Opportunities in the Marcellus and Utica Shale for Increased Japanese Trade and Investment

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During the 1990’s and early 2000’s George Mitchell of Mitchell Energy was determined to extract natural gas from the Barnett Shale in Texas; long considered too tight and lacking in permeability to produce.

He unlocked the puzzle and changed the energy supply picture in the United States for decades by using and advancing two known technologies:

- **Hydraulic Fracturing**: invented in 1959, injects water, surfactants (improve viscosity) and sand (proppant) under high pressure to artificially create fractures and permeability.

- **Horizontal Drilling**: used since the 1960’s, involves turning the drill bit horizontally to expose substantially more wellbore to the target formation.

Two technological advances enabled production from “tight” shale rock about 15 years ago.
Today, commercially productive shale is abundant in the U.S. but the Marcellus and Utica are dominant.
What and Where is the Marcellus Shale?

- Sedimentary formation created about 380 million years ago in Middle Devonian age
- Dead critters and plants died and fell to the bottom of a deep ocean (the Appalachian Basin) where a lack of oxygen prevented decay
- Organic rich sediments were buried over time by erosion of Appalachian Mountains
- Organics converted to hydrocarbons through the process of thermogenesis (pressure, heat and time)
- Formation rests more than a mile below surface and is between 50-250 feet thick
- Areal extent is approximately 95,000 square miles
- First successfully drilled in 2004
- Core producing areas in SW Pennsylvania/NW West Virginia and in NE Pennsylvania
The Marcellus Shale is massive and low-cost

- The Marcellus Shale is estimated to contain nearly **500 trillion cubic feet (Tcf)** of recoverable natural gas making it the second largest natural gas field in the world.

- The Marcellus Shale is the lowest cost source of natural gas in North America.
What and Where is the Utica Shale?

- Sedimentary formation created about 500 million years ago in Middle Ordovician age
- The Utica lies approximately 4,000 feet below the Marcellus Shale and ranges from 100-500 feet thick
- Areal extent is approximately 135,000 square miles
- First successfully drilled with modern horizontal techniques in 2010
- A core area where commercial production has been established is centered in SE Ohio, SW Pennsylvania and NW West Virginia
- Early estimates place recoverable natural gas reserves at approximately 50 Tcf
The Marcellus and Utica Shale represent the lowest cost source of natural gas in the U.S.

Prompt Natural Gas Price: $2.81/mcf

Source: Goldman Sachs Global Investment Research.
Northeast natural gas production was irrelevant five years ago.....Today, it has become the base load supply for the U.S.
Production from the Marcellus Shale represents almost all the growth in U.S. natural gas production since 2008.
Lack of pipeline infrastructure has trapped natural gas in Pennsylvania; causing a collapse in local pricing.

- Henry Hub: NYMEX
- TGP (NE Pa index price) separates from NYMEX in spring of 2013
- New York City Gate: short pipeline capacity in winter
- Dom SP (SW Pa index price) separates from NYMEX in Spring 2014
- Warm December: Pa natural gas prices collapse

Source: ITG IR. raw data provided by Bloomberg
Northeast demand and pipeline capacity will comfortably exceed Northeast production by 2017.
Nearly 30 major pipeline expansion projects in the Northeast U.S. are under construction or in advanced planning.

Over $35 billion committed to new pipeline infrastructure in the Northeast
New pipeline capacity should enable the northeast natural gas market to return to equilibrium by 2017

- Over the next 3-5 years, new pipeline capacity will enable Marcellus/Utica natural gas producers to export between 20-30Bcf/d to the Gulf Coast, Midwest, Southeast and Canada.

- In a balanced market, Marcellus/Utica gas will trade between $0.40 and $0.60 (variable transportation costs) less than NYMEX in the summer injection season and even with NYMEX during the winter withdrawal season.
As Pennsylvanians: Why should we care about the Marcellus and Utica Shale?

- Shale gas is **clean burning** (90% less particulates; 50% less CO2 vs coal)
- Shale gas is **abundant** and can meet a substantial percentage our nation’s energy demands for many decades
- Shale gas development is a **huge job creator** and **contributor to our economy**
  - Pa Department of Labor has identified 239,000 direct and related jobs
- Low cost Marcellus Shale Gas is significantly **lowering our energy bills** and is spurring a **manufacturing renaissance** in Pennsylvania
- Shale gas development is **domestic** and can lead the United States to **energy independence** and change our geo-politics for the better
- Shale gas development in Pennsylvania has contributed **$2.1 billion in state taxes**; including nearly $830 million in impact fees
- The production of shale gas has proven **safe and reliable** over time.
Why should Japan care about shale gas production in Pennsylvania?

• The import of natural gas from Liquefied Natural Gas (‘LNG”) tankers is critical to future energy supplies in Japan

• The landed cost of imported U.S. LNG from shale gas is projected to be the lowest in the world

• As a country that must import nearly all of its future energy supply, sourcing LNG from a close ally like the United States is a national priority

• Marcellus/Utica shale gas is among the lowest cost natural gas resource in the world
Liquefied Natural Gas (LNG) will connect burgeoning U.S. natural gas production with growing markets overseas

- First developed in 1917
- Natural gas is liquefied at -260 degrees Fahrenheit
- LNG is 1/600th of volume of natural gas
- Transported overseas through specially designed refrigerated tankers
- At its destination, LNG is stored or re-gasified and delivered through pipelines
- The landed cost of LNG, including liquefaction and shipping, is estimated to be between $5.00 and 6.00 per MMBtu above the cost of the natural gas
Japan is currently the largest importer of LNG......but the most significant growth is in China.
Qatar currently is the dominant global LNG supplier but the U.S. and Australia will compete to meet projected LNG growth.
The historical landed cost of LNG in Japan is significantly higher than natural gas prices in the U.S.

(1) Monthly LNG Japan Corp Import Price: LNG imports from all countries into Japan, updated on a two-month lag basis, and inclusive of freight cost. Source: Bloomberg (LNGJLNJP Index)
Landed costs of U.S. born LNG in Tokyo Harbor is projected to be the lowest in the world.

Notes: Dotted lines represent capital cost range; assumes LNG delivery to Tokyo Bay Harbour (FOB Destination, seller pays for LNG transport); 25 year project life; Western Australia liquids yield of 15 bbl/mmcf and price realization of $102/bbl.
Source: Company Reports, IHS CERA, RBC Capital Markets estimates
Four LNG liquefaction plants are under construction representing 6 Bcf/d of demand......expansion and additional facilities could add 5-12 Bcf/d

**Sabine Pass (four trains)-**
- Developer: Cheniere Energy
- Off-take: BG Group; GAIL (India); Korea Gas; Gas Natural Fenosa
- First deliveries: 2015

**Cameron LNG (three trains)-**
- Developers: Sempra Energy; GDF Suez; Misui; Mitsubishi
- Off-take: GDF Suez; Misui; Mitsubishi
- First deliveries: 2018

**Freeport LNG (two trains)**
- Developers: ConocoPhillips, Michael Smith; Osaka Gas; ZHA FLNG (Zachry)
- Off-take: Osaka Gas; Chuba Electric; BP Energy; Toshiba, SKE&S LNG
- First deliveries: 2018

**Cove Point (one train)-**
- Developer: Dominion Energy
- Off-take: Sumitomo; GAIL (India); Kansai Electric
- First deliveries: 2017
LNG contracts are long-term and there are risks to overseas buyers

- LNG liquefaction plants are $4-5 billion of capital investments and developers demand 15-20 year take or pay contracts
- Most foreign LNG deliveries are indexed prices to Brent Sea crude oil prices
- U.S. Natural gas trades based on hub indexed prices; the Henry Hub in Louisiana being the most important
  - Difficult to hedge this basis risk long-term
- Competing LNG projects in other countries, such as Australia, Canada and Qatar, could drive down future LNG prices
- Significant changes in energy technology and supply can take place in 20 years
- Transportation costs can rise significantly; however, expansion of the Panama canal could substantially reduce today’s U.S. born LNG transportation costs to Japan
One way Japanese energy suppliers could hedge their costs and capture more margin along the supply chain is to own and operate shale gas reserves in Pennsylvania.

- Fully-loaded costs of developing Marcellus and Utica Shale reserves (including finding and development, land, gathering, transportation and operations) are between $1.80 and $2.25 per Mmbtu.

- The Marcellus and Utica have established production curves, thereby reducing reserve risk.

- Most of the Marcellus and Utica Shale producing areas have been delineated, thereby reducing “dry-hole” risk.

- Production in the Marcellus and Utica Shale has moved to a “Manufacturing” stage, thereby reducing operating risk.
Questions?