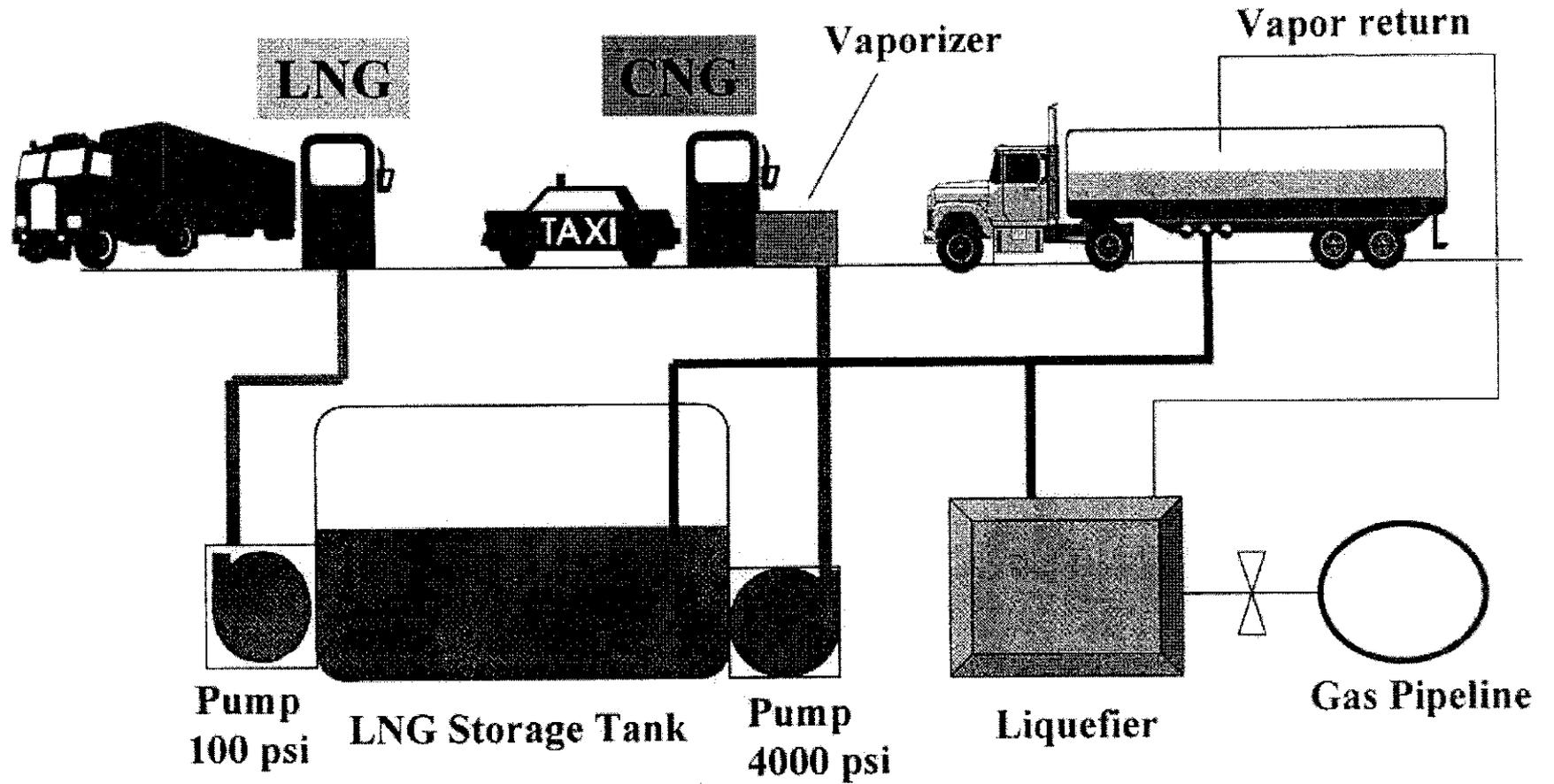


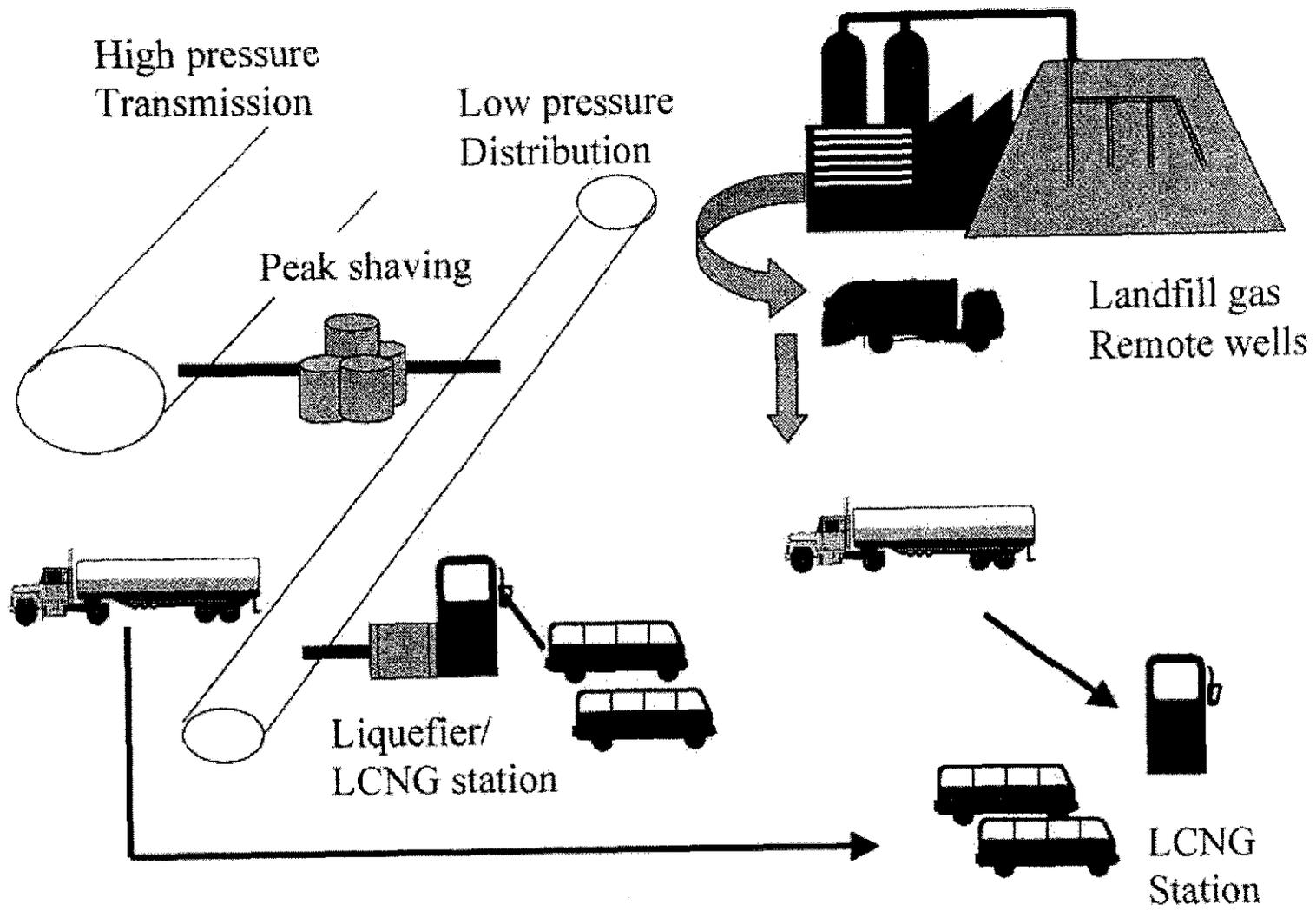
Environmental Impact and Cost of Using  
Liquefied Natural Gas as a Heavy Vehicle Fuel

**6th Annual Diesel Engine Emissions Reduction Workshop**  
**August 21, 2000**

**JAMES WEGRZYN**  
**Brookhaven National Laboratory**

# L/CNG Refueling Station





High pressure  
Transmission

Low pressure  
Distribution

Peak shaving

Landfill gas  
Remote wells

Liquefier/  
LCNG station

LCNG  
Station

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## LNG as a Heavy Vehicle Fuel

### Fuel Cost

- Pipeline
- Unconventional

### Production Cost

- Gas clean-up
- Liquefier
- Operation and maintenance

### Vehicle Cost

- Engine
- Fuel delivery system
- Operation and maintenance

### Refueling Station Cost

- L/CNG
- CNG
- Siting and permitting
- Operation and maintenance

### Legislation, Regulations, Funding

- Taxes and tax credit
- State/ federal incentive programs

## High Fuel-Use Assumptions by Vehicle Segment

<b>Vehicle Class</b>	<b>Annual Miles Travelled</b>	<b>Miles per Gallon</b>	<b>Gallons Consumed/ Year</b>
Automobile	12,000	30 GGE	400
Light-Duty Truck	16,000	16.0 GGE	1,000
Medium-Duty Truck (Class 3-5)	25,000	11.0 GGE	2,270
School Bus	12,500	3.0 GDE	4,170
Transit Bus	40,000	3.5 GDE	11,430
Heavy-Duty Truck (Class 6-8)	100,000	6.5 GDE	15,385

GGE: Gallon gasoline equivalent; GDE: Gallon diesel equivalent

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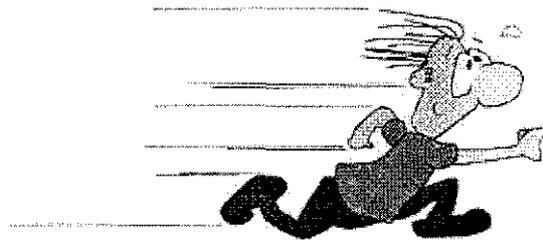
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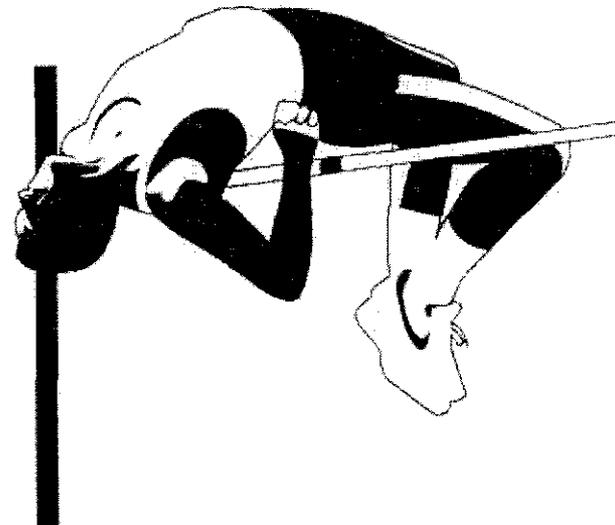
## LNG as a Heavy Vehicle Fuel

- Engine/Storage
  - Pumps
  - Fuel tanks
  - Heat exchanger
- Infrastructure
  - L/CNG
  - Liquefiers
  - Gas clean-up
- Health Effects
  - “New start” Natural Gas Vehicle Exhaust Particle Measurements
  - “Session 5” Health Effects of Diesel Engine Emissions

## LNG raising the performance bar



**Reformulated Diesel  
Gas-to-Liquid  
Fischer-Tropsch Diesel**



**LNG**

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## LNG as a Heavy Vehicle Fuel Long-Term Goal

To reduce our dependency on imported oil in an environmentally responsible manner by using natural gas as a transportation fuel

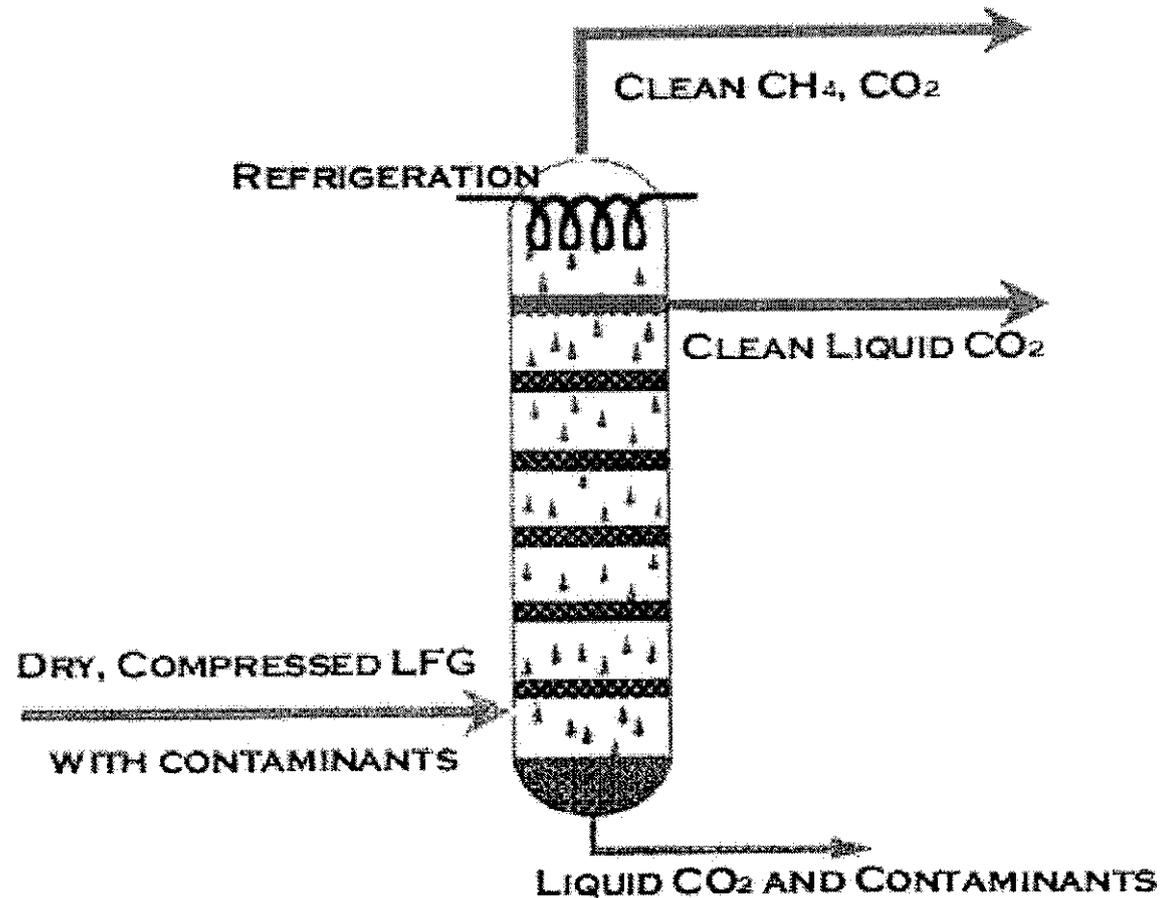
	38	Quads	Petroleum
	25	Quads	Natural gas
	23	Quads	Coal
	<u>14</u>	Quads	Other
Total	100	Quads	Annual energy usage

Over 50% petroleum imported

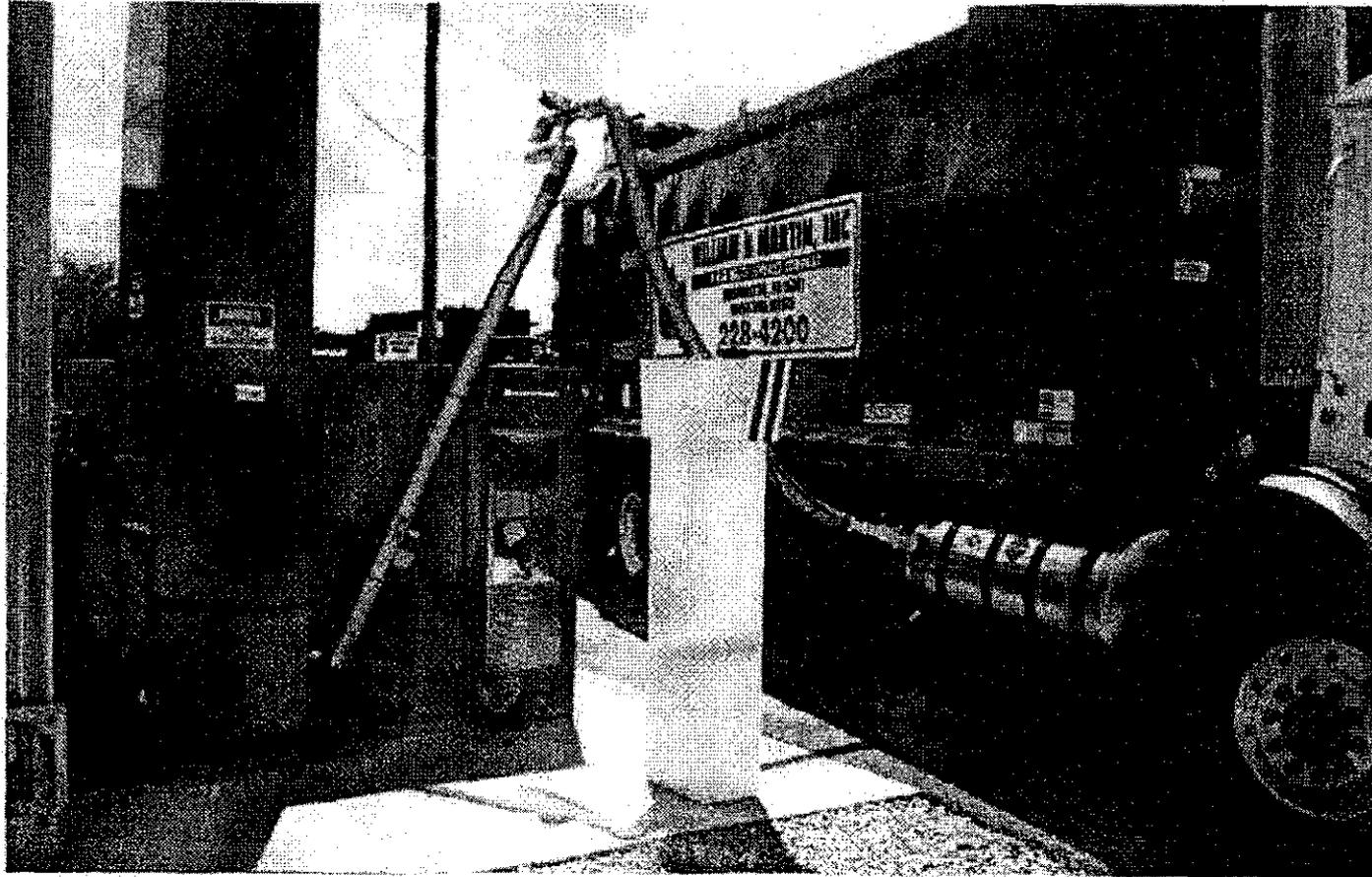
1 tcf NG = 1 Quad

1 tcf NG fuels 525,000 Class 7 & 8 trucks annually

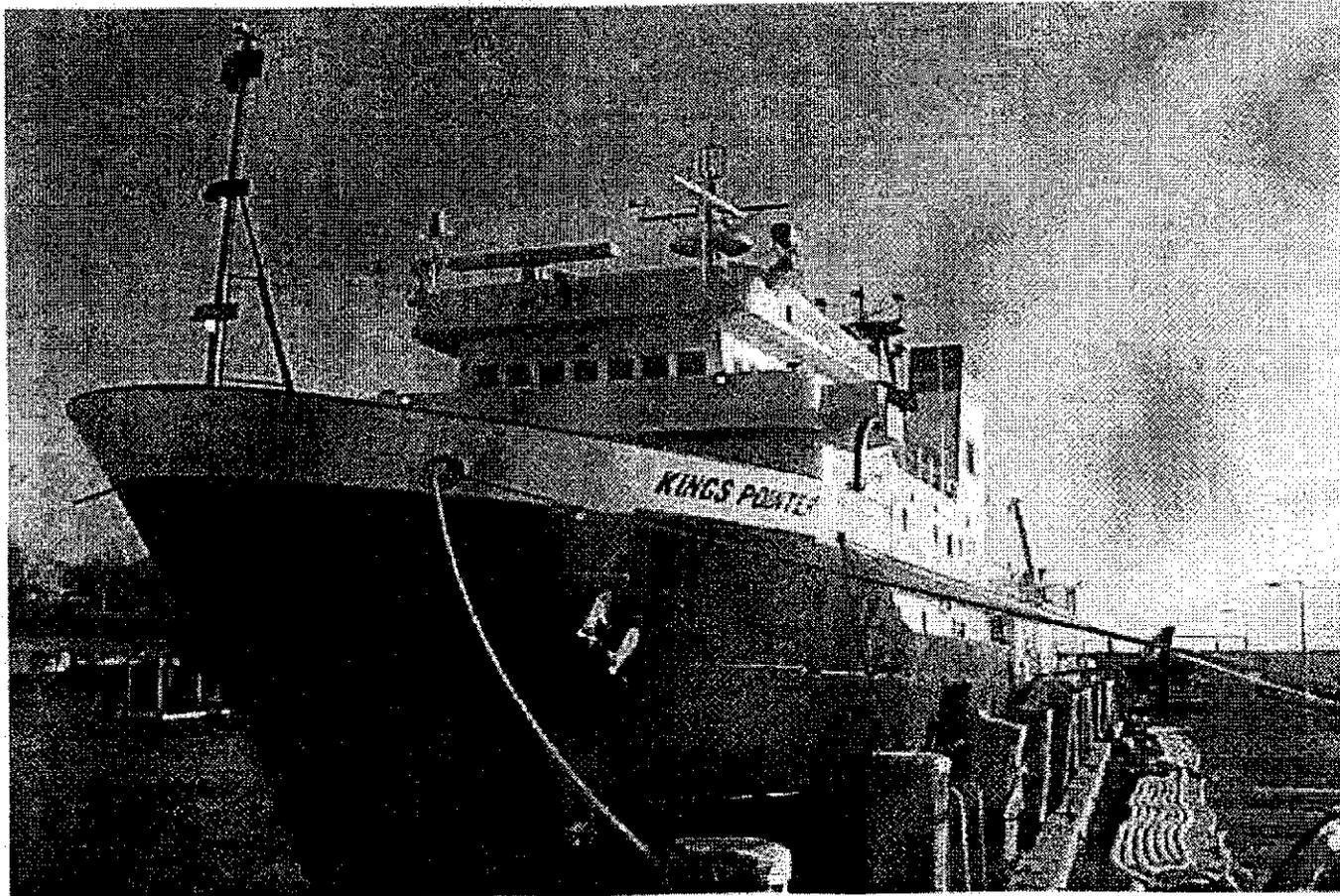
## Acrion Technologies' liquid CO<sub>2</sub> gas cleanup module



**CVI - Refueling Station at Arden Landfill Site (Washington, PA)**



## Conversion of U.S. Merchant Marine Vessel to Natural Gas



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## LNG as a Heavy Vehicle Fuel SUMMARY

- A need for codes, best practices and standards
- Not “the” answer to oil dependency problem
- But can be part of a solution
  - NG engines, low NO<sub>x</sub>, PM
  - Refuse trucks
  - Marine applications
  - L/CNG station
- Must offer competition with diesel and GTL