Unconventional Gas Development
Mitigating Environmental Risk

For More Information Contact
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The “Age of Gas”

Natural gas is taking a larger role in global energy mix

Percent of Primary Global Energy Production

- 20% in 1990
- 23% in 2012
- 26% in 2025

“Age of Gas” Outlook ‘12 –’25 (Bcm per year)

Global growth 36% ‘12 to ’25

Key drivers

- Unlocking new gas supply sources
- Need for environmental mitigation
- Price competitiveness ... Asia & EU
- Gas network growth


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Growing shale gas supply in the US

Major unconventional gas sources

- Horn River Basin Shale
- Monteny Tight Sands
- Pinedale Tight Sand
- Jonah Tight Sand
- Piceance Tight Sand
- Powder River CBM
- Marcellus Shale
- Fayetteville Shale
- Woodford Shale
- Barnett Shale
- Haynesville Shale
- Deep Bossier Tight sands

Large potential

Current Production in 2008: 9.9 Bcf/d
14% of N. American Production

+ Additional between 2008 and 2010: 5 Bcf/d

+ Additional between 2010 and 2015: 8.4 Bcf/d
potential to be 25% of N. American production by 2015

Source: EIA, EnCana, Chesapeake, industry news

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Source: GE Energy outlook 2009
Public Concerns Intersect with Industry Operations

Water Impacts

- Industry uses a lot
- Industry doesn’t recycle enough
- Injection wells are bad

Air Impacts

- Methane leaks
- General GHG issues
- Flaring

Community Impacts

- Noise
- Dust
- Traffic

The social license to operate is the critical element
Three approaches to balancing energy imperatives with environmental concerns

- Good business practices
- Advanced Technology
- Smart regulations

Unconventional is safe today, but can be better tomorrow!

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Good business and operational practices

Leasing

Contracts

Set backs

Water treatment

Well integrity

Operational timing

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Technology Solutions

Water
- Less, not fresh or an alternative
- Recycle more
- Less injection

Air
- Maintenance
- Use new technology
- Monetize the gas

Community
- Power to Lift

R&D to find substitutes to fresh water is needed!

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### Solutions for unconventional O&G

#### Coal Seam Gas
- Environmental discharge
- Evaporation pond availability
- Brine volumes & disposal

#### Shale Gas

##### Produced Water
- OnePass filtration
- Biocide alternative
- Tank cleaning, pump changes

##### Produced Water & Flow Back

#### Shale Gas

##### Water Disposal
- Thermal ZLD (mobile/central)
- Brine disposal & transport
- Source water – mobile UF

#### Water Disposal/Supply
- Mobile evaporators operating
- Source Water UF piloted
- UF cost 10% ↓ vs. biocide

#### Recovery & Brine
- Environmental discharge
- Evaporation pond availability
- Brine volumes & disposal

#### Current Status
- 150MLD installed
- Mobile systems for gas wells
- Piloting beneficial brine soln’s

#### Current Status
- Piloted successfully
- Validated cost $0.07/bbl
- More effective control

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How much methane leakage is too much?

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Oilfield Power Generation & Electrification

Power solutions need to be **Flexible, Scalable, Economic, & Reliable**

- Mobile / temporary power generation from 1 MW to +20MW
- Utilization of field gas as primary fuel improves economics & environment
- Modularized purpose built power management reduces grid degradation
- OPEX side procurement models free up CAPEX for value add investment
- Microgrid systems that provide complete power control/assurance
- RM&D optimizes response to ever evolving power conditions across assets

GE allows operators more **control & flexibility in their power/production choices**
Oil field diesel-to-gas drill rig power

GE’s gas engines solutions are creating value today…

Jenbacher J320
- Rated output: 1007 kW
- Lean burn
- Installations on both field gas & LNG
- 1st U.S. EPA certified for mobile & stationary
- Up to 37.2% electrical efficiency
- Up to 25% reduced emissions
- Over 20 installed in N. America as of 2012

Waukesha VHP 7044
- Rated output: 1200 kW
- Rich burn
- Fuel flexible for variable gases
- Up to 31.2% electrical efficiency
- Up to 25% reduced emissions
- First units shipped for 1Q 2013

- Up to 60% lower operating costs
- Up to 25% lower NOx/CO emissions

Marcellus shale, Pennsylvania, USA
- 6 x J320 engines
- 1st U.S. EPA certified technology for mobile and stationary drilling
- Operating on LNG
- Up to 60% lower fuel costs compared to diesel
- Emissions reduction up to up to 25%
Industry operations in communities cause conflict

Technology Solutions

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Trucks for Fuel ...
Trucks for Water

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Goals

- Support the development of natural gas resources
- Promote adoption of GE technologies

In the US, community engagement is essential

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A balanced approach will maintain the social license

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See tutorial regarding confidentiality disclosures.
Thank You