Lessons Learned from LFGTE Mega-Projects in Argentina & Chile and Application to Projects in North America

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South America LFGTE Mega-Projects

• Argentina 12 MW, 2012

• Chile 16 MW, 2013

• Application to North America
Central BuenAyre

6 x G3520C, 1500 rpm
12 MW
Buenos Aires, Argentina
Benito Roggio Ambiental (BR.a)

- Owner and operator of Central BuenAyre

- Member of Grupo Roggio (est.1908)
  - Long tradition in construction, transportation, water treatment, environmental solutions, other businesses.

- BR.a
  - A leader in Latin America for the supply of environmental infrastructure and services.
  - 25 years operating, 580 pieces of equipment
  - 4,200 employees, $245 MM (2012)
BR.a – Key Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>MSW collection (several cities)</td>
<td>1 MM tons/yr</td>
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<tr>
<td>MSW disposal (operation of 3 landfills)</td>
<td>6 MM tons/yr.</td>
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<td>Mechanical-Biological treatment plant</td>
<td>1,000 tons/day</td>
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<td>LFG Value-adding (electricity, other uses)</td>
<td>69 MM m3/yr.</td>
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<td>Hazardous waste treatment &amp; disposal</td>
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- CLIBA – TECSAN – TAYM – ENERCO2
Finning International, Inc.

- Largest Caterpillar dealer in the world
- 15,300 employees, $6.6 billion (2012)
Landfill & GCCS

- Norte III.c
- Owner: CEAMSE
- Opened in 2008
- Area: 100 ha
- MSW collection
  - 14,000+ tons/day
- Wells: 266
- Blowers:
  - 3 x 6,500 m³/hr ea.
- Flares:
  - 2 x 4,500 m³/hr ea.
Energy Project Development

Scope of Supply

• Benito Roggio Ambiental:
  – Design & Construction

• Finning Argentina:
  – Gas cleaning equipment
  – Generator sets
  – Switchgear and controls
  – Installation & start-up
  – 10 yr. maintenance contract
  – Financing via CAT Financial

Leveraged Finning U.K experience
Technical Solution – Central BuenAyre

• 6 x G3520C @ 1500rpm, 2MW ea.
  – 400V, 50Hz

• Requires siloxane removal equipment due to levels well above G3500 limit (e.g., 9 ppm*)

*Siloxanes (as Si), based on 500 Btu/scf fuel
Gas Cleaning Equipment
Engine Cooling & Air Handling
Central BuenAyre – Operational Status

- G3520C Factory Shipment
  - 1Q 2012
- Genset Commissioning
  - June-July 2012
- Plant Start-up:
- First Top-Ends
  - 8,000 – 9,000 hours
- YTD hours:
  - 9,000+
Santa Marta Power Plant

8 x G3520C, 1500 rpm
16 MW
Santiago, Chile
Consorcio Santa Marta (CSM)

- Owner of Santa Marta power plant
- Established in 1998
- Mission: To provide an effective and sustainable solution for MSW management in South Metropolitan Santiago
  - Puerta Sur Transfer Station
  - Santa Marta Sanitary Landfill
- Serves 2 MM people (33% of Santiago pop.)
- 182 employees (2012)
Santa Marta Landfill

• Opened 2002, 296 ha.
• First dry landfill in Chile
  – No leachate pools
  – Green filter 40 ha.
• Flare System: 10,000 m³/hr
Energy Project Development – Santa Marta

Finning Chile Scope of Supply
(Turn-key + 6 months)

- Detailed engineering
- Procurement & construction
- Start-up
- 6-Month initial operation
  - Full operation & maintenance
  - Energy production

Leveraged Finning U.K experience with LFGTE
Technical Solution – Santa Marta

• 8 x G3520C @ 1500rpm, 2MW ea.
  – 400V, 50Hz

• SCR required to meet strict NOx restrictions in metropolitan Santiago area

• Siloxane removal required in order to enable use of SCR on landfill gas generator set
Gas Cleaning Equipment
Air Outlet & Electrical Sub-Station
Santa Marta LFGTE – Operational Status

- G3520C Factory Shipment
  - 3Q 2012
- Genset Commissioning
  - April-May 2013
- Plant Start-up:
  - Sep. 2013
- 2,000 hour maintenance
  - Dec. 2013
- Jan.’14: Approx. 2,500 hrs.
Application to North America Projects
The Search for Increased Power Density

• How can I extract more power from the same engine footprint?

• G3520C used in North American LFGTE market:
  – 1200 rpm, 60Hz, 1.6 MW
  – Not easy nor inexpensive to develop 1800 rpm offering

• Alternative: Keep Engine @ 1500 rpm ➔ gearbox ➔ alternator end @ 1800 rpm ➔ 60Hz, 2MW
- Includes gearbox price and O&M cost in 1500 rpm unit.
- Results match real-life experience with U.K landfill units (60,000+ hours) and other int’l projects.
Thank You For Your Attention!

http://www.catelectricpowerinfo.com/gas/