Presentation Overview

1. Shale Oil & Gas – Major Challenges Ahead
   - Over-Supply and Slow Demand Growth Will Suppress Prices
   - Economic Challenges for Canadian Shale Gas
   - Environmental Challenges
     - Water Supply
     - Water Disposal

2. Portable Water Treatment Facility to Enable Water Recycle
   - Oak Point Technology and Process Configuration
   - Portability
   - Economic and Environmental Benefits

   - Processing Produced Water for Re-Use
   - Uses for Reclaimed Produced Water
   - Facility Deployment and Relocation to Activity Areas
   - Water Management as a Third Party Service
Global Supply/Demand Imbalance  
Production Outpaces Demand Growth

Over-Supply Leads to Price Collapse
- US, Saudi-Arabia, Canada, Iraq and Russia led unprecedented 5-year supply growth
- Widening supply-demand imbalance
- High inventories and ability of shale oil to quickly fill any supply shortages will limit prices increases for the foreseeable future

2014-15 Crude Spot Pricing

Source: Short-Term Energy Outlook, August 2015.
Rapid Rise of US Shale Gas Production
Marcellus – Haynesville – Eagle Ford

The New Threat to Canadian Gas Markets

- > 23 bcf/d incremental US gas production in the past 8 years (primarily from Marcellus, Haynesville and Eagle Ford basins)
- More than replaces the peak Canadian production of 18 bcf/d (2000-2006)
- Continued drilling signals profitability in the $2-$3/MMBtu range
US Gas Market Disappearing for Canada
US Nat. Gas Growth Eclipses Canadian Supply

Producers Compete for Markets
- AECO discount ($0.50-$1.00) on NYMEX
- Marcellus discount ($1.50-$2.00) on NYMEX
- LNG spot price is collapsing
- Canadian suppliers compete with US shale gas for US markets and also face pressure from US supply to eastern Canadian markets

Benchmark Gas Prices - US$/MMBtu

<table>
<thead>
<tr>
<th></th>
<th>Last</th>
<th>Δ 1M</th>
<th>Δ 1Y</th>
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<tbody>
<tr>
<td>NYMEX</td>
<td>$2.67</td>
<td>-5.3%</td>
<td>-33.9%</td>
</tr>
<tr>
<td>AECO</td>
<td>$2.19</td>
<td>-5.5%</td>
<td>-41.4%</td>
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<tr>
<td>Marcellus (Tennessee)</td>
<td>$1.02</td>
<td>-18.1%</td>
<td>-47.0%</td>
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Source: Platts, Heren, Petroleum Association of Japan and Bloomberg (Feb 2015)
Economic Challenges
Economic Viability is at Stake

- Economic Challenges for Canadian Producers
  - Low Netback Prices
    - Lower commodity prices at the wellhead compared to US producers
    - Competing with low cost Marcellus gas that can replace all Canadian imports and Marcellus gas now competing into eastern Canadian markets
    - Market access issues adding to cost and uncertainty associated with product delivery
  - New Markets Needed
    - US shale gas displacing Canadian gas imports
    - US shale gas increasing supplies to Eastern Canada
  - Cost Reductions to Maintain Competitiveness
    - High development costs in remote locations without existing infrastructure (roads, pipelines, disposal wells, accommodations, etc.)
    - Significant operating cost associated with water handling and disposal
Environmental Challenges
Rapidly Increasing Frack Water Volumes

Fracturing Water Requirements:
- 3 to 5 million gallons per horizontal well (3-8 million gallons over to the full well life)
- 250 billion gallons used for hydraulic fracturing in US from 2005 to mid-2013 (average of 1.9 million bpd)
- 100 billion gallons used from January 2011 to May 2013 (2.7 million bpd)
- Fracturing requirements could be met by recycling <5% of on-shore produced water

Nearly half of the wells hydraulically fractured since 2011 were in regions with high or extremely high water stress, and over 55 percent were in areas experiencing drought.

Source: Ceres analysis using PacWest FracDB from FracFocus data from wells drilled January 2011-May 2013.
Environmental Challenges
Increasing Produced Water Volumes

Produced Water Volumes:

- Onshore production resulted in 20 billion bbl/yr (55 million bpd) of produced water
- 98% sent to disposal wells (60% into producing formations and 40% to non-producing formations)
- >90% of produced water from off-shore operations is discharged to the sea
- As the figure illustrates, the states that yield the most produced water are also regions where water supply is a major concern

Figure 1. Total U.S. produced water generated (barrels) in 2007 by state (five states with the greatest produced water generation are shown)
Environmental Challenges
Wastewater Disposal Linked to Earthquakes

Number of Associated Earthquakes Rapidly Increasing:

- Between 2009–2013, this rate jumped to an average of 99 M3+ earthquakes per year and rising.
- In 2014 alone, there were >650 earthquakes.
- The oil and gas industry will need alternatives if deep well disposal of waste water is banned or restricted.

New study finds “High-rate injection is associated with the increase in U.S. mid-continent seismicity”

Source: Science Magazine June 19, 2015
“Fort Nelson First Nation wins ruling against Nexen: Water license for fracking operation cancelled” ¹

“Fracking poses 'significant' risk to humans and should be temporarily banned across EU, says new report “ ²

“N.Y. Officially Bans Fracking With Release of Seven-Year Study” ³

Public concerns over environmental impacts is becoming a major hurdle for the shale industry

Sources:
1. National Post September 8, 2015
2. The Independent June 20, 2015
Water Recycling for Fracking
Address Economic & Environment Concerns

• Economic Benefits of Recycling Water
  - Reduce water handling costs
    - Trucking costs for source frack water
    - Trucking for flow back and produced water to disposal well site
    - Disposal well costs

• Environmental Benefits of Recycling Water
  - Reduce or eliminate the potable water demand for fracking
    - In most regions, produced water far exceeds frack water demand
    - Produced water rates tend to remain fairly steady over time
    - Matching produced water treating capacity to produced water production is ideal
    - Industrial/municipal waste water streams or non-potable (high TDS) subsurface water would be additional sources of feed to the treating facility

  - Reduce or eliminate wastewater disposal
    - Recycle wastewater for fracking
    - Treat water for agricultural use or release into natural watershed
Produced Water & Frack Water Volumes
Volumes on the Rise

- US frack water and produced water volumes are massive

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<tr>
<th></th>
<th>Billion BPY</th>
<th>Million BPD</th>
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<tbody>
<tr>
<td>Produced Water Volumes (2007)</td>
<td>21.0</td>
<td>57.5</td>
</tr>
<tr>
<td>US Frack Water Usage (Jan'11 to May'13)</td>
<td>2.3</td>
<td>2.6</td>
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</table>

- Canada’s shale gas industry is lagging the US, but will face increased pressure if LNG projects proceed
  - > 1,700 Tcf of natural gas resource potential for Duvernay, Montney, Horn River, Cordova and Liard
  - LNG or other export alternative as the US is no longer a buyer

- High costs associated with frack water acquisition and produced water disposal

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<tr>
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<th>Range of Cost</th>
<th>Cost for Economics</th>
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<tr>
<td>Fresh Water Acquisition (including trucking)</td>
<td>$0.88 - $6.05/ bbl</td>
<td>$2.00/ bbl</td>
</tr>
<tr>
<td>Disposal Costs (including trucking)</td>
<td>$1.13 - $10.75/ bbl</td>
<td>$5.00/ bbl</td>
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   - Oak Point Technology and its Origins
   - Process Configuration
   - Portability
   - Economic and Environmental Benefits

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Selecting the right technologies to process produced water (incl. flow back water) into a high quality product with multiple potential uses

- Proven technologies to process produced water into a high quality distilled water that can be used for multiple purposes
- Portable evaporator system - The heart of Oak Point’s SAGD facility design consists of a produced water treating facility that can produce a high quality water that is suitable for use as boiler feed water
- Plug and play modules that can be tailored to suit site specific water quality specs
The Solution: Standardized Portable Water Treating Facilities

<table>
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<tr>
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<th>UltraLite Evaporator</th>
<th>InSite Evaporator</th>
<th>MultiSite Evaporator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (bpd)</td>
<td>4,300</td>
<td>25,000</td>
<td>75,000</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>CDN$ 8,800,000</td>
<td>CDN$ 19,000,000</td>
<td>CDN$ 43,000,000</td>
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</table>
1st Generation Evaporator Design
Oil Accumulation & pH Control

**Hardness** – on-line acid wash system to descale exchanger surfaces

**Silica** – control pH of the feed, but actually want to control pH of the sump

**Oil** – accumulates on top of the sump due to its lighter density and doesn’t vaporize with the distillate

**Liquid entrainment** – Tapered steam path with increasing vapor velocity is a poor design for liquid disengagement

**Size** – Large diameter to accommodate the sump and annular space for steam flow.

**Distilled Water**

**Caustic Addition**

**Evaporator Feed**

**Brine Blowdown**

**Circulation Pumps**
Next Generation Evaporator Design
Portable and Reliable Evaporator Design

Oak Point’s proprietary evaporator was designed specifically for oil service:

- Control system designed to robustly and automatically control oil and silica contamination
- Blowdown system designed to prevent oil accumulation
- Dedicated sump to prevent brine carryover to steam circulation loop and reduce equipment size to support portability
- Two effect evaporator system provides on-line maintenance capability, reduce size individual equipment components (modularity) and reduces fouling
- Modular portable single train evaporator possible above 70,000 bpd
- Water wash trays on compressor suction to prevent carry-over
Portable water treating facility that can be assembled or dismantled in two weeks. This single feature addresses many of the industry challenges

- **Cost and Economics** – portable water treating facilities that can use non-potable water sources (industry waste water, produced/flow-back water, high TDS well water) as a feed stream and produce a high quality water that can be used for fracking, agricultural or release into the natural watershed. Economics driven by lower water handling and disposal cost for frack water, flow back water or produced water

- **Development Flexibility** – Install water treating facilities near the fracking location and recycle produced/flow back water as source water. Relocate facilities as the fracking locations shift over time
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A Better Water Management Strategy
Utilizing Non-Potable Water Source

- **Economics: Recycling vs Disposal**
  - Reduce costs to compete in a low oil price environment
    - Portable water processing facilities to augment infrastructure requirements in remote undeveloped locations
    - Recycle produced water for fracking to reduce water supply and disposal costs.
      - Produced water disposal cost: $5.00/bbl
      - Fracking water supply cost: $2.00/bbl
      - Total Disposal and Supply Cost: $7.00/bbl
    - Produced water processing costs $1.30 to $3.00 per bbl
    - On a per barrel of oil basis this is much higher since for every barrel of oil production there is a multiple of associated produced water
    - Current energy prices will not support these costs

**Economics Favour the Environmental Solution:**
Recycling produced water is both a lower cost option and more responsible water management strategy
A Better Water Management Strategy
Balancing Water Sources and Uses

- **Water Sources**
  - **Produced Water Volumes**
    - *In most regions, produced water far exceeds frack water demand*
    - *Produced water rates tend to remain fairly steady over time*
    - *Matching produced water treating capacity to produced water production is ideal*
  - **Alternate Waste Water Streams**
    - *Industrial/municipal waste water streams or non-potable (high TDS) subsurface water would be additional sources of feed to the treating facility*

- **Water Uses**
  - **Fracturing Demand**
    - *Fracturing demand tends to be intermittent (large volume for a short duration)*
    - *Storage will be an important consideration (clean water can be stored in ponds)*
  - **Agricultural Demand**
    - *80% of US fracking activity occurs in water stressed regions*
    - *Excess produced water could be used for irrigation (a truly “green” solution)*
    - *Volumes beyond local demand meets specs for release into the natural watershed*
A Better Water Management Strategy
Water Treating Where it is Needed

- **Portability**
  - Locate Facilities to Minimize Water Handling Costs
    - *Ideal location is where both produced water and fracking exist*
    - *Produced water handling costs are higher than frack water supply cost so locating near produced water sources will be preferred*
  - Relocate as Demand Changes
    - *As we all know today...markets change quickly and the industry needs to adapt at the same speed. Portability provides that flexibility*

- **Midstream Service Potential**
  - Portable Equipment is an Ideal Fit for the Service Industry
    - *Leasing reduces the capital requirements for the producer*
    - *Portable, modular equipment can easily be appended to the offerings already being provided to the industry through the energy service companies*
    - *In low oil price cycles this provides an excellent opportunity to reduce the capital requirements of E&P companies*
In Conclusion
Final thoughts!!!

“We need to address public concerns”
We need to get ahead of this if we want to change public sentiment and that means doing more than the minimum!

“Economic and environmental objectives are not mutually exclusive”
It’s is not easy but often the best solutions can be both environmentally responsible and economic. Otherwise environmental issues will just add to the cost of doing business.

“Alberta needs to be a leader”
Let’s not wait for someone else to solve our problems. We have the most to gain or, conversely, lose