. DOT-HS-041-062, U.S. Department of Transportation, Washington, D.C. 20591, Nov. 1971.

[89] *Qualitative Risk Assessment for an LNG Fueling Station and Review of Relevant Safety Issues*, Nathan Siu et al, INEEL/EXT-97-00827 rev.2, February 1998 and "GRI Workshop on LNG Vehicle Technology", GRI 92/0330.

SECTION 7

OUTLOOK FOR EXPANDED LNG USE IN NEW YORK

POTENTIAL DEMAND BY ECONOMIC SECTOR

LNG holds the potential to expand in-State natural gas availability, create new businesses and manufacturing jobs statewide, provide a motor vehicle alternative to gasoline and diesel fuel, and in the future satisfy unique electric generation resource requirements.

LOCAL GAS DISTRIBUTION COMPANIES (LDC)

There are two traditional ways that LNG is used as a source of gas supply for delivery by LDCs:

- Peakshaving Plants - Pipeline gas is liquefied during the summer, stored, and revaporized during the winter to meet needle peak system demands.
- Import Terminals - LNG is imported in bulk, stored, and revaporized for use as a baseload gas supply source.

A third possibility is the use of portable LNG storage facilities to provide a temporary supply to a portion of a transmission or distribution system during a pipeline outage, or as a permanent supply source (resupplied via truck deliveries) for small, isolated distribution systems. Finally, portable LNG facilities can serve as a temporary source of natural gas to new customers while a distribution system is expanded or extended. Portable LNG equipment has never been used in New York State, but is available.

Future Role of Peakshaving

The natural gas market will likely have a growing need for peaking gas supplies, including needle peaking supplies. Natural gas has become the fuel of choice and natural gas demand is projected to grow significantly in the future.[90] Some LDCs serving markets that include a high proportion

90 The November 1998 New York State Energy Plan projects a near doubling of natural gas demand between 1996 and 2016 (see Section 3.0 Forecast Summary).

of heat-sensitive load have turned to LNG as an economic peak supply. In addition, as the natural gas market becomes more dynamic, peaking facilities may become more important to maintaining system reliability.

The structure of the gas industry has changed dramatically and will continue to do so as the industry evolves and becomes more competitive. As a result of a series of actions culminating in FERC Order 636,[91] with few exceptions, interstate pipelines no longer sell gas but instead provide delivery or "transportation" service of gas to LDCs[92]

The PSC, in promoting a competitive natural gas industry, now allows all LDC customers in New York to purchase gas directly from natural gas marketers, with the LDC providing delivery or "distribution" service to end users. Currently, approximately 40% of the gas delivered by LDCs in New York is purchased directly by customers from marketers. As more customers chose to purchase gas from alternative suppliers the role of LDCs as sellers or "merchants" of gas should diminish. In fact, the PSC has established a vision for the future of the gas industry in New York which indicates that the most effective way to establish a competitive market in gas supply is for LDCs to exit the merchant function.[93]

Non-LDC businesses likely will gain a growing share of pipeline and storage assets in the future to serve the merchant role. Further, it is likely that the use of the delivery system will change as new players employ different approaches to more efficiently use those assets. Potentially, LNG applications could represent economical options for these new companies.

A related question is who will perform the functions of system operator and supplier of last resort traditionally performed by LDC. As the number of gas suppliers increase, the need to ensure that

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[91] Order 636 - Docket No. RM91-11-000 - Pipeline Service Obligations and Revisions to Regulations Governing Self-Implementing Transportation Under Part 284 of the Commission's Regulations, and Docket No. RM87-34-065 - Regulation of Natural Gas Pipelines After Partial Wellhead Decontrol, issued April 8,1992.

[92] Similarly, the Transcontinental Gas Pipe Line Corporation owns and operates an LNG peakshaving plant in Carlstadt, NJ, that it uses to provide a peaking service (customers provide the gas).

[93] See Policy Statement Concerning The Future Of The Natural Gas Industry In New York State An Order Terminating Capacity Assignment issued and effective November 3, 1998 Cases 93-G-0932 and 97-G-1380.

sufficient capacity is available in the event that a supplier fails to perform becomes more critical. As a result, the need for assets to perform these functions will likely increase the importance of peaking services. While siting new LNG plants in major cities will be difficult, LNG facilities located near, but outside of, major cities may represent an economic alternative to meet peak requirements.[94] Given the ongoing changes in the gas industry, LDCs may become reluctant to make the capital investment needed to build these new liquefaction plants. However, it is important to provide the option to consider and pursue LNG plants to serve peak requirements.

FUTURE ROLE OF IMPORTED LNG

LNG is a global commodity. The potential for use of imported LNG as a base source of supply is influenced by several global factors that ultimately will influence the price at which LNG will be offered and determine its competitiveness in U.S. gas markets.

According to a DOE report,[95] not every country is a potential market for LNG. In general, the following criteria need to be met:

- Domestic energy resources must be limited or expensive. Domestic gas production must be very low or declining, with little prospects of future increases. As a corollary, pipeline imports of natural gas must be impossible or limited in potential quantity. Domestic coal production must be limited or costly.

- The domestic market for boiler fuel must be large and relatively concentrated--large enough, at a minimum, to absorb 250 to 500 million cubic feet per day of gas. If a large amount of new pipeline infrastructure is required to bring the gas to the consumers, the acceptable ceiling price for LNG may be correspondingly lower to justify construction of the infrastructure.

- Consumers may be willing to pay a premium for LNG if they believe it is important to reduce emissions of pollutants, particularly sulfur dioxide and carbon.

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[94] The current cost and competitiveness of new LNG plants will have to be examined by project sponsors on a site-specific basis.

[95] *Development Patterns for LNG Supply and Demand, Issues In Midterm Analysis and Forecasting*, July 1997, DOE/EIA-0607(97).

While five major LNG import terminals were built in the U.S., only two are now in operation as import terminals -- those located in Everett, MA and Lake Charles, LA.[96] These terminals were placed into service in 1971 and 1978, respectively, during a period of tight gas supplies, government price regulations, and the need for additional imports. It was during this period that LNG imports increased, peaking at 253 bcf in 1979.

Imported LNG used as a base source of gas supply can also provide economic and system operational benefits. These benefits are especially true for market areas with the need for additional gas supplies but with limited access to pipeline capacity and for market areas where the cost of gas pipeline deliveries are relatively high (i.e., at the end of the pipeline). Further, the introduction of a large volume of gas at the end of a pipeline system can increase the operational flexibility of the delivery system and, if priced competitively, place downward pressure on gas prices. For example, the LNG import terminal located in Everett, MA provides an incremental supply of gas for the New England area and also provides important peaking supply benefits. [97]

Worldwide demand for LNG is expected to increase significantly in the future. However, the growth is expected mostly in those countries with limited access to other sources of gas supply that currently are the biggest users of LNG, such as Asia and Western Europe. While U.S. LNG imports are expected to increase in the 2005-2010 period, they are expected to remain within the capacity of the existing LNG import terminals and to be confined to those regions now dependent on these terminals.

The interstate pipeline infrastructure serving New York State has expanded significantly over the last decade, and numerous proposals have been announced for further expansion of pipelines in the Northeast. As a result, pipeline gas supplies are readily available on a competitive basis. Overall these factors tend to support growing worldwide use of LNG and growth in LNG imports to the U.S. While such imports are forecast to double between 1996 and 2002 to more than 130

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[96] The Cove Point, MD facility has been operating as a peaking plant with its own liquefaction capability; the Elba Island, GA facility is mothalled and not scheduled for operation through 2000; and a LNG import terminal was built at Rossville, Staten Island, NY but never certificated.

[97] Another example of using imported LNG to satisfy a regional peak demand is the Boston Gas Company LNG plant, which was completed in 1968 and received imports from 1968-1973, but now is operated as a peakshaving facility.

bcf, these volumes will remain small relative to total domestic gas consumption. It is conceivable, but not likely, that a combination of factors could result in LNG becoming more competitive as an alternative base source of gas supply.

INDUSTRIAL OUTLOOK

Despite the relatively low market penetration of LNG nationwide, there are several New York companies involved in various aspects of the LNG industry whose ability to market LNG products in New York are affected by the moratorium. An example of New York firms involved in the LNG industry include:

- Cummins Engine Co., Inc. has a large manufacturing operation in Lakewood, NY. The company recently announced that 1997 sales of natural gas engines, which operate on LNG or compressed natural gas depending on engine and tank configuration, increased by 32%. Cummins alternative fuel engines now power over 2,600 vehicles in various bus and truck fleet applications operating in revenue service today.

- Snyder Tank Corp. is a Buffalo-based manufacturer of tanks used in LNG vehicles. Snyder was established in 1939, has nearly 150 employees, and is the industry's largest fuel tank manufacturer.

- Air Products and Chemicals, Inc. has three small manufacturing operations in New York and is a world leader in designing liquefaction systems and supplying main cryogenic heat exchangers for the LNG industry. According to the company, 11 of 14 LNG plants currently operating or under construction and representing over 90% of the world's baseload LNG capacity have selected Air Products' liquefaction process technology and equipment.

The growing demand for advanced energy equipment and engines that operate on alternative fuels could lead to business and job opportunities in New York. On June 5, 1998, Brookhaven National Laboratory selected Snyder Tank Corporation in Buffalo to receive a $453,000 Federal grant to design, manufacture, and test a new LNG fuel tank for heavy-duty trucks and buses. Brookhaven hopes to enhance the development of LNG fuel storage systems and improve the potential of LNG as an alternative fuel. CFIC Inc. in Troy, NY has contracted with DOE to conduct an economic study and proof-of-concept evaluation of a linear orifice pulse thermal resonator (LOPTR) liquefaction system. "The LOPTR has application for the recovery of stranded and remote natural gas. Upstate New York has significant amounts of stranded gas

reserves, which if recovered using the LOPTR system or another low-cost liquefier, would provide the State with greater indigenous energy resources and associated economic benefits."[98]

Other projects in New York include:

- Carlyle Compressor Division of Carrier Corp. in Syracuse is producing a twin-screw compressor to be used by the Institute of Gas Technology's design for a low-cost liquefier.
- Brookhaven National Laboratory is setting up an LNG experimental station to study high-pressure fuel-delivery systems at SUNY Farmingdale.
- Long Island Clean Cities Coalition in Hauppauge is designing an LNG fueling station with Brookhaven National Laboratory.
- Acrion Technologies, Inc. is developing a cleanup and liquefaction system to recover natural gas from landfills at the Al Turi (Goshen) landfill. This technology will integrate a carbon dioxide wash design with methane liquefaction.[99]

LNG portable pipelines consisting of LNG highway transport trailers and portable LNG vaporizing equipment are an evolving technology that could help satisfy customer natural gas demand and service continuity requirements. Typically, this technology is used by suppliers to supplement pipeline natural gas deliveries to meet a customers peak demand. Additionally, potable pipelines can support an extremity of a distribution system that is undersized to serve peak seasonal system loads. Each portable pipeline project is unique, requiring an assessment of onsite conditions and the selection of the appropriate complement of equipment and manpower to get the job done.[100]

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[98] Wegrzyn, James, E., *Overview of LNG Technology in the Transportation Sector*, Brookhaven National Laboratory, Upton, NY, 1998, page 4.

[99] Ibid. Page 2.

[100] Victor Baur, and Charlie Buckley, Transgas, Inc., Lowell, Mass., *LNG Portable Pipeline Service Provides Options for Uninterrupted Gas Supply*, LNG Express, July 1997, Vol. VII, No. 7., page 5.

LIGHT- AND HEAVY-DUTY VEHICLES

Currently, 60 LNG transportation projects worldwide power more than 700 vehicles that range from light duty passenger cars to full-size locomotives. There also are 120 LNG transport trailers with a capacity of 11,000 gallons that make 10-15,000 deliveries annually.[101] In the U.S., several medium- and heavy-duty vehicle LNG demonstration projects are now underway.

Buses are excellent candidates for using LNG because they operate over a fixed route, have high fuel usage, and may be able to lower their operating costs by potentially generating emission reduction credits.[102] There are many large, long-haul trucking companies with the resources and energy demand that could justify investing in LNG. The American Trucking Association is coordinating activities on an industry wide basis.

State Transportation Examples

The nearest LNG demonstration transportation projects to New York State have been in Pennsylvania and Maryland. USA Waste, in Washington, PA, operates the William Martin Landfill site, which has four LNG trucks, with another three to be added by the end of 1999.[103] The trucks will be evaluated over a three-year period to compare the alternative fueled vehicle to a conventional fuel vehicle. The same group also funded a LNG fueling station. LNG will be supplied by various outside producers as well as from landfill sites.[104]

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[101] Conversation with Bob Nimmocks of Zeus Development Corporation, Houston, TX, 6/19/98.

[102] EA Engineering, Science, and Technology in "The Maryland Mass Transit Administration Demonstration of Liquefied Natural Gas Buses" report concluded that LNG bus emissions would be less than EPA emission standards, which could generate emission reduction credits, page ES-3.

[103] The project, which is managed by the American Trucking Association, is funded through a public/private partnership with the American Trucking Association Foundation, USA Waste Services, Inc., the U.S. DOE's National Renewable Energy Laboratory, the Pennsylvania Department of Environmental Protection, Columbia Gas System, Consolidated Natural Gas, Pacific Gas and Electric, and the Gas Research Institute.

[104] "Underground LNG Storage Tank Built in Pennsylvania", *The Clean Fuels Report*, November, 1997, page 111.

The Maryland Metropolitan Transit Authority (MTA) conducted a LNG bus demonstration program. A temporary fueling facility was constructed using a 3,000-gallon LNG storage trailer parked in a safety basin and connected to a transit-scale refueling island by insulated fuel lines. The fuel for this demonstration was supplied by Baltimore Gas and Electric from the Spring Garden, MD LNG plant. The fueling facility and the vehicles performed well, but the capital costs related to convert the entire MTA 240-coach fleet and complete bus garage modifications were estimated in the $2.6 million to $10.8 million range. This expense was deemed prohibitive and prevented the project from moving to fruition.

Other state projects include:

- **Texas:** Four major cities use LNG in their transportation authorities. The Dallas-Area Rapid Transit (DART) Authority has built an LNG storage and fueling facility (30,000 gallons) to supply 210 LNG buses during the summer 1998 through 2000 period. Houston METRO converted 242 buses to LNG and has a fueling facility that has two 27,200-gallon LNG storage tanks and four 60-gallons per minute (gpm) centrifugal LNG pumps that can fuel two buses simultaneously. The City of El Paso has 77 full-size LNG buses that consume 9,000 gallons daily. The El Paso refueling facility has multiple fueling dispensers, an estimated 60,000-gallon storage tank, and three additional 22,000-gallon capacity vertical tanks. The facility also refuels 30-40 light-duty CNG vehicles by converting LNG to CNG.[105] The Greater Austin Transportation Company (GATC) has 30-40 light-duty LNG buses in operation. Based on estimated usage, the Texas transit agencies will lead the nation in total LNG consumption at almost 30,000 gallons daily.[106]

- **California:** Los Angeles International Airport (LAX) has 40 heavy-duty transit vehicles that use LNG and LAX's five-year plan calls for 100% of the bus fleet to operate on LNG by the end of the century. Raley's Supermarkets and Drug Centers (a chain of stores in California) has eight LNG trucks in its fleet and a 13,000-gallon refueling facility.

- **Arizona:** The Phoenix Public Transit Department currently has 120 LNG buses in service with plans to add another 158 buses. The buses average 175 miles per day consuming 103 gallons for a total daily fleet LNG usage of 12,400 gallons. The fleet also has 15 LNG mini-vans. Currently, the fleet has one fueling station

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[105] Conversation with Bob Nimmocks of Zeus Development Corporation, Houston, Texas, 6/19/98

[106] J.E. Sinor Consultants Inc., " Texas Transit Agencies Headed For 30,000-Gallon Per Day LNG Consumption: Liquefied Natural Gas", *The Clean Fuels Report*, Volume 9, Number 4, September 1997, page 97

for the mini-vans and a skid-mounted fueling station capable of fueling one bus at a time. The Transit Department is currently preparing for the construction of a permanent turnkey operated station.[107] The Tempe Transit System operates 16 LNG buses and anticipates that an additional 44 buses will be in service in 1999.

Barriers to LNG Use in Vehicles

Lack of an infrastructure, in part reflective of the infancy state of LNG as an alternative fuel, is one of the major barriers to increased use of LNG in the New York transportation sector. Elements of a LNG infrastructure would include liquefaction facilities, storage capacity, re-gasification capability, and refueling stations. Although construction of such an integrated alternative fuel system is receiving less attention than present government and industry efforts to modernize the gasoline/diesel delivery system, one regional LNG system is moving forward.

This regional effort includes Las Vegas, Reno, Los Angeles, the San Joaquin Valley, Sacramento, San Francisco and Salt Lake City which have been developing a western "clean corridor" of public LNG fueling sites since May 1998.[108] The driving force that will support the emergence of such systems is the decision of sufficient centrally fueled fleets to operate LNG vehicles. The network eventually could extend through Utah into Colorado and from New Mexico into Texas, where an LNG refueling infrastructure is already in place and expected to expand because of a new Lone Star Energy and Amoco joint LNG marketing venture announced in November 1995. This alternative fuel highway is called the Interstate Clean Transportation Corridor (ICTC). "The corridor will span more than 2,000 miles and include routes I-80, I-5, CA-99, I-10, and I-15."[109]

Small-scale liquefiers are needed to resolve the dilemma created by long distances between some emerging LNG markets and existing LNG plants. These liquefiers could be developed using in-state gas reserves (stranded or remote). The developing market and natural gas vehicles (NGVs)

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[107] *Liquefied Natural Gas & Liquefied To Compressed Natural Gas Fuel Station: City of Phoenix,* Phoenix Public Transit Department

[108] Port, David, Hot Stuff: "A look at some of the best, most promising NGV markets and products," *Natural Gas Fuels*, Volume 5, Number 1, January 1996, page 19

[109] *Clean Fuels Corridor to Span Three States, Alternative Fuels Today:* A Daily News Summary Covering Natural Gas, Propane and Biofuel Vehicles, July 6, 1998, page 2

technology advances could create opportunities and incentives for lowering liquefaction facility installation costs. The recent growth in LNG demonstration programs and dedicated LNG fueled fleets is promoting a demand for small "shop-assembled" liquefiers in the 3,000 gallon per day capacity range.[110]

Another barrier is the incremental costs of LNG fueled vehicles compared to standard vehicle prices. Recent purchases from the Dallas and El Paso bus companies indicate incremental costs for LNG vehicles are large. DART (Dallas) purchased 110 LNG units from NOVA Buses in April 1997 for $318,175 each, which represented an incremental cost of more than $35,540. Each bus was equipped with a high-pressure fuel system and three LNG tanks that hold 186 combined gallons (gross volume). Alternately, similar low-pressure fuel system buses with an 180-equivalent-gallon fuel supply would have an incremental $15,000 cost. Sun Metro (El Paso) reported that it purchased thirty 25-foot Blue Bird para-transit coaches in June 1997 for $1.2 million. Sun Metro estimated that the incremental cost for these LNG para-transit coaches was between $16,000 and $21,000 and included, in part, $10,500 for the single 101-gallon (net capacity) LNG tank and fuel system installation.

LNG fueling stations represent a large initial capital outlay, although these facilities have an advantage over other forms of natural gas in that the fuel can be transferred rapidly to the vehicle. LNG fueling times are equivalent to those of fuels it would replace, such as diesel, and LNG can be trucked to existing fueling stations dispensing other liquid fuels.[111] LNG fueling stations are constructed on a case-by-case basis rather than according to a standardized station design and are a costly undertaking. For example, the capital cost of a high-pressure transit bus turnkey facility is estimated at over $1.2 million (1998) dollars. This cost breaks down to about $267,000 for each fill point and roughly $170,000 dollars for general fueling facility costs, including site improvements, utilities, emergency power, etc. A comparable low-pressure turnkey facility would

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[110] Bartlett, Steve and Norton, Paul, *Liquefied Natural Gas as a Transportation Fuel for Heavy-Duty Trucks: Volume I,* National Renewable Energy Laboratory, Golden, Colorado, December, 1997, pages 52-53

[111] Beale, Jeffrey, "LNG Infrastructure," *Natural Gas Fuels*, September, 1994, page 9

have estimated costs of $825,000 with $112,00 for each fill point.[112] Costs for a smaller fueling facility with only one 4-gpm fueling point are estimated at over $436,400 dollars "which would have a capacity of about 4,000 gallons per day, sufficient for the medium-duty delivery fleet."[113] In the Maryland MTA demonstration program, EA Engineering, Science and Technology Inc.

Estimated the refueling station cost at $1.42 million, with the need to spend an additional $5.63 million on liquefiers.[114] The fuel storage tanks and fuel dispensing equipment alone accounted for $1.05 million of the facility cost.

Current State of Technology

Passage of the Clean Air Act Amendments in the early 1990s stimulated interest in using natural gas as a transportation fuel. Initial government and industry emphasis focused on compressed natural gas (CNG) as the preferred means to accomplish this objective. However, successful LNG demonstration programs in recent years are encouraging vehicle-related industries to advance LNG technologies in the transportation sector.

Although research on improving LNG engine technologies continues, engine availability is not a major obstacle to expanding LNG use in the transportation sector. As shown in Table 3, a wide range of heavy- and medium-duty vehicle engines that operate using LNG have been available commercially since 1994.

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[112] Low pressure turnkey facility costs provided by Snyder Tank Corporation, Buffalo New York.

[113] *A White Paper: Preliminary Assessment of LNG Vehicle Technology, Economics, and Safety Issues,* Revision 1, Gas Research Institute, January 10, 1992, page 3-12

[114] Bechtold, Richard L., Gibbs, Jerry L.,*The Maryland Mass Transit Administration Demonstration of Liquefied Natural Gas Buses,* EA Engineering, Science, and Technology, Inc., MTA Contract # MTA-3-45-1, October 18, 1996, pages 51 and 52.

LNG ENGINE AVAILABILITY			
Engine	**Type**	**Available Since**	**Emission Characteristics**
Caterpillar 3306	HD	1996	CARB ULEV
Cummins B5.9G	MD	1994	EPA ULEV
Cummins L10	HD	1994	CARB EPA Truck
Cummins C8.3G	MD Bus	1996	CARB EPA Bus
Cummins C8.3G	MD Truck	1996	CARB EPA Truck
Detroit Diesel 30G	MD	1995	LEV
Detroit Diesel 50G 260 HP	HD	1994	CARB
Detroit Diesel 50G 275 HP	HD	1994	CARB
Detroit Diesel 60G	HD	R&D	CARB
Mack E7G325	HD	1997	CARB

TABLE 3

Five large engine companies[115] (Detroit Diesel, Mack, John Deere, Cummins and Caterpillar) now are either selling or developing LNG engines. Also, Mack, John Deere, and Cummins are participating in a joint Department of Energy/Gas Research Institute research program to raise the thermal efficiency of natural gas engines from 35% to 50%. A need does exist for a natural gas engine that is greater than 350 HP.

Despite the Bloomington, MN- headquartered MVE, Inc. company accounting for more than 95% of the onboard LNG vehicle storage tank market, efforts are underway to advance technology in this area. In June 1998, Brookhaven National Laboratory (BNL) selected Snyder Tank Corporation to receive a $453,000 Federal grant to design, manufacture, and test new configurations of LNG fuel tank for heavy-duty trucks and buses. The objective is to provide technologies with better thermal performance and lower operating pressure than the currently available systems. BNL hopes to enhance the development of LNG fuel storage systems and improve the outlook for LNG as an alternative vehicle fuel. Currently, these tanks are being

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[115] *Heavy Duty Resource Guide*, Office of Energy Efficiency and Renewable Energy, US Department of Energy, Washington, DC, January 30, 1998, page 4-5.

evaluated by Nova Bus in New Mexico, which will be supplying the DART with more than 100 new LNG buses. Snyder Tank is also working on creating newer storage tanks with Cryogenic Fuels, Inc. of Fort Collins, CO. Two other companies that can provide onboard LNG tanks are Essex (St. Louis, MO) and Taylor-Wharton (Camp Hill, PA). These companies will supply tanks on request; however, they are not actively pursuing this market.[116]

There are businesses actively engaged in design and construction of advanced natural gas fueling stations and cryogenic storage facilities.[117] Currently, three major manufacturers are engaged in cryogenic storage equipment: CH-IV, Chart Industries, and MVE. CH-IV is located in Lawrence, MA. Chart Industries is based in Costa Mesa, CA, but has many other offices throughout the country. Chart Industries includes subsidiary companies CVI in Costa Mesa, CA, PSI in Westboro, MA, and Cryenico in Denver, CO. MVE has built both a Quick Response Station (QRS) and a permanent station. The QRS is designed for use at a fleet while a permanent station is constructed. The QRS typically can serve a fleet of 2 to 30 vehicles.[118]

Indicators of Potential New York Transportation LNG Demand

New York State Department of Motor Vehicles data indicate 8,849 long-haul vehicles are registered in New York State, which comprise 4.45% of the vehicles that use diesel fuel in the State. This low percentage arises because the majority of heavy-duty vehicles that use New York's roadways are not registered in New York State.

NYSDOT information indicates that an estimated 64,500 light-, medium-, and heavy-duty trucks traveled within New York State in 1992 and that these vehicles consumed more than 350 million gallons of diesel fuel (assuming each vehicle gets 6 miles per gallon of diesel).[119] In a 5- to 10-

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[116] Comments from Jim Wegrzyn, Brookhaven National Laboratory, Upton, New York, August 25, 1998.

[117] Comments from Jim Wegrzyn, Brookhaven National Laboratory, Upton, New York, August 25, 1998.

[118] *Raley's LNG Truck Fleet / Start-Up Experience : Alternative Fuel Truck Evaluation Project,* Center for Transportation Technologies, National Renewable Energy Laboratory, Golden, CO, October 1997, page 3.

[119] Based on 1992 Truck Inventory and Use Survey statistics obtained from the NYSDOT Planning Data Analysis Group. This survey is conducted every five years.

year period, converting 10% of these long-haul trucks to use LNG would displace more than 34.7 million gallons of diesel fuel on an annual basis if LNG use as a transportation fuel was permitted in New York.[120]

The Long Island Clean Cities Coalition is a locally-based government/industry partnership coordinated by the U.S. DOE to expand the use of alternatives to gasoline and diesel fuel in that area. This coalition, in conjunction with BNL and KeySpan, is working to establish an LNG and CNG refueling station in Farmingdale, NY. This site was selected based on the number of fleet vehicles located in the region that would be candidates for switching to LNG. Since Long Island relies solely on its underground aquifer, a major advantage of LNG over petroleum is that LNG will not lead to groundwater contamination in the event of a leak. [121]

BNL hopes to spur the advancement of LNG fuel storage systems and improve the potential of LNG as an alternative fuel. Brookhaven manages a $2-$3 million per year natural gas vehicle program for the U.S. DOE Office of Heavy Duty Vehicles. Under this program, BNL has subcontracts in the area of LNG production, storage, delivery, and market strategy. The objective is to promote natural gas as a transportation fuel that is market-competitive with diesel. Brookhaven National Laboratory promotes the benefits of using natural gas, which include less air pollutant emissions and greater fuel diversity in the transportation sector. The BNL program also promotes the "green" approach of new technologies where overall greenhouse gas emissions are reduced.[122]

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[120] Heavy-duty vehicle information was provided by NYSDOT. The analysis was based on miles traveled per vehicle per fuel type. The numbers provided were in a histogram format (between 0-5000 miles, 5,001-10,000 miles) and represented the number of vehicles that traveled the respective range. The average for each range was multiplied by the total number of vehicles that traveled in that range. The numbers were summed and divided by six (6 miles per gallon) to determine the total number of gallons of diesel fuel. The environmental benefits of substituting LNG for diesel fuel in the transportation sector are discussed in Section 8 of this report.

[121] Comments from Jim Wegrzyn, Brookhaven National Laboratory, Upton, New York, August 25, 1998

[122] Comments from Jim Wegrzyn, Brookhaven National Laboratory, Upton, New York, August 25, 1998

Federal LNG Taxes

In 1997, Congress passed the Revenue Reconciliation Act, which reduced the excise tax on LNG. The LNG excise tax was lowered from $0.315 to $0.205 per diesel gallon equivalent. The tax on diesel is $0.243 per gallon, which allows for a significant tax advantage to LNG. "This new Act removes what has long been considered the greatest single market barrier to widespread adoption of heavy-duty LNG trucks."[123] Other proposals to reduce the federal highway tax on LNG are pending in Congress.

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[123] New Tax Act Removes Disparity Between LNG and Other Liquid Fuels, *The Clean Fuels Report*, Volume 9, Number 4, September, 1997, page 97

SECTION 8

ECONOMIC AND ENVIRONMENTAL CONSEQUENCES OF EXPANDED LNG USE

JOB CREATION POTENTIAL

Expanded use of LNG could result in relatively small-scale, short-term economic benefits for residents and municipalities in New York. While increased use of LNG in the State may result in gas-acquisition cost savings for LDCs, these savings in themselves unlikely would be sufficient to create a measurable amount of economic development activity at the respective site. Building new LNG peakshaving plants or liquefaction facilities at industrial sites, as with any large construction project, would create a temporary increase in employment during the construction of these plants. The potential for permanent job creation associated solely with LNG facilities appears to be limited as the number of facilities constructed would be small and each plant would employ relatively few operating personnel.

Over the long term, the growth in worldwide and domestic demand for LNG could have positive benefits for New York-based businesses. However, LNG cannot compete with either diesel fuel, its main competitor in the transportation sector, or pipeline gas, on purely economic terms. There are several reasons for this, the most important being the added cost for LNG of liquefaction, cryogenic storage, long-distance transport, and the added cost in vehicle construction or modification needed to allow LNG to be used in trucks, buses or other vehicles. Even if this cost differential between LNG and its alternatives were to disappear, the industry still would have other hurdles to scale such as the cost of providing LNG dispensing infrastructure and acceptance of LNG by the business community and the general public.

Public policy makers are recognizing that for LNG and other alternative fuels to become more widely used, incentives to "push" demand are required. In New York, several tax credits were enacted in Chapter 389 of the Laws of 1997 that are designed to encourage development of the alternative fuel vehicle industry in the State. This tax incentive program applies to clean fuel vehicles registered in New York and that qualify under the Federal Internal Revenue Code,

Sections 30 and 179A for similar favorable tax treatment,[124] and to clean-fuel refueling property in the State placed into service beginning on January 1, 1998. The maximum credit is $5000 for vehicles under 14,000 pounds and $10,000 for all other eligible vehicles and 50% of the cost of qualifying property. Qualifying clean-burning vehicle refueling property includes storing, dispensing, and recharging facilities as described in 26 USCA, Section 179A, Subsection d.[125] The incentive period closes February 28, 2003.

If LNG demand sufficiently materializes, orders for New York-made natural gas engines and other gas equipment could increase, along with demand for other services. However, once the infrastructure to support LNG use is in place, much of its use will be as a substitute for conventional gasoline, diesel fuel, and pipeline natural gas. Liquefied natural gas may be a non-indigenous fuel for New York consumers and its purchase will continue to involve dollars leaving New York. Any jobs gained in the production and distribution of LNG likely will be offset, at least partially, by job losses related to the traditional fuels it displaces.

One encouraging area for economic expansion in New York is reliance on LNG processes to increase indigenous natural gas production. New York imports more than 98% of its natural gas. Furthermore, the natural gas that is produced in New York is limited to reserves in the Western and Southern Tier regions of the State. The volumes produced annually have been declining and are small, averaging less than 20 bcf in recent years (or about 1.5% of statewide consumer demand). Despite this trend, natural gas and petroleum production in 1995 yielded New York property owners an estimated $6 million in royalties, while local governments collected $1.4 million in real property taxes on these assets. The NYSDEC indicates that currently there are tens of thousands of acres of State lands available for lease and virtually all of it has potential for gas development. NYSERDA has recently initiated five programs designed to increase indigenous natural gas production.

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124 Electric vehicles are eligible for a tax credit equal to 50%, but not to exceed $5000, of their incremental costs, defined as the difference in the cost between an electric- and gasoline-powered vehicle of comparable size and style. Other clean-fuel vehicles qualify for a tax credit equal to 60%, but not more than $5000, of the original or retrofit equipment costs that permit the vehicle to be clean burning.

125 The New York State tax credit for clean-fuel vehicle refueling property is 50% of the cost of the property and there is no maximum amount for this incentive.

Small-scale natural gas liquefaction technology is one means of increasing New York's production from remote drilling sites. Typically, output from these distant locations would be too small to warrant the financial investment to connect them into the existing natural gas pipeline collection network and production efforts would not proceed. Similarly, small-scale liquefaction of landfill methane is another alternative for producing LNG in New York. Projects of this nature would lead to more royalties, greater property tax payments, and potentially greater economic development within the State.

LNG ENVIRONMENTAL IMPACTS

Air emission impacts that result from combustion of vaporized LNG as a fuel represent the primary environmental impact associated with increased LNG use. At the point of actual combustion LNG takes the form of natural gas, which generally is cleaner burning than other fossil fuels. Liquefied natural gas' sulfur content is near zero, thereby eliminating most sulfur dioxide emissions (SO_2). Compared to other fossil fuels, LNG generally has lower emissions of carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (VOC), and fine particulates (less than 2.5 microns in size). In addition, LNG has lower emissions of carbon dioxide (CO_2) and toxic, heavy metals.

For example, replacing diesel-fueled buses now in operation with LNG buses would reduce SO_2 emissions by 100%, CO by 99%, NO_x by 62%, non-methane VOC by 84%, particulates by 97%, and CO_2 by 6%. These estimated comparative diesel fuel emissions, while based on advanced controls that meet U.S. 1991 standards, do not reflect diesel technology or clean diesel fuels currently under development. Also, substituting LNG combustion for coal, residual oil, or distillate oil in stationary source applications would reduce CO_2 emissions by about 43%, 33%, and 27%, respectively.[126]

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[126] Emission reductions for CO, NO_x, particulates, and CO_2 for buses are based on emission rates in grams per mile from *New York State CNG Bus Users Group CNG Bus Demonstration*, Report prepared for NYSERDA by EA Engineering, Science, and Technology, Inc., August 1994, p. B-1. Emission reduction for non-methane VOC for buses and CO_2 reductions for stationary sources based on emission rates from U.S. Environmental Protection Agency, *State Workbook: Methodologies for Estimating Greenhouse Gas Emissions,* Third Edition, EPA-230-B-98-001, May 1998, p. D13-11, p. D13-13, and p. 1-9.

Replacing diesel buses with LNG buses could potentially assist New York in meeting the requirements of Title I of the Federal Clean Air Act (CAA) amendments of 1990, which address nonattainment of National Ambient Air Quality Standards (NAAQS) for six "criteria" pollutants, with emphasis on ozone.[127] The New York City Metropolitan Area, comprising New York City and the counties of Suffolk, Nassau, Westchester, Rockland, and the lower part of Orange, is classified as a "severe" nonattainment area for ozone. Ozone, or smog, is formed when emissions of NO_x and volatile organic compounds (VOCs) chemically react in the presence of sunlight. Similarly, New York City and Nassau and Westchester counties, are classified as nonattainment areas for CO, and Manhattan is classified as a nonattainment area for particulates. LNG buses could contribute to improving air quality in the New York City Metropolitan Area, as required under the CAA amendments, by reducing emissions of the ozone precursors NO_x and non-methane VOC, as well as CO and particulates.

LNG vapor below -170^0 F is heavier than air, which causes it to be negatively buoyant and results in a LNG release hugging the ground. In this state it could potentially contact groundwater or other large bodies of water. However, LNG is non-toxic and is not absorbed by water. As the temperature rises above -170^0 F, it becomes positively buoyant and disperses in the atmosphere. LNG that is in contact with water will leave that media with no lasting impact. The environmental impacts of a gaseous LNG release to the atmosphere are typically the same as with a release of methane (the principal component of LNG). Methane is classified as a non-photochemically reactive hydrocarbon and is not currently controlled by existing Federal or State regulations, so it can be claimed that LNG has no significant effect on air pollution.

Recent research has indicated that methane is a greenhouse gas (GHG) and, like CO_2, has the potential to affect global warming. U.S. anthropogenic methane emissions, those related to human activity, have three principal sources: production and transportation of coal, natural gas, and oil;

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[127] The six "criteria" pollutants addressed by CAA Title I are ozone, sulfur dioxide, particulates, nitrogen dioxide, carbon monoxide, and lead. Among the criteria pollutants, ozone is considered to be the most significant and pervasive threat to human health. Section 182 (c)(4) of CAA Title I requires that ozone nonattainment areas classified as "serious" or above must implement a "Clean Fuel Vehicle Program (CFVP)," which could potentially consist partially of vehicles fueled by LNG. However, New York has "opted-out" of the light-duty portion of the CFVP requirement, as permitted by Section 182, by substituting the Low Emission Vehicle (LEV) program. (See *New York State Implementation Plan for Ozone Phase II Alternative Attainment Demonstration*, Department of Environmental Conservation, April, 1998.) Similarly, under New York State Conservation Law, as amended by Chapter 37 of the Laws of 1997, New York has proposed to also substitute the LEV program for the heavy-duty portion of the CFVP.

anerobic decomposition of municipal waste in landfills; and raising livestock. Smaller sources include combustion of fossil fuels, rice cultivation and industrial processes. National emissions of methane (1996) are estimated to be 30.9 million metric tons, which represent about 0.5% of U.S. GHG emissions by actual weight. However, when methane emissions are weighted by their global warming potential (GWP), which is an index of radiative forcing relative to CO_2, they represent about 10% of U.S. GHG emissions.[128] In the broad context of global warming, the emissions and impact from a potential single LNG incident would be minuscule. However, it should be recognized that the global warming potential from a ton of LNG, released into the air, is 21 times that of a ton of CO_2.[129] On the positive side, if expanded use of LNG results in the construction of small liquefaction facilities at landfills or as part of natural gas and oil field projects, methane that would normally be emitted into the atmosphere or flared and burned would be converted into LNG, thereby reducing an existing contributor to the global warming phenomena.

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[128] "Emissions of Greenhouse Gases in the United States," DOE/EIA-0573, October 1997, p. ix-xii.

[129] "Ibid.", p. 7.

SECTION 9
RECOMMENDATIONS

LNG is as safe as other available conventional fuels and over the past two decades it has had an excellent safety record. Since 1980, there have been seven plant or ocean tanker accidents worldwide and four vehicle-related accidents in the U. S., with no fatalities, which compares favorably with the safety record of facilities for competing fuels.

Allowing construction of new LNG facilities and the intrastate transportation of LNG over new routes will have economical and environmental advantages for New York constituencies. New York businesses already are manufacturing equipment components for LNG systems and facilities for use in other states. As demand for natural gas increases and use of advanced energy equipment and engines that operate on alternative fuels escalates, interest in LNG could expand, creating more job opportunities in New York. Additionally, LNG could contribute to reducing transportation-relatedair pollution levels. Programs in other states have already demonstrated that LNG can power vehicles, maintain customer service levels, and lower transportation sector pollution. Also, small LNG peakshaving plants can quickly bring natural gas to new geographic areas, where current pipeline capacity is inadequate, to provide customers with the benefits associated with competitive energy markets.

New York is the only state that has an existing moratorium on constructing new LNG facilities and certifying new transportation routes. A 1973 fire at the Staten Island LNG peakshaving plant, which caused the death of 40 workers, was the primary motivating factor for New York adopting this LNG moratorium in 1978. A repeat of the 1973 Staten Island accident in any new facility, however, could not occur because that accident involved combustible materials and tank design that are now prohibited. As discussed fully in the Regulatory Assessment section (Section 2), safety concerns now are adequately addressed by existing federal and State statutes and regulations. The industry has an excellent safety record over the last 20 years and the current regulatory framework is more extensive than the one that was in effect in 1978, when the moratorium was originally imposed. The regulatory role assigned to DEC under Title 17, Article 23 of the Environmental Conservation Law, which was passed just prior to the moratorium, but

never implemented, could duplicate the roles played by other agencies under existing statutes and regulations. For these reasons, the Legislature should:

- Discontinue the existing moratorium by allowing the statute to lapse effective April 1, 1999.
- Repeal Title 17, Article 23 of the Environmental Conservation Law, which imposes duplicative regulatory responsibilities on DEC.

The New York City Fire Department participated in the Resource Group that assisted the Energy Planning Board staff in developing this Report. The Fire Department indicated that it had some concerns about extensive new use of LNG in the densely populated City limits. If the moratorium is lifted, the Fire Department requested that the legislative findings or memorandum in support of any legislation ending the moratorium contain the following language:

> The City of New York will retain its authority to regulate the storage, transportation, and use of LNG within City limits, including its authority to restrict or prohibit such activities as it determines appropriate in the interest of public safety. Such restrictions and prohibitions could be applied to existing and new LNG transportation routes, as well as to the construction of bulk LNG plants and vehicle fueling stations.

It is noted that there is a possibility that the moratorium could be allowed to expire without any further legislation. In such case, the Legislature could consider other methods of recognizing the Fire Department's concerns.

Applicable local zoning and building permit laws and regulations should govern where such plants may be located in the same manner as local zoning and building codes currently apply to the siting of other fuel storage facilities, including petroleum products and propane. Federal Energy Regulatory Commission (FERC) and the U.S. DOT regulate facilities connected to interstate pipelines. The Public Service Commission has regulations (16 NYCRR Part 259) that address the safety aspects of any proposed LNG plant where the facility would supply a local distribution company in New York State. New plants constructed outside New York City to serve end use or vehicle fuel applications would be subject to the New York State Uniform Fire Prevention and Building Code or to local requirements that are stricter than that Code. The

Department of State is available to provide training or assistance to local employees or officials, as necessary. A developer proposing to build a new LNG facility would have to apply to the local governing jurisdiction and proceed through the SEQRA process, complying with all applicable government regulations.

SECTION 10

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APPENDIX A

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APPENDIX B

MAJOR SAFETY FEATURES OF THE EXISTING NEW YORK STATE LNG PLANTS

A detailed examination of the three existing LNG plants in New York State is not the intended purpose of this report. However, continued operation of these existing plants is essential to the provision of a reliable and economical supply of gas to meet system demands on peak days. Therefore, it is useful to examine some of the more important safety features present at those plants. In addition to double-wall tank construction, use of cryogenic steel to preclude brittleness and containment dikes that surround the tanks, there are other safety features undoubtedly contributing to the excellent safety record that has been maintained at the plants during the 24 to 30 years they have been in operation. Further, since these plants were built, extensive regulations have been enacted at the Federal and State levels and in New York City governing the design, construction, and operation of LNG plants, which further ensures the safety of any new LNG plant that may be built today.

ADDITIONAL SAFETY FEATURES

Fire protection at each of the three plants includes a water supply system consisting of either wells or an adjacent salt water source that supplies hydrants within the plant. The water system also supplies cooling water spray systems and water curtains around key process facilities and, in some cases, around the tanks.

Ultraviolet (UV) fire detection systems at each of the plants that survey critical plant areas would trigger alarms at the plants' control rooms and activate dry powder fire extinguisher systems and, in some cases, water curtains in the affected areas.

Heat sensors at the plants would set off alarms at their control rooms and activate water curtains or deluge systems to protect various plant structures.

Each of the plants is equipped with an automatic gas detection system with sensors located throughout the facility, which would detect gas and trigger an alarm at a concentration level of gas in air substantially lower than the lower explosive limit.

Process equipment at the plants is generally protected by mechanisms that measure critical variables (e.g., temperature, pressure) and would either shut the equipment down or sound an alarm if those variables exceed safe levels. Each plant also has a flare system that would burn off gas vented by relief valves, precluding the equipment from being over pressurized.

Double fences topped with barbed wire, intrusion alarm systems (activated by vibration, photoelectric beam, or infrared detectors) and video camera/ TV monitor systems provide security at the plants. Security personnel also patrol the grounds. Access to the plants requires verification of identity by control room personnel or electronic means.

Plant personnel receive hands-on training in LNG firefighting at the Massachusetts Fire Fighting Academy. Emergency response drills and training exercises are conducted on a regular periodic basis with the fire department personnel who would be called to respond to a fire or emergency situation at the specific plant.

Each of the plants is audited under the respective utility's Quality Assurance Program. Department of Public Service Safety Section staff also audit the plants to verify compliance with federal and State safety codes.

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