Distributed LNG Solutions

Flare Elimination Solution
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Oil Production – Associated Gas Flaring Issues

- State and local gov’t cracking down on associated gas flares from oil wells
- New regulations require flare elimination, reduction, or recovery
- Threat to curtail or shut-in existing wells
- Required flare elimination solutions with each new drilling permit
- Traditional flare recovery via gas gathering infrastructure buildout is generally out-of-sync with drilling

Associated gas flares are negatively impacting oil production revenues

Global Flaring (5 Tcf/yr)
1. Russia 1320 Bcf/yr
2. Nigeria 520 Bcf/yr
3. Iran 400 Bcf/yr
4. Iraq 330 Bcf/yr
5. USA 250 Bcf/yr

US Associated Gas Flaring
1. Bakken 350 Mcf/day
2. Permian 52 Mcf/day
3. Barnett 49 Mcf/day
4. Eagle Ford 30 Mcf/day

Source: worldbank.org, eia.gov (2011)
Flare Recovery Options

- Pipeline Gathering
  Small-diameter pipes move natural gas from the wellhead to the gas processing plant or to a larger pipeline.

- Reuse as a Fuel Substitute
  - Consumption at Wellhead ($/mmBtu)
    Using natural gas on site as fuel for uses such as local power generation, heaters, boilers, etc.
  - Capture as NGL & CNG ($$/mmBtu)
    Associated gas is captured, treated, and compressed (screw or reciprocating compressor) at the wellhead.
  - Capture as NGL & LNG ($$/mmBtu)
    Associated natural gas is captured, treated, and liquefied (LNGo™) at the wellhead.
Flare Recovery Options

- There is no universal best choice solution
- Flare operators must consider their specific situation
- NGL/LNG is a good option for flares and stranded well locations with high horsepower diesel consumers nearby

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<th></th>
<th>Flare</th>
<th>Pipe</th>
<th>Wellhead</th>
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<tbody>
<tr>
<td>Environmental Impact</td>
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<tr>
<td>Initial Investment</td>
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<tr>
<td>O&amp;M costs</td>
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<tr>
<td>Transport cost ($/delivered mile)</td>
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<tr>
<td>Redeployable</td>
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<tr>
<td>Energy Density</td>
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<tr>
<td>Value of Product ($/mmbtu)</td>
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<td>Current Available Off-Take Market</td>
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<thead>
<tr>
<th></th>
<th>CNG</th>
<th>LNG</th>
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<tbody>
<tr>
<td>NA</td>
<td>Poor</td>
<td>Good</td>
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[Legend: NA = Not Available, Poor, Good]
Distributed LNG Flare Solution

See video at lng.dresser-rand.com
D-R Flare Recovery Solution - One Stop Shop

Flare Gas → Gas Treatment → Liquefaction

NGLs (sold or used locally)

LNG Consumers

- Drill & Frac Fuel (self-consumption)
- Diesel Fuel Substitute
- Pipeline Sales
- Local Storage & Transport
- LNG

D-R Flare Recovery Solution - One Stop Shop
LNGo™ Liquefaction System Overview

**Gas Conditioning Module** – Molecular sieve removes CO₂ and H₂O. The purge flow, with C₂ and above, is blended into the fuel supply to the Guascor engine.

**Power module** – Genset driven by D-R Guascor 1MW engine consumes purge gas from mole sieve to power unit.

**Compressor module** – D-R MOS™ Compressor drives efficient process.

**Process Module** – delivers ~7,000 gallons LNG per day.

**D-R Enginuity®** - Control and Monitoring Systems.
LNGo™ cycle uses methane as the fuel, refrigerant, and liquefied product.
LNGo™ Liquefaction System Overview

- Modular system converting natural gas to Liquefied Natural Gas (LNG)
- Small scale, point of use (~7,000 gpd) output
- Re-deployable, skid mounted design with small footprint
- Liquefaction cycle uses feed gas as fuel, refrigerant, and liquefied product
- Self powered and easy to permit (no flares) required

Integral part of flare elimination system – potential to eliminate all flaring
LNGo™ Demonstration Unit

Operational Since Dec 2013
LNGo™ Flare Recovery Benefits

- **Oil Well Production Assured.** Meets local and state environmental requirements for flare recovery and elimination
- **One Stop Shop.** Dresser-Rand (D-R) and partners offer complete flare capture solution including all equipment and personnel to manage flare recovery from the wellhead to disposition of Natural Gas Liquids (NGL) & Liquefied Natural Gas (LNG) fluids
- **Positive Economics.** Fixed monthly fee with positive economics for clients self-consuming at least 30% of produced LNG as diesel fuel substitute
- **Re-deployable.** Skid mounted and movable from well to well
- **Premier Equipment and Service.** Backed by proven D-R engineered product technologies and D-R/Siemens Worldwide service and support network
- **Quick Deployment.** Systems in stock ready for immediate delivery

More details and video at lng.dresser-rand.com
Distributed LNG Solutions Contact

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lng.dresser-rand.com
Residual gas is captured, treated, and compressed (screw or reciprocating compressor) at the wellhead. Compressed Natural Gas (CNG) is stored and distributed at pressures between 2,900 & 3,600 psi.

<table>
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<tr>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>• Reduces environmental impact</td>
<td>• Requires NGL removal/ gas pretreatment</td>
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<tr>
<td>• Monetizes gas by creating a transportable fuel</td>
<td>• Low energy density fuel compared to diesel or LNG</td>
</tr>
<tr>
<td>• Processed at wellhead</td>
<td>• Competes against pipeline delivered natural gas</td>
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<tr>
<td>• Scalable &amp; redeployable</td>
<td>• Not appropriate in markets requiring energy dense fuel</td>
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<td>• Large potential market in passenger vehicles</td>
<td>• Medium capital investment</td>
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* Energy density/ tank capacity fluctuates with ambient temperature by ±30% assuming 80 F basis (Source: Clean Energy)
Liquefied Natural Gas (LNG)

Residual natural gas is captured, treated, and liquefied (LNGo™) at the wellhead. Liquefied natural gas (LNG) is natural gas in a dense liquid form at approximately -260°F and low pressure for easy storage and transportation.

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<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>• LNGo™ can operate at wellhead</td>
<td>• Requires NGL removal/ gas pretreatment</td>
</tr>
<tr>
<td>• Monetizes gas by creating dense transportable fuel</td>
<td>• Medium capital Investment</td>
</tr>
<tr>
<td>• Scalable &amp; redeployable</td>
<td>• Short shelf life for LNG (45-300 days)</td>
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<tr>
<td>• High energy density</td>
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<tr>
<td>• Ideal for high horsepower markets requiring energy dense fuel</td>
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<tr>
<td>• Easily competes against diesel fuel pricing ($28/mmbtu)</td>
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![Image of truck and LNG tanks]