32 MW Combined Cycle Turbine Plant at the Olinda - Alpha Landfill

Unique Technical Challenges
Introducing Your Panelists

• Stephen Galowitz
  • Chief Development Officer, Broadrock Renewables

• Donald Ries
  • Renewable Energy Program Manager OC Waste & Recycling

• D. Chris Lyons
  • Manager, Power Generation Solar Turbines Incorporated

• Paul Ryan
  • Executive Vice President, DCO Energy LLC
Project is 2nd largest in U.S.

- Utilizes waste heat recovery and beneficial water reuse
- Commenced in 2006 and cost over $120MM
- One of the most efficient LFG-to-electricity plants
- Establishes new BACT standard
- Received $10MM DOE stimulus grant and Treasury §1603 grant
The mission of OC Waste & Recycling is to provide waste management services, protect the environment and promote recycling in order to ensure a safe and healthy community for current and future generations.
The challenge was integrating the construction and operation of a new power plant into the site infrastructure; both administratively and physically.
Renegotiating the Gas Rights

- For the County
  - Stressed compliance and teamwork.
  - More clearly outlined Operations & Maintenance duties & responsibilities.
  - Included an escalating guaranteed minimum royalty amount.

- For Broadrock
  - Flexible term start tied to Commercial Operations Date
    - Includes drop dead timelines and financial requirements
    - Allowed for a phased construction

- Mutual benefit
  - Potable water, recycled water and sewer
Wildfire Throws Us a Curveball

Plant Site
Significant regulations such as NSPS, NPDES, CEQA, sensitive habitat, air rules, and Title 27 have specific and stringent compliance requirements.
Communication and teamwork with all of the parties through monthly, weekly and sometimes daily meetings ensured that the compliance and operational needs of the landfill were continuously addressed while minimizing any impact to the construction and testing activities.
Takeaways

• Communication, communication, communication
• Spend the time you need upfront and create an agreement strong enough to keep things moving and flexible enough to change quickly with the unforeseen.
• If you’re going to do business in CA, hire a local consultant to educate you on the unique laws.
• Build a relationship with the adjacent property owners and local jurisdictions early on in the project.
• Establish the point of contact for public inquiries, such as a Public Info Officer.
• Silicone-based polymers found in consumer products such as shampoos, cosmetics, and deodorants.

• Siloxanes volatize and become part of the gas stream in several forms and composition.

• Typical siloxane levels in raw landfill gas – 35 to 180 mg/m³ Si (Silica)

• Untreated raw gas combusted at high Temp & Press leaves hardened silica deposits on metal surfaces.
Siloxanes on turbine blades

turbine blades

silica deposits
Siloxanes on engine cylinders

Recip engine cylinders
silica deposits
Siloxanes on SCR catalyst

SCR catalyst – silica deposits
Olinda project – bases of design

- Air permit limits
  - NOx – 25 ppmv
  - CO – 130 ppmv
- Solar T-60 guarantee
  - NOx – 42 ppmv
  - CO – 130 ppmv
- SCR and CO catalyst required by air permit.
- Maximum siloxane levels in pilot test – 140 mg/m³
- Volume of gas to be treated – 11,500 scfm
**Allowable siloxane levels for system components**

- **Solar turbine T-60** – 10 mg/m³
- **Solar turbine M-50** – 5 mg/m³
- **Recip engine** – 5 mg/m³
- **Cormetech SCR** – 0.38 mg/m³
Passive adsorber

DCO Energy – BCUA project - 2006

Gas Press – 8 psi
Gas flow - 500 scfm
Raw gas Si – 85 mg/m³
Media volume – 23,400 lbs
Treated gas Si - < 5 mg/m³
Media replacement – 6 months
Regenerative adsorber - LP

low pressure system
DCO Energy – Broad Mountain project - 2008

Gas Press – 25 psi
Gas flow - 2,300 scfm
Raw gas Si – 50 mg/m³
Media volume – 12,000 lbs/train
Treated gas Si - < 5 mg/m³
Media replacement – 12 months
Gas Press – 80 psi
Gas flow - 4,500 scfm
Raw gas Si – 85 mg/m³
Media volume – 9,000 lbs/train
Treated gas Si – 0.38 mg/m³
Media replacement – 12 months
Siloxane treatment system design

- NMOC’s - 2500 ppmv
- H2S - 100 ppmv
- Landfill gas volume – 11,500 scfm
- Raw gas siloxane levels – 140 mg/m3
- Treated gas siloxane levels – 0.38 mg/m3, or 75 ppbv
- Upstream chilling to remove moisture.
- 12-15 hours of regeneration time.
- Regen flare – Ultra Low Emission (ULE)
Siloxane treatment system design

- High pressure system – 125 psig
- Two trains – 3 vessels & 28,000 lbs of media per train
- 3 layers of media – in each vessel
  - Activated Alumina
  - Silica Gel
  - Mole Sieve
- Carbon polisher
  - Passive System
  - 2 Vessels in lead – lag
  - Activated Carbon fill
  - 18,000 lbs of media
3-D Model helped with logistics

Olinda – Gas Conditioning and Compression (GCC)
Bulk system and carbon polisher
Risk mitigation measures

- Carbon polisher
- Solar T-60
  - Guarantee NOx – 42 ppmv
  - Actual – 25-30 ppmv
- Cormetech SCR
  - Guarantee NOx – 25 ppmv
  - Design – 15 ppmv
- Sacrificial catalyst guard bed upstream of CO and SCR catalysts.
- Quarterly testing of SCR bed and siloxane levels in gas to turbine.
• Variable gas quality – NMOC > 2500 ppmv
  • Very high levels of certain Benzene compounds
  • Very high levels of other volatile compounds

• Temperature excursions
  • Oxidation reaction
  • Chemical adsorption
Performance assessment

• Stepped regeneration sequence
  • Start with air only
  • Stepped temperature rise
  • Soak-in time
  • Heater off
  • Cool down time
• Increase regeneration cycle time
• Life expectancy of media reduced
Several Technologies Evaluated

- Reciprocating Engines
- Solar Turbines Mercury 50 Simple Cycle
- Solar Turbines Mercury 50 Combined Cycle
- Solar Turbines Taurus 60 Simple Cycle
- Solar Turbines Taurus 60 Combined Cycle
Technology Options

Reciprocating Engine Plant

Mercury 50 w/WHRU

Mercury 50 SC

Taurus 60 SC w/ SCR
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<th>Products</th>
<th>Issues</th>
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<tr>
<td>Recips</td>
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<tr>
<td>M50 SC</td>
<td>New technology @time, power</td>
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<tr>
<td>T60 SC</td>
<td>Power</td>
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<tr>
<td>T60 CC</td>
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Bottoming Cycle was Worth the Incremental Capital Investment
## Technology Comparisons

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### Tariff Rates, Capital Cost & Output are Key

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<th>NPV</th>
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<tr>
<td>Taurus 60 SC</td>
<td>$ Base</td>
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<tr>
<td>Mercury 50 SC</td>
<td>$ Plus 6%</td>
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<tr>
<td>Mercury 50 CC</td>
<td>$ Plus 40%</td>
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<tr>
<td>Taurus 60 CC</td>
<td>$ plus 105%</td>
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Combined Cycle Provides Excellent Net Plant Heat Rate

**HEAT RATE SUMMARY**

- Fuel MMBtu/hr LHV: 258.5
- Gas Turbine Power kW: 23,160
- Steam Turbine Power kW: 9,610
- Power Produced kW: 32,770
- Less Power Island Ancill kW: 4,400
- Less Utility Transformer Loss kW: 142
- Net Power kW: 28,228
- Heat Rate LHV BTU/kW: 9,157
- Net Cycle Efficiency: 37.3%

**NOTE:** ALL DATA IS BASED ON EXPECTED PERFORMANCE
• Water use in Southern California
  • Secure commitment on cost of water upfront
• Small scale combined cycles are as complex as large scale plants
• A combined cycle plant entails more systems
• Capital cost is typically more than expected
  • Difficult to overestimate the complexity of piping and wiring
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