Evaluating Liquefied Natural Gas (LNG) Options for the State of Hawaii

Dr. Fereidun Fesharaki
Dr. Jeff Brown
Shasha Fesharaki
Tomoko Hosoe
Background

• FACTS had been asked to examine the prospects for LNG in Hawaii
  – Why the interest?: environment, fuel diversification, declining costs, options for future

• Act as impartial information source over the course of corporate visits

• Focus of this presentation:
  – Key Issues in LNG
  – Topics corporate reps may not discuss
    • Potential competitors
    • Strengths/weaknesses

• The final report will be submitted Nov. 1, 2003

• Who/What is FACTS?
FACTS
Retainer List
Private Corporations

1. ExxonMobil Corporation (USA, Singapore)
2. ChevronTexaco Corporation (USA)
3. Unocal Corporation (USA)
4. ConocoPhillips (USA)
5. Universal Oil Products: UOP (USA, Singapore)
6. Tesoro Petroleum Companies (USA)
7. Nippon Oil Company (Japan)
8. Showa Shell Sekiyu (Japan)
9. Cosmo Research Institute/Cosmo Oil (Japan)
10. Idemitsu Kosan (Japan)
11. Mitsubishi Corporation (Japan)
12. Kansai Electric Company (Japan)
13. Itochu Corporation (Japan)
14. BP (Singapore, UK)
15. Oiltanking (Singapore, Germany)
16. LG-Caltex/LG Gas/Kukdong Gas (Korea)
17. SK Corporation: Yukong (Korea)
18. S-Oil Corporation (Korea)
19. Reliance Petroleum Limited (India)
20. Reliance Industries Limited (India)
21. Tata International, Ltd. (India)
22. Total (France)
23. Aluminium Pechiney (France)
24. Shell Oil Products (Singapore)
25. Arthur D. Little (Singapore)
26. Singapore Petroleum Corporation, Ltd. (Singapore)
27. Societe Generale (Singapore)
28. Koch Supply & Trading Co. (Singapore, USA)
29. Shell International Gas (UK)
30. McKinsey and Company (UK, USA, Singapore)
31. BHP Billiton (Australia)
32. North West Shelf Australia LNG (Australia)
33. Gorgon Australian Gas (Australia)
Government-Owned State Oil Companies* and Agencies

1. Saudi Aramco (Saudi Arabia)
2. Kuwait Petroleum Corporation: KPC (Kuwait)
3. Abu Dhabi National Oil Company: ADNOC (Abu Dhabi, UAE)
5. Emirates National Oil Company Ltd.: ENOC (Dubai, UAE)
6. Bahrain Petroleum Company: BAPCO (Bahrain)
7. Petronas (Malaysia)
8. Malaysia LNG: MLNG (Malaysia)
9. Pertamina (Indonesia)
10. Korea National Oil Corporation: KNOC (Korea)
11. Korea Gas Corporation: KOGAS (Korea)
12. SINOPEC/CPCCC (China)
13. Chinese Petroleum Corporation: CPC (Taiwan)
14. Petron Corporation (Philippines)
15. PTT Public Company Limited: PTTPLC (Thailand)
16. Petroleos de Venezuela: PDVSA (Venezuela)
17. Indian Oil Corporation: IOC (India)
18. Petronet LNG Limited (India)
20. Statoil (Norway, Singapore)
21. U.S. Government
22. U.S. Department of Energy
23. U.S. Energy Information Administration

Note: *some partially privatized
Presentation Overview

- What is LNG?
- Why LNG?
- Key players in LNG
- Trends in contract terms
- Trends in pricing
- Environmental and safety Issues
- LNG: Advantages for Hawaii
- LNG: Challenges for Hawaii
What is LNG?

- Natural gas (mostly methane) cooled until it liquefies at -256° F or -161° C.
- In its liquid state it occupies 1/600th the volume of its gaseous state
- **LNG IS NOT PRESSURIZED/FLAMMABLE**
- LNG has been around for a long time:
  - First plant (1917)
  - Peak shaving (1941)
  - International transport (1959)
What is LNG?

U.S. has the largest number of LNG facilities in the world—Most used for peak shaving

Total withdrawal capability is 78 billion cubic feet per day.

Source: EIA
What is LNG?

LNG Chain Overview

Cost: $0.30-1.25 ($/MMBTU)  
$0.50-1.50  
$0.50-1.40  
$0.30-.65  
Total: $1.60-4.80  
(HI?: $0.90-1.22)

• Greenfield vs. expansion projects

• FOB vs. CIF

• Ownership structure typically varies from project to project

Photos: BG
Why LNG?

World Natural Gas Consumption, 2002

- LNG: 5%
- Piped Natural Gas: 95%

Source: EIA
Why LNG?

Growth Rates by Fuel, World 2002-2020
(2001=100)

Source: EIA International Energy Outlook 2002

FACTS Inc.
Why LNG?

- Remote markets and/or remote gas
- Environmental benefits
- Fuel diversification
- Cost competitiveness
- Abundant resources/Flat supply in some markets
- Alternative uses for gas—CNG, hydrogen
Why LNG?

- Environmental benefits (e.g., power)
Why LNG?

LNG COSTS ARE DECLINING
Does not include feedstock prices

$/MMBTU

2.5
2.0
1.5
1.0
0.5

1980's
Liquefaction
Shipping
Regasification and Storage
2000's

2.5
0.5
0.1
0.1
1.8

Source: El Paso
Why LNG?
Electricity Generating Costs
(80% Load Factor, 10% Discount Rate)

Source: Cedigaz
Why LNG?

Hawaii needs roughly 1.5 Tcf to support demand of 1.2 mtpa + demand growth for 20 years.
Why LNG?

Gas leaves options open:

• “Clean” applications, e.g., CNG.
  – Relative to **diesel** engines, natural gas engines produce over 90% less CO and particulate matter and over 50% less NO\textsubscript{X}.

• Potential bridge to a hydrogen economy
  – Currently **steam methane reforming** (using natural gas) is the most **energy-efficient** and **cost-effective** way to produce hydrogen.
  – Could be used to produce hydrogen for **fuel cells** until other methods become more competitive.
    • Develop **hydrogen infrastructure**
  – Eventually move to **renewables/electrolysis** as hydrogen source.
Key LNG Players
Current LNG Market

Source: BG

- W.Africa: 29mtpa
- Middle East: 77mtpa
- S.E.Asia: 5mtpa
- Algeria
- Trinidad
Key LNG Players
LNG Market 2010+

Note: The Hawaii market would initially require approx 1.2 mtpa—The global market is currently approximately 111 mtpa.
East of Suez LNG Liquefaction Plants (Current & Proposed)

- Kenai
- Sakhalin
- Das Island
- Lumut
- Bontang
- Tangguh
- Donggi
- Greater Sunrise
- Gorgon
- Bayu Undan
- Arun
- MLNG
- NWS
- RasGas
- Qatargas
- Omani LNG

Red=Existing
Green=Greenfield
NWS - ALNG
• Consortium: Woodside, Shell, BHP, ChevronTexaco, BP, Japan ALNG, (all have 16.66% share)
• Commissioned in 1989
• Existing Markets: Japan
• Potential New Markets: China, Korea, USWC, Hawaii
• Uncommitted Supply: 3.5-5.5 mtpa

Australia (World LNG Ranking: 5th)

Gorgon
• Consortium: ChevronTexaco (57%), Shell (29%), ExxonMobil (14%)
• Onstream: 2007
• Potential Markets: China, Japan, Korea, USWC, Hawaii
• Uncommitted Supply: 5.0 mtpa
Greater Sunrise
• Consortium: Woodside (33%), ConocoPhillips (30%), Shell (27%), Osaka Gas (10%)
• Onstream: 2010
• Potential Markets: Japan, Korea, USWC, Hawaii
• Uncommitted Supply: 5.3 mtpa

Bayu Undan
• Consortium: ConocoPhillips (54%), Agip (13%), Santos (12%), TEPCO (6%), Tokyo Gas (3%)
• Onstream: 2006
• Potential Markets: Japan
• Uncommitted Supply: 0 mtpa
Indonesia (World LNG Ranking: 1st)

**Bontang**
- Consortium: Pertamina (55%) Vico (20%), Jilco (15%), Total (10%)
- Commissioned: 1977
- Existing Markets: Japan, Korea, Taiwan
- Potential New Markets: USWC, Hawaii
- Uncommitted Supply: 3.0 mtpa

**Arun**
- Consortium: Pertamina (55%), ExxonMobil (30%), Jilco (15%)
- Commissioned: 1978
- Existing Markets: Japan and Korea
Indonesia contd.

Tangguh

- Consortium: BP (37.5%), Mitsubishi (17%), BG (10%), Kanematsu (10%), Nippon Oil (10%), Nissho Iwai (1%), CNOOC (12.5%)
- Onstream: 2007
- Potential Markets: China, Japan, Korea, USWC, Hawaii
- Uncommitted Supply: 4.4 mtpa

Donggi

- Consortium: Pertamina (100%)
- Onstream: 2010?
- Potential Markets: Japan, Korea, USWC, Hawaii
- Uncommitted Supply: 7.0 mtpa
Malaysia (World LNG Ranking: 3rd)

**MLNG**
- Consortium: Petronas (60%), Shell (15%), Sarawak Gov’t (10%), Nippon Oil (10%), Diamond Gas (10%)
- Existing Markets: Japan, Korea, Taiwan
- Potential New Markets: USWC, Hawaii
- Uncommitted Supply: 1.8-2.8 mtpa
Russia

Sakhalin II

Consortium: Shell (55%), Mitsui (25%), Mitsubishi (20%)

Onstream: 2006

Potential Markets: Japan, Korea, China, USWC, Hawaii

Uncommitted Supply: 7.3 mtpa
Qatar (World LNG Ranking: 4th)

Qatargas
- Consortium: Qatar Petroleum (65%), ExxonMobil 10%, Total (10%), Mitsui (7.5%), Marubeni (7.5%)
- Commissioned: 1998
- Existing Markets: Japan
- Potential New Markets: India, US, Europe
- Uncommitted Supply: 14.0 mtpa

RasGas
- Consortium: Qatar Petroleum (63%), ExxonMobil (25%), Kogas (5%), Itochu (4%), LNG Japan (3%)
- Commissioned: 2000
- Existing Markets: Korea
- Potential New Markets: India, US, Europe
- Uncommitted Supply: 19.7 mtpa
Key LNG Players—Corporate Snapshot

• A number of LNG players were informed that Hawaii is exploring the possibility of LNG
  – For example:
    • BP
    • ChevronTexaco
    • Shell
    • Australia LNG
    • Mitsui
Key LNG Players

Equity LNG Capacity, 2002

Source: Deutsche Bank estimates and company information
Key LNG Players

Global LNG Capex, 2002-2010

Source: Deutsche Bank estimates and company information
Key LNG Players—Corporate Snapshot

• **British Petroleum**
  – World’s **third largest** private oil and gas producer (behind ExxonMobil and Shell) with upstream activities in 24 countries.
  – **Largest gas producer** in both the US and UK.
  – Significant LNG player with projects in:
    • Atlantic Basin-Trinidad (operator)
    • Middle East-Abu Dhabi
    • Asia-Pacific-Australia (NWS), Indonesia
  – Recently purchased **2 LNG tankers** (w/option for 3 more) that are not assigned to specific projects
Key LNG Players—Corporate Snapshot

• **ChevronTexaco**
  – Fourth largest oil and gas producer in the world (behind ExxonMobil, Shell, and BP).
  – Among the more oil-heavy of the majors
    • Gas accounts for only around 27% of global upstream production.
  – Gas markets concentrated in North America and Europe. **Looking to expand in Asia.**
  – Not a major LNG player yet, but (potential) projects in:
    • Africa - Nigeria, Angola
    • Asia-Pacific - Australia (NWS and Gorgon)
  – Hawaii’s Chevron refinery
## Key LNG Players—Corporate Snapshot

### BP Key Corporate Data

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>85,277</td>
<td>150,562</td>
<td>176,551</td>
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<tr>
<td>Net Income (Reported)</td>
<td>5,006</td>
<td>11,868</td>
<td>8,008</td>
</tr>
<tr>
<td>Total Assets</td>
<td>89,561</td>
<td>143,938</td>
<td>141,158</td>
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<tr>
<td>Cash Flow from Operations</td>
<td>9,195</td>
<td>14,365</td>
<td>17,433</td>
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<tr>
<td>Capex</td>
<td>7,345</td>
<td>47,613</td>
<td>14,124</td>
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<tr>
<td>Total Gas Sales (mmscf/d)</td>
<td>8,930</td>
<td>14,471</td>
<td>18,794</td>
</tr>
<tr>
<td>Gas Reserves (Bcf)</td>
<td>35,526</td>
<td>43,918</td>
<td>46,715</td>
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<tr>
<td>Gas Production (mmscf/d)</td>
<td>6,067</td>
<td>7,532</td>
<td>8,524</td>
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<tr>
<td>Market Capitalization (at year-end)</td>
<td>196,487</td>
<td>183,699</td>
<td>172,494</td>
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</tbody>
</table>

### ChevronTexaco Key Corporate Data

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
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<tbody>
<tr>
<td>Revenue</td>
<td>79,684</td>
<td>112,529</td>
<td>99,699</td>
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<tr>
<td>Net Income (Reported)</td>
<td>3,247</td>
<td>7,727</td>
<td>3,288</td>
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<tr>
<td>Total Assets</td>
<td>-</td>
<td>77,621</td>
<td>77,572</td>
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<tr>
<td>Cash Flow from Operations</td>
<td>7,771</td>
<td>13,467</td>
<td>11,457</td>
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<tr>
<td>Capex</td>
<td>10,137</td>
<td>9,520</td>
<td>12,028</td>
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<tr>
<td>Total Gas Sales (mmscf/d)</td>
<td>8,876</td>
<td>9,700</td>
<td>10,505</td>
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<tr>
<td>Gas Reserves (Bcf)</td>
<td>17,163</td>
<td>17,844</td>
<td>19,410</td>
</tr>
<tr>
<td>Gas Production (mmscf/d)</td>
<td>-</td>
<td>4,466</td>
<td>4,417</td>
</tr>
<tr>
<td>Market Capitalization (at year-end)</td>
<td>56,856</td>
<td>89,899</td>
<td>95,634</td>
</tr>
</tbody>
</table>
Trends in Contract Terms

• **Historical Contracts**
  – Prevalence of **CIF/ex-ship** contracts
  – Strict **destination clauses**
  – **Long term** 20 year or greater contract durations
  – 90% or greater **take-or-pay**
  – Minimal seasonal **offtake flexibility**
Trends in Contract Terms

• Recent Developments
  – New contracts predominately on a **FOB basis** (over 80% since 1995).
  – Increased **flexibility in destination** clauses
    • Bayu Undan to TEPCO and Tokyo Gas allows resale within Japan.
  – Some **relaxation of take-or-pay** levels (existing projects)
  – Season **offtake flexibility** has increased with KOGAS medium-term contracts.
Trends in Contract Terms

• **Anticipated Trends through 2010/2015**
  – Contracts will **continue to move towards an FOB basis** as this gives buyers more control.
  – Destination clauses will continue to be **relaxed**.
  – More **long term and short term contract combinations** along with options (creates greater offtake flexibility).
  – Take-or-pay levels expected to remain high for financing new projects (internally financed projects may be more flexible).
Trends in Pricing
Natural Gas Pricing by Region

Europe
Oil Products
Asia
Crude Oil (JCC)

US
Henry Hub
Trends in Pricing

- Until recently, Henry Hub normally the lowest (not in 2003).
- Asian LNG price roughly in line with Brent crude oil price.
Trends in Pricing

- **Historical Prices**
  - Formula pricing with an 85% crude oil linkage (Asia)
Trends in Pricing

• 2003
  – Formula pricing with tiered or lower crude linkages (Guangdong 30%)
Trends in Pricing

- Evolution of LNG Pricing in Asia

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Pricing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969</td>
<td>Start of LNG trade (Alaska to Japan)</td>
<td>Fixed Pricing</td>
</tr>
<tr>
<td>1973</td>
<td>First oil crisis - High oil prices</td>
<td>Change to Crude Oil Index</td>
</tr>
<tr>
<td>1986</td>
<td>Oil price crash</td>
<td>Provisional pricing, Introduction of S-Curve</td>
</tr>
<tr>
<td>Late 90s-</td>
<td>Market changes, Supply to new markets</td>
<td>Discussion of new indexes and mechanisms</td>
</tr>
</tbody>
</table>
Trends in Pricing

• Anticipated Trends through 2010/2015
  – More buyers inviting bids for prices.
  – Lower prices for increased volumes.
  – Lower crude oil linkages and lower overall prices.
  – Linked to coal prices (India).
  – Possible return to fixed price (alleviates uncertainty related to price fluctuations).
  – Index a portion of prices to inflation.
Environmental and Safety Issues

• Facts:
  – LNG is lighter than water
  – Natural gas is lighter than air
  – LNG vaporizes rapidly and natural gas dissipates quickly (depending on conditions)
  – LNG itself does not explode or burn
  – Natural gas needs to be in vapor form and appropriately mixed with air to burn

• Environmental concerns (accidental release)
  – Because LNG vaporizes quickly the localized environmental concerns are minimal, especially when compared to oil.
  – 1991 study: oil spill cost estimated at 3 billion dollars
    • (Assuming oil washes up on Oahu and Kauai beaches)

Source: US DOE
Environmental and Safety Issues

- **Safety concerns (accidental release)**
  - LNG vaporizes and causes condensation of atmospheric moisture, forming a visible cloud
  - As the vapor cloud warms it lifts
  - An ignition source close to the origin is likely to cause ignition and result in rapid burn-off
  - Downwind ignition (probably from multiple ignition sources) of a plume would result in burn back (extremely unlikely, but potentially the most dangerous)
Environmental and Safety Issues

• Safety concerns (collision or terrorism)
  – A **catastrophic failure caused by collision or terrorism** would likely result in ignition sources close to the vessel and **ignition and rapid burn down** would occur.
  – Note **LPG (propane) tanker incident** in Iran/Iraq war.

• Summary
  – In general, the hazards appear to be **manageable**
  – Over **30+ years** there have been no major LNG transport problems
  – **US Coast Guard** is comfortable with LNG—LPG (propane) is generally considered higher risk:
    • Under pressure
    • Heavier than air—does not disperse as easily
## LNG in Hawaii: Alternative Scenarios

### Potential Fuel Substitution for LNG on Oahu (Fuel Use 2001)

<table>
<thead>
<tr>
<th>LNG Application</th>
<th>Fuel Type</th>
<th>Displaced</th>
<th>Billion BTU</th>
<th>LNG equivalent ( tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HECO Steam Generation Units</td>
<td>LSFO</td>
<td>46,668</td>
<td></td>
<td>906,343</td>
</tr>
<tr>
<td>Kalaeloa Partners</td>
<td>LSFO</td>
<td>12,503</td>
<td></td>
<td>242,824</td>
</tr>
<tr>
<td>HECO Combustion Turbine Units</td>
<td>Diesel</td>
<td>132</td>
<td></td>
<td>2,567</td>
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<tr>
<td>AES Hawaii</td>
<td>Coal</td>
<td>13,930</td>
<td></td>
<td>270,534</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,422,269</strong></td>
</tr>
<tr>
<td><strong>Utility Gas Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility SNG and Propane</td>
<td>SNG and Propane</td>
<td>3,107</td>
<td></td>
<td>60,350</td>
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<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>60,350</strong></td>
</tr>
<tr>
<td><strong>Highway Transportation Sector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LPG Highway Vehicles</td>
<td>LPG</td>
<td>27</td>
<td></td>
<td>530</td>
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<tr>
<td>Diesel Highway Vehicles</td>
<td>Diesel</td>
<td>2,619</td>
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<td>50,869</td>
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<tr>
<td>Gasoline Highway Vehicles</td>
<td>Gasoline</td>
<td>33,009</td>
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<td>641,085</td>
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<tr>
<td><strong>Sub-Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>692,484</strong></td>
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<tr>
<td><strong>Total LNG Demand</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>2,175,103</strong></td>
</tr>
</tbody>
</table>

*LSFO=Low Sulfur Residual Fuel Oil; SNG=Synthetic Natural Gas; LPG=Liquefied Petroleum Gas*

1 Tonne of LNG=51.49 million BTU

Source: FACTS update of DBEDT's draft, "A Proposed Assessment of LNG Options for Hawaii"
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<tr>
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<td></td>
<td></td>
<td>1,149,167</td>
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<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td>60,350</td>
</tr>
<tr>
<td><strong>Total LNG Demand</strong></td>
<td></td>
<td></td>
<td><strong>1,209,518</strong></td>
</tr>
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1 Tonne of LNG=51.49 million BTU

Source: FACTS update of DBEDT’s draft, "A Proposed Assessment of LNG Options for Hawaii"

Increasing to approximately 1.5 mtpa by 2015
Advantages/Challenges for Hawaii

• Advantages
  – Environmental
  – Cost competitive
  – Fuel diversification/energy security
  – Options for the future—CNG/Possible bridge to a hydrogen economy

• Challenges
Advantages for Hawaii
Global Warming Potential of Oahu Power Generation
Current Fuel Plans vs. LNG in 2007

Source: Steve Alber, DBEDT
Advantages for Hawaii

Cost of LNG vs. Other Fuels
(Hi/Low Range and Average)

$0.00
$1.00
$2.00
$3.00
$4.00
$5.00
$6.00
$7.00
$8.00

$/MMBTU

Range

Average

Industry standard
Major producer for HI (Shell)
HECO fuel oil (1990-2001)
HECO diesel (1990-2001)
### Estimated Comparative Costs for Delivery to Honolulu, Hawaii ($/mmBTU)

<table>
<thead>
<tr>
<th>Supply</th>
<th>Indonesia (Bontang)</th>
<th>Australia (NWS)</th>
<th>Malaysia (Bintulu)</th>
<th>Qatar</th>
<th>Russia (Sakhalin)</th>
<th>Indonesia (Tangguh)</th>
<th>Oman</th>
<th>Australia (Bayu-Undan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedgas</td>
<td>0.50</td>
<td>0.30</td>
<td>0.70</td>
<td>0.50</td>
<td>0.95</td>
<td>0.70</td>
<td>0.70</td>
<td>0.90</td>
</tr>
<tr>
<td>Liquefaction</td>
<td>0.80</td>
<td>1.00</td>
<td>0.85</td>
<td>0.70</td>
<td>1.10</td>
<td>1.20</td>
<td>0.80</td>
<td>1.30</td>
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<tr>
<td>Shipping</td>
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<td>0.85</td>
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<td>0.70</td>
<td>1.20</td>
<td>0.75</td>
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<tr>
<td>Regasification</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$2.65</strong></td>
<td><strong>$2.75</strong></td>
<td><strong>$2.95</strong></td>
<td><strong>$3.05</strong></td>
<td><strong>$3.15</strong></td>
<td><strong>$3.20</strong></td>
<td><strong>$3.30</strong></td>
<td><strong>$3.55</strong></td>
</tr>
</tbody>
</table>

*All costs are estimates; Hawaii port costs not included*
Advantages for Hawaii


- Oil, 89.1%
- Coal, 5.6%
- MSW, 1.5%
- Biomass, 1.5%
- Solar*, 1.3%
- Hydro, 0.3%
- Geothermal, 0.7%

*Note: Solar includes wind and solar heated water.

Hypothetical State of Hawaii Primary Energy Fuel Mix w/LNG: 2001
(1.209 mtpa LNG)

- Oil, 68.7%
- Gas, 20.4%
- Coal, 5.6%
- MSW, 1.5%
- Biomass, 1.5%
- Solar*, 1.3%
- Hydro, 0.3%
- Geothermal, 0.7%

*Note: Solar includes wind and solar heated water.

Clear opportunity to diversify—especially if gas price is not closely linked to oil price
Challenges for Hawaii

- Major undertaking (public concerns, permits, etc.)
- Estimated capital expenditure $150-275 million
- Site: Target harbor (Barbers Point) may be inadequate for LNG—e.g., dredging required
- Potentially disruptive to existing energy supply
  - ChevronTexaco refinery most at risk
    - Smaller, older
    - Simulation: Profits decline by 43 percent w/ LNG
  - Neighbor islands
    - May not be viable to include in LNG plans
    - LNG barges?
Possible Questions

• Infrastructure/site requirements?
• Scope of supply (e.g., all the way to the burner)?
• Integration with other projects?
• Tanker options?
• Alternative supply?
• Pricing?
• Supply to neighbor islands?
• Viability of Chevron refinery?
Thank you