NATURAL GAS IN TRANSPORTATION
FUELING THE FUTURE
TODAY’S DISCUSSION:

GLOBAL CONSIDERATIONS

NATURAL GAS VEHICLES 101

THE SHALE GALE AND PRICING FUNDAMENTALS

PAYBACK ECONOMICS

ADDITIONAL CONSIDERATIONS

NEXT STEPS
CHESAPEAKE ENERGY OVERVIEW

- Second-largest producer of U.S. natural gas and a Top 15 producer of U.S. liquids
- Most active explorer for natural gas and liquids with 130 active U.S. drilling rigs as of July 12, 2012
- Employ over 13,500 people in 17 states
- Applying unconventional thinking and state-of-the-art technologies, Chesapeake has grown from a $50,000 startup in 1989 to a $30 billion enterprise
- CHK has the #1 or #2 position in the top 10 oil and gas basins in America
Once asset monetization is complete, focus will be on 10 leading plans where CHK holds a #1 or #2 position.
NATURAL GAS DELIVERY SYSTEM

- **Upstream**
  - Producing Wellheads

- **Midstream**
  - Gathering lines
  - Underground Storage for Future Use
  - Compressor Station
  - Transmission lines
  - City Gate (Regulators/Meter) Sells to Retail Customers

- **Downstream**
  - Electric Plant to Generate Electricity
  - Large Volume Customer
  - Commercial Customers
  - Residential Customers
  - Service lines
  - Distribution main line
AMERICA ON THE BOTTLE

- U.S. consumes 23% of the world’s petroleum

- By 2020, the IEA predicts world oil consumption will increase 60%
  - This does not take production decreases into account
  - This means we will need 4 more Saudi Arabias... Where will they be?

- To keep pace with demand and depletion, the world must add 64 million barrels of production per day until 2020:
  - This growth will require $350 billion per year on new projects
  - OPEC only spent $390 billion in total on new projects from 2000-2007
GLOBAL COMPETITION INCREASING

2009 to 2015E

CHINA
- 2.2 up to 10.1 Bbl/Person

INDIA
- 0.9 up to 5.4 Bbl/Person

Chinese vehicle ownership per capita is equal to where the U.S. was in 1925.

Source: US Energy Information Administration, Annual Energy Review 2009
WHERE IN THE WORLD?

1. PAKISTAN
   Natural gas vehicles: 2,740,000
   Refuelling stations: 3,285
   (December 2010)

2. IRAN
   Natural gas vehicles: 1,954,925
   Refuelling stations: 1,574
   (December 2010)

3. ARGENTINA
   Natural gas vehicles: 1,954,925
   Refuelling stations: 1,878
   (December 2010)

4. BRAZIL
   Natural gas vehicles: 1,664,847
   Refuelling stations: 1,725
   (December 2010)

5. INDIA
   Natural gas vehicles: 1,080,000
   Refuelling stations: 571
   (December 2010)

6. ITALY
   Natural gas vehicles: 730,000
   Refuelling stations: 790
   (December 2010)

7. CHINA
   Natural gas vehicles: 450,000
   Refuelling stations: 1,350
   (December 2009)

8. COLUMBIA
   Natural gas vehicles: 340,000
   Refuelling stations: 614
   (December 2010)

9. THAILAND
   Natural gas vehicles: 218,459
   Refuelling stations: 426
   (November 2010)

10. UKRAINE
    Natural gas vehicles: 200,000
    Refuelling stations: 285
    (December 2006)

14. USA
    Natural gas vehicles: 112,000
    Refuelling stations: 1,000
    (December 2010)

Source: http://iangv.org/tools-resources/statistics.html
NATURAL GAS VEHICLES WORLDWIDE

Natural Gas Vehicles by Region 1991 - 2011 (count)

- ASIA-PACIFIC
- EUROPE
- NTH AMERICA
- LATIN AMERICA
- AFRICA

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NATURAL GAS IN TRANSPORTATION

- Natural Gas is CLEAN
  - Mostly methane, only one carbon atom
  - Reduces GHG by 21-27%
  - Reduces particulate matter by up to 95%

- Natural Gas is SAFE
  - Higher ignition temperature than diesel or gasoline (1000 – 1100 degrees F)
  - Narrow range of oxygen/fuel combustion ratio (5-15%)
  - Highly engineered tanks and components

- Natural Gas is POWERFUL
  - Octane rating of ~130
  - HD natural gas engines have equivalent torque and horsepower to diesel counterparts

- Natural Gas is QUIET
  - HD engine DB level 80-90% lower than diesel

CNG AND LNG BASICS

**COMPRESSED NATURAL GAS**
- Natural Gas that is compressed, typically to 3,600 PSI, for dispensing and storage
- Gas is distributed through natural gas pipeline (the same infrastructure that delivers to homes and businesses currently) to the fuel location
- Gas is compressed at fuel location into CNG for dispensing into the truck
- Dispensing is similar to gasoline or diesel fuel
- The CNG is stored on the vehicle in one or more cylinders

**LIQUEFIED NATURAL GAS**
- Natural Gas that is cryogenically cooled to 260°F for dispensing and storage
- Gas is processed at LNG production and transported by special truck to the fuel location
- LNG is stored at fuel location in cryogenic tanks and dispensed directly into the truck
- Dispensing requires special safety equipment
- The LNG is stored on the vehicle in cryogenic tanks
WATER INTENSITY OF TRANSPORTATION FUELS

- Compressed Natural Gas (CNG)
- Source: Adapted from King and Webber 2008a;
- *Adapted from King and Webber 2008b, combined with data from USDOE 2006
- Non-irrigated biofuels not shown on plot above

Average Consumption: Gallons of Water Per 100 Miles Driven

- Ethanol from Irrigated Corn Grain: 2,800
- Ethanol from Irrigated Corn Stover: 1,900
- Biodiesel from Irrigated Soybeans: 800
- Hydrogen via Electrolysis: 42
- Syn Diesel from Coal: 38.5
- Electric Vehicle (Electric from Nuclear)*: 35
- Oil Sands Gasoline: 33
- Syn Diesel from Natural Gas: 27.5
- Oil Shale Gasoline: 26
- Electric Vehicle (Electric from Coal)*: 23
- Gasoline: 10.5
- Electric Vehicle (Electric from Shale NG)*: 10
- Diesel: 8
- CNG using Electricity for Compression: 6.5
- Hydrogen from Natural Gas: 6
- CNG using NG Generator for Compression: 3

Gasoline with 10% irrigated ethanol blend: ~ 200 gallons water consumed per 100 miles driven
CNG SYSTEM COMPONENTS

1. Fuel Tank
2. Compressor
3. Fuel Gauge
4. Fuel Lines
5. Regulator
6. Fuel Injectors
7. Electronic Control Unit
8. Fuel Rails

Source: Westport Light Duty Inc.
THE SHALE GAS REVOLUTION

PGC Resource Assessments, 1990-2010

Total Potential Gas Resources (Mean Values)

Data source: Potential Gas Committee (2011)
**PRICE STABILITY EXAMPLE**

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<thead>
<tr>
<th>INPUT</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas (divide by 8)</td>
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<td>Transport Costs &amp; Fees</td>
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**Natural Gas @ $2.80 per MCF**

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Price inputs based upon historical operating information
PRICING PRINCIPLES

Regular Gasoline (January 2012)
Retail Price: $3.38/gallon

- Crude Oil: 76%
- Refining: 6%
- Distribution & Marketing: 6%
- Taxes: 12%

CNG (July 2012)
Retail Price: $1.85/gge

- Crude Oil: 27%
- Distribution & Compression: 20%
- Natural Gas: 13%
- Marketing & Profit: 40%
- Taxes: 13%

Source: U.S. Energy Information Administration
NGVS ARE A FLEET OWNER’S DREAM

- Local/State Governments
- Airports
  - Terminal Buses, Shuttles, Taxis, Tarmac Vehicles
- Refuse
  - Collection, Recycling
- Transit
  - City Buses, Maintenance, Shuttles
- School Districts
  - Buses, Vans, Maintenance
- “Short Haul” Delivery
  - Food & Beverage Distributors, Postal, Newspapers, Linens, Uniforms, Regional Freight
- Utilities & Telecom
  - Gas/Electric/Water, Communications
- Small Businesses
  - Plumbers, Electricians, Florists, Service Companies
- Energy Companies
NATIONAL FLEETS WITH NGVS
PICKUP – BREAK EVEN ANALYSIS

- **Ford F-250**
  - 16 mpg – 24,000 miles per year
  - 1,500 GGE/year
  - Cost Premium: $9,000
  - Increased Resale: $4,500
  - Bi-Fuel CNG/Gasoline

- **At Fuel Differential of $1.50**
  - Simple payback in 4 years
  - Net Life Cycle Savings: $4,500
    - 100,000 mile turnover target

Increased resale assumption based upon recent auction prices achieved by Chesapeake Energy
DETROIT ROLLS OUT CNG IN 2012
DON’T WORRY... THERE’S AN APP FOR THAT!

- Free iPhone and Android Application
  - Locate and Plan your next trip
  - Get the latest News
  - Update Prices
  - Post to Facebook or Twitter
  - Post Pictures of the Station

Create your own profile at www.cngnow.com
HOW DOES A CNG STATION WORK?

TIME FILL STATION

FAST FILL STATION
MOVING FORWARD...

Our goal is to help companies identify opportunities where natural gas is a fit for their operational needs today, resulting in an initial pilot program.

- What are the remaining barriers to adoption?
  - Infrastructure?
  - Engine Availability?
  - Price of Conversion?
  - Lack of Faith in Commodity?

- How can Chesapeake continue to serve as a resource?

- Next Steps and Action Items
William Freeman
Manager, Market Development
Office: (717) 230-8620
Mobile: (717) 810-7675
william.freeman@chk.com