

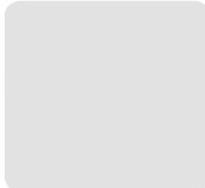
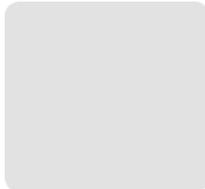
Texas Natural Gas Summit:

Drilling Rig Natural Gas Technology

Todd Fox

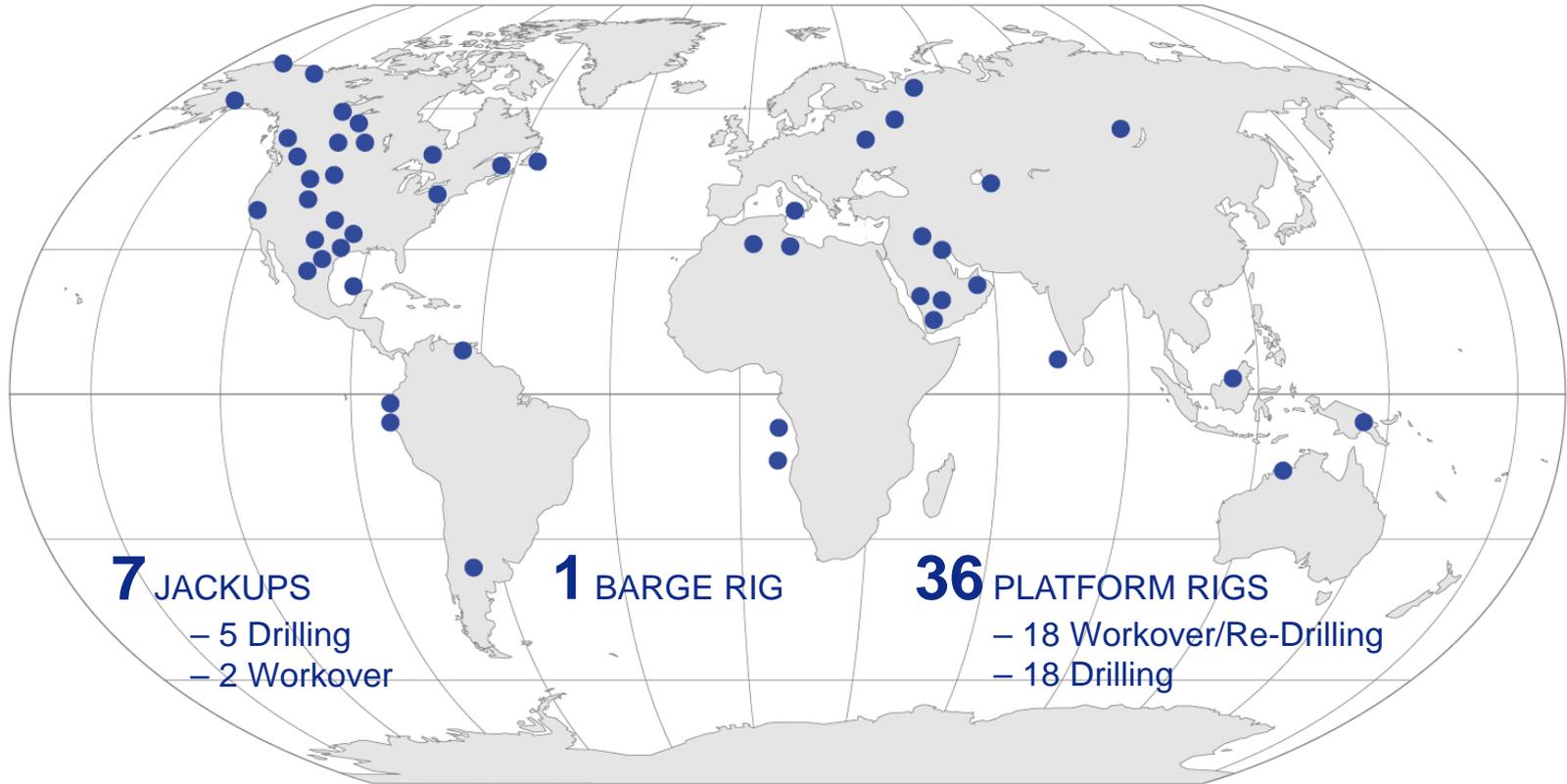
Vice President
Projects, Support, & Performance

October 23, 2014



Worldwide Rig Fleet Status

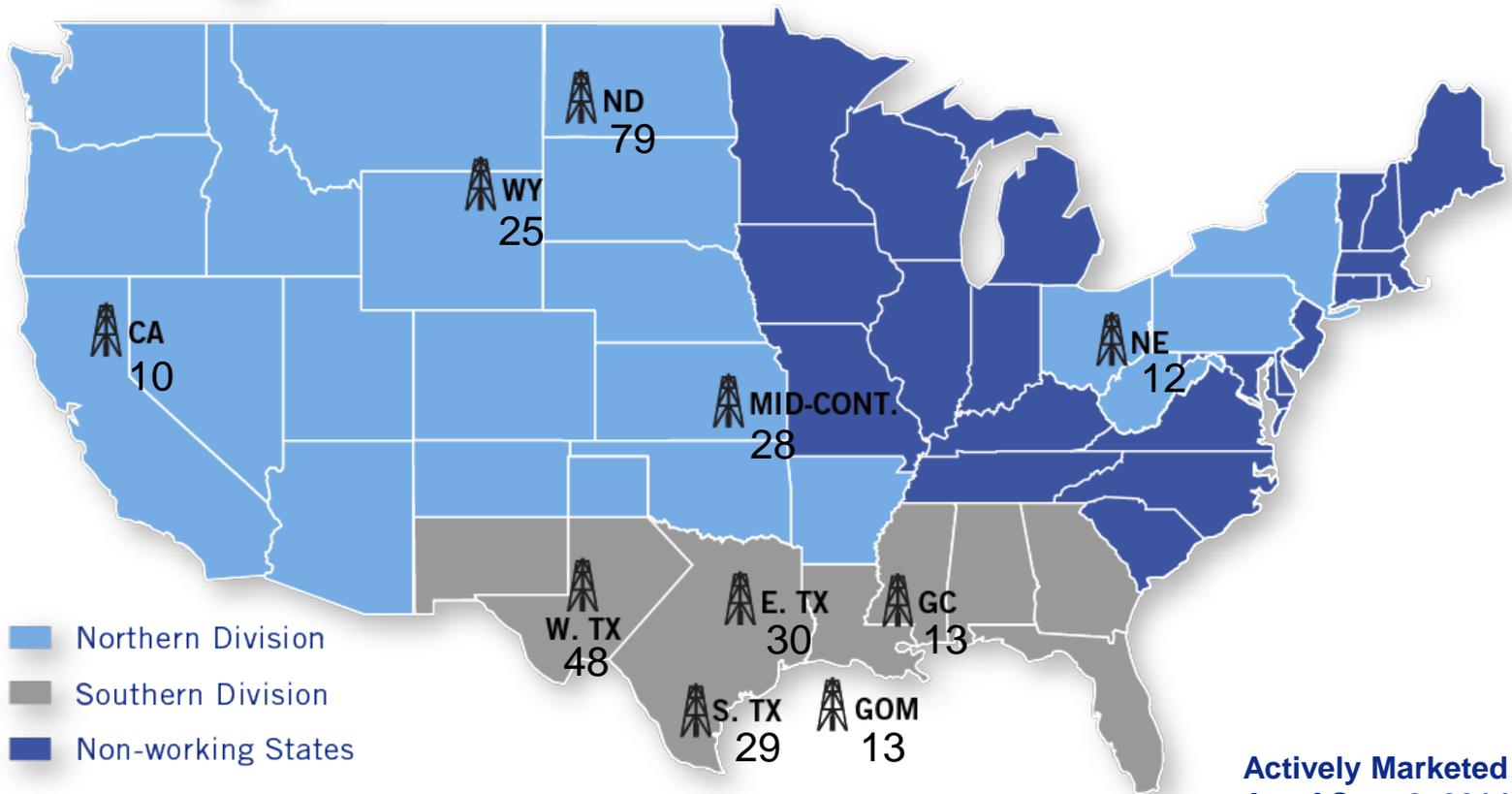
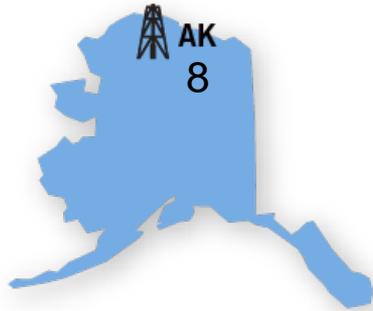
Actively Marketed Rigs Only
As of June 30, 2014



544 LAND WORKOVER RIGS

496 LAND DRILLING RIGS

US Drilling Group



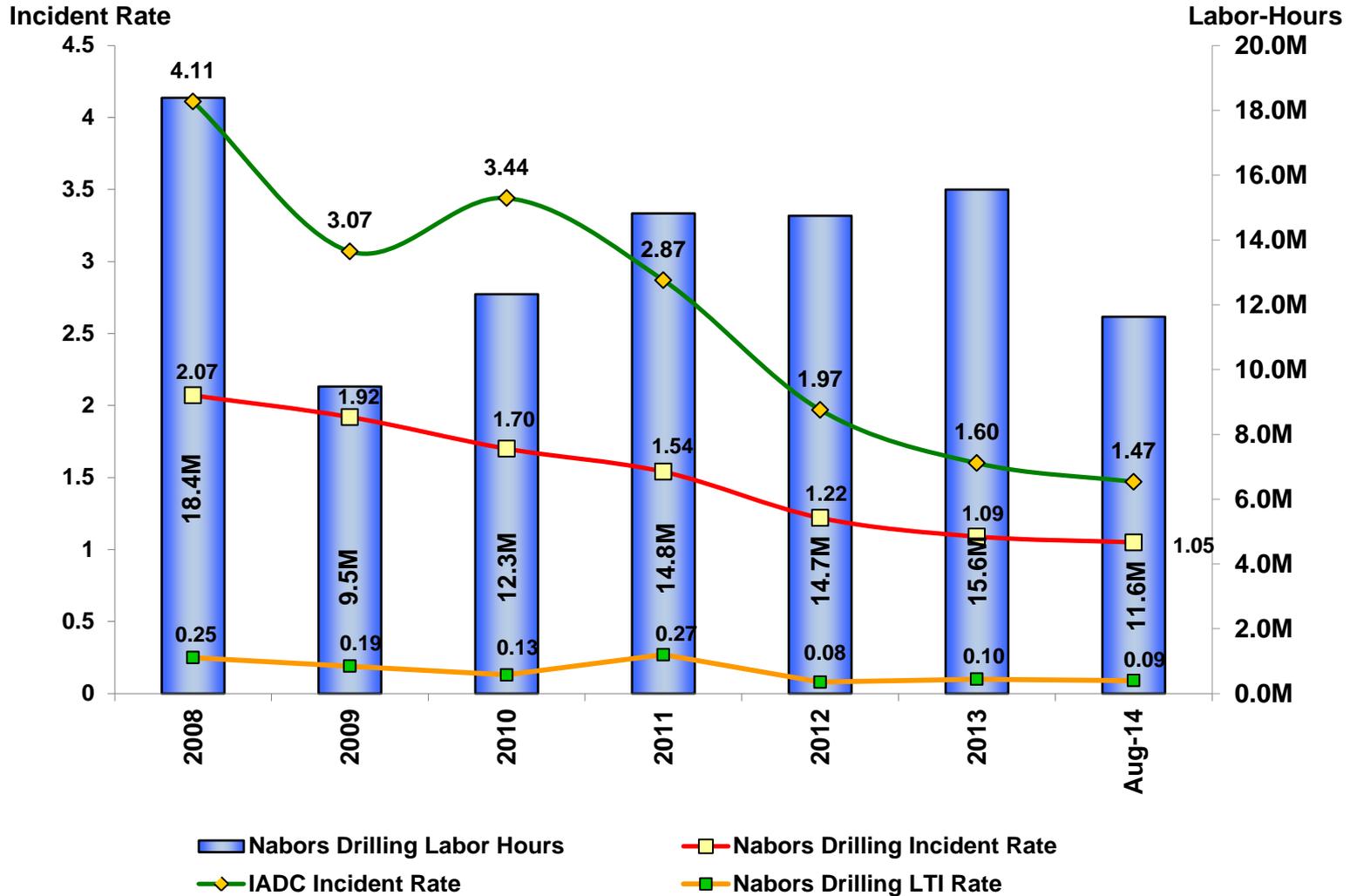
Actively Marketed Rigs
As of Sept 8, 2014



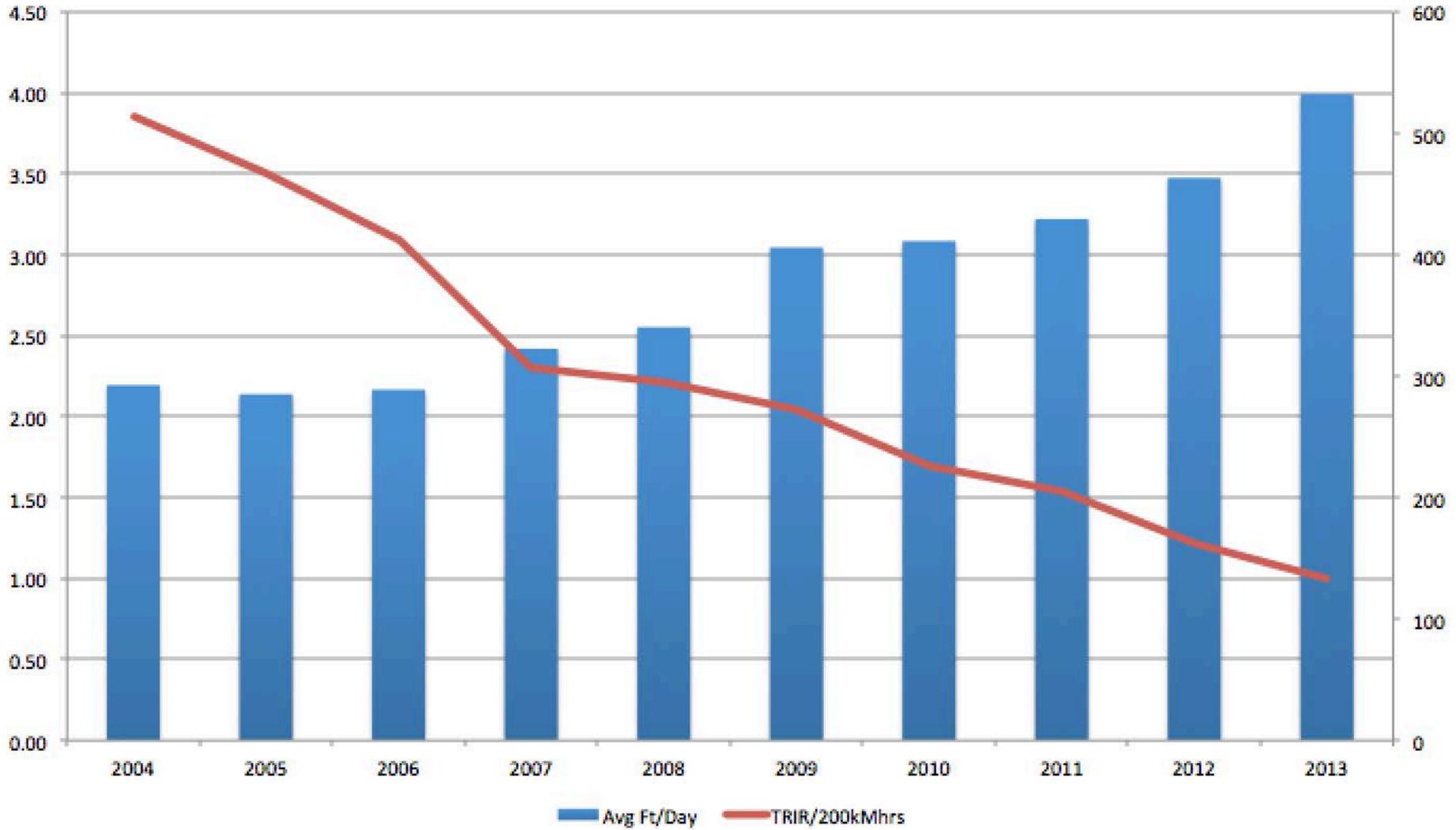
HSE – Mission to Zero Incidents

NABORS US DRILLING SAFETY PERFORMANCE

2008 – August 2014



Safety & Drilling Efficiency Gains Continue





Drilling Rig Natural Gas Technology Overview

A transition to alternative fuel- currently two methods for rigs:

1. Dual Fuel- add-on to existing engines, 61 rig installations to date.

2. 100% Natural Gas- new engines, 2 rig installations to date (2013).



Natural Gas Supply- 4 current methods

1. **Wellhead Gas**
2. **Pipeline Gas**
3. **LNG- Liquefied Natural Gas**
4. **CNG- Compressed Natural Gas**



Push Back to Natural Gas

- > **Supply concerns due to lack of reliable infrastructure.**
- > **Safety concerns.**
- > **Few first adopters.**
- > **Concerns regarding return on investment.**
- > **Technology and rig performance barriers.**
- > **Lack of training and technical expertise on natural gas engines.**



Natural Gas Safety



Gas Flow rate is 73 scfh (max),
3/8 psi max.



Gas Flow rate is 3300 scfh (max),
15-50 psi.

Natural Gas Safety- your home



> Safety Features*:

- Gas Control device (thermostat)
- Air/Fuel shut-off device built into thermostat
- Temperature and pressure relief valve (water)
- Flame arrestor plate
- Vent hood to atmosphere
- Manual shut off valve

* Source: Home Depot online manual for Rheem 75 gal hot water heater.

Natural Gas Safety- drilling rigs



Natural Gas Safety- drilling rigs



Engine flame and gas detection systems



**Gas Detector
Gas Supply Line
at Power House**



**Gas Detector
Front of #3 Generator**



**Gas Detector
Middle of #1 Generator**



**Gas Detector
Gas Supply Line
at Edge of Location**



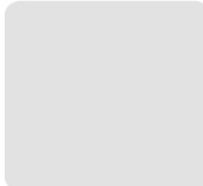
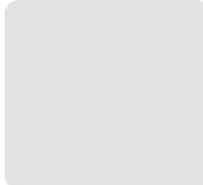
**Gas Detector
Scrubber Skid and
Alert Systems Panel**



**Gas Supply Line
at Power House
Gas Detector**



**Flame Detector above each Generator
Set at 190 F.**



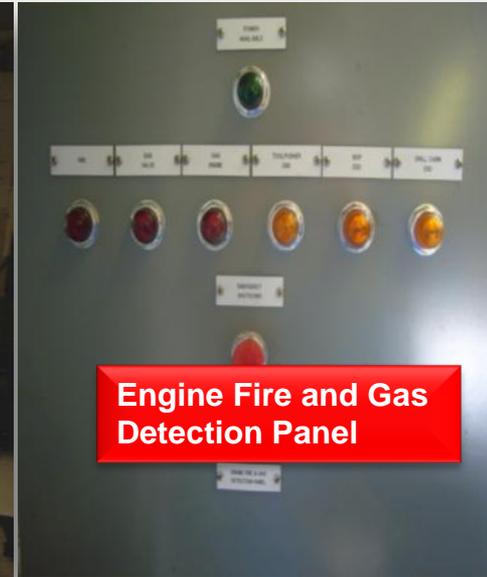
Remote Emergency Shutdown (ESD) switches



Driller's Cabin



Rig Manager's Quarters



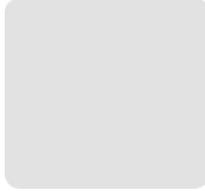
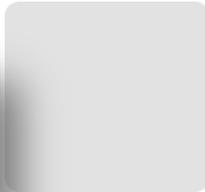
Engine Fire and Gas Detection Panel



Engine House



Scrubber Skid



Economics

- > **Primary business driver today for the drilling contractor is increased rig marketability.**
- > **Dual Fuel System savings can be up to 70% yet currently average 40%.**



Economics

- > **Current dual fuel rigs diesel consumption drops by approx. 1,000 gpd.**
- > **DGE (Diesel Gas Equivalent) pricing of natural gas is roughly \$2.10-\$2.50* per gallon.**

***Unofficial estimate**



Forecast for the future (subject to change!)

- > **LNG facilities will become more prevalent, starting with the larger plays- Eagleford and Bakken.**
- > **Frac spreads and trucking fleets will drive the conversion due to better economics. Drilling rigs will benefit as a result due to improved supply chain.**
- > **Engine technology will improve, dual fuel will become a standard feature if the natural gas price remains low.**



Forecast for the future (subject to change!)

- > **Substitution rates will improve as the OEM's enter the market.**
- > **As LNG facilities become more prevalent, 100% natural gas engine rigs will become more prevalent.**
- > **Energy storage systems will enter the market and improve the economics of 100% natural gas engines as well as dual fuel.**



Questions?

