Peaking plant Bayonne (NJ/USA)
A flexible solution to support a volatile grid based on aero-derivative turbines
Tom Scarinci & Tobias Aschoff

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Case study – Bayonne Energy Center – Key facts

Owner (NYSE:MIC)
Macquarie Infrastructure Corporation

Operator
EthosEnergy Group

- Eight aero-derivative Siemens SGT-A65 TR* with 512 MW generating capacity, in operations since 2012
- Currently building additional 132 MW (two more SGT-A65 TR) on adjacent land owned by IMTT
- Also constructing additional gas lateral to Spectra TETLP M3 pipeline (already connected to Transco Z6)
- Dual fuel capable with liquid fuel connection from Buckeye Terminal
- Provides peak power to New York City via a 6.5-mile submarine cable

* formally know as Industrial Trent 60
Bayonne Energy Center – Necessity

BEC is needed to ensure competitive peaking power and grid stability for NYC

Why …

NYC load is **predominantly driven by the ambient temperature** and the weather forecast (A/C demand depending on temperature)
The NYC grid has a **load spread of 3,500 MW** and more per day
Most of the other NYC power plant facilities are more than 40 years old

How …

BEC is the New York City peaking facility providing the most **flexible operating range** and the only one offering **10min non-spinning-reserve** with automatic dispatch

→ 500 MW in 10 min
## Bayonne Energy Center – Purchasing Criteria

<table>
<thead>
<tr>
<th>BEC Requirements</th>
<th>SGT-A65 TR</th>
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<tbody>
<tr>
<td>Multiple starts and stops per day</td>
<td>Unlimited cycles per day, no lock-out</td>
</tr>
<tr>
<td>Low cost per start</td>
<td>Low parasitic loads, fast acceleration</td>
</tr>
<tr>
<td>10 minute start (non-spinning reserve)</td>
<td>500 MW in &lt;10 minutes (cold to full load)</td>
</tr>
<tr>
<td>High full and part load efficiency</td>
<td>Best in class efficiency levels</td>
</tr>
<tr>
<td>High availability and starting reliability</td>
<td>Very low eFORd, very high starting reliability</td>
</tr>
<tr>
<td>High power density</td>
<td>Highest MW output on BEC’s footprint</td>
</tr>
<tr>
<td>Black start capable</td>
<td>Low starting power requirement (&lt;350 kW)</td>
</tr>
<tr>
<td>Automatic generation control</td>
<td>Automatically starts &amp; achieves MW set point</td>
</tr>
<tr>
<td>Low operation and maintenance costs</td>
<td>Two operators on shift for eight turbines</td>
</tr>
<tr>
<td>State of the art (SOTA) emission levels</td>
<td>Best achievable emission performance</td>
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Bayonne Energy Center –
High cycling capability

March 7, 2016: 33 total start (six starts on unit 2)

Total plant Output
(~500 MW peak)

Unit No. 2 Output
(64 MW max)

No EOH counter
Bayonne Energy Center –
10 minutes start up capability & low cost per start

Fast start enables 10 min non-spinning-reserve and low start up costs due to less time at lower efficiency

Cost per start:
$40-60

Based on ≈20 MMBTU
gas required to accelerate
to base load and
$2-3 per MMBTU
Bayonne Energy Center – High full and part load efficiency

Multiple unit concept enables flexibility and optimized efficiency at all operating points

Advantages of multiple unit power plants

- High simple cycle full load efficiency
- Better efficiency at most part load operating points
- Fast start and steep ramp rates
- Low station power loss during gas turbine maintenance outage (up to 448 MW available)
- Turndown to <5% plant output
- Emission compliance over entire curve

BEC efficiency higher than most other NYC peaking facilities

* Schematic
Bayonne Energy Center –
High availability and starting reliability

IEEE Standard – eFORd
A measure of the probability that a generating unit will not be available due to forced outages or forced derating when there is a demand on the unit to generate

Average simple cycle eFORd
≈ 5.30%

BEC 2016 YTD eFORd
= 0.86 %

Only 13 failed starts out of 2653 attempts.

Average failed start
≈ 15 minutes

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<tbody>
<tr>
<td>January</td>
<td>207</td>
<td>206</td>
<td>99.5%</td>
<td>0.40</td>
<td>96.82</td>
</tr>
<tr>
<td>February</td>
<td>263</td>
<td>261</td>
<td>99.2%</td>
<td>0.73</td>
<td>99.90</td>
</tr>
<tr>
<td>March</td>
<td>512</td>
<td>511</td>
<td>99.8%</td>
<td>1.76</td>
<td>98.50</td>
</tr>
<tr>
<td>April</td>
<td>423</td>
<td>422</td>
<td>99.8%</td>
<td>0.29</td>
<td>88.07</td>
</tr>
<tr>
<td>May</td>
<td>328</td>
<td>325</td>
<td>99.1%</td>
<td>0.03</td>
<td>81.06</td>
</tr>
<tr>
<td>June</td>
<td>275</td>
<td>273</td>
<td>99.3%</td>
<td>0.14</td>
<td>99.89</td>
</tr>
<tr>
<td>July</td>
<td>311</td>
<td>311</td>
<td>100.0%</td>
<td>0.59</td>
<td>97.63</td>
</tr>
<tr>
<td>August</td>
<td>334</td>
<td>331</td>
<td>99.1%</td>
<td>1.30</td>
<td>97.90</td>
</tr>
<tr>
<td><strong>Report Totals</strong></td>
<td><strong>2653</strong></td>
<td><strong>2640</strong></td>
<td><strong>99.5%</strong></td>
<td><strong>0.86</strong></td>
<td><strong>94.94</strong></td>
</tr>
</tbody>
</table>

Att. = Attempted Starts | Act. = Actual Starts | Rel. = Starting Reliability | eFORd = Equivalent Demand Forced Outage Rate | EAF = Equivalent Availability Factor
Bayonne Energy Center –
Highest power density

Optimal land utilization in the high price NYC area

The applied solution enables about 20% more power on the give ground

<table>
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<tr>
<th>SGT-A65 TR</th>
<th>Other solutions</th>
</tr>
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<tbody>
<tr>
<td>512 MW</td>
<td>~400 MW</td>
</tr>
<tr>
<td>19 kW/m²</td>
<td>14.5 kW/m²</td>
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+132 MW BEC Expansion Site
Bayonne Energy Center ("BEC"): 6.8 acres (≈27,500 m²)
Siemens SGT-A65 TR
Heritage from Rolls-Royce Aero Trent

~30 Million – Aero Trent 800 hours
1.2 Million – SGT-A65 TR fleet hours

104 – Total engines sold
Siemens SGT-A65 TR
Combustion Systems

Wet Low Emission (WLE)

Dual fuel with water injection burner
No EOH on liquid operation.

Dry Low Emission (DLE)
Siemens SGT-A65 TR
Package

Designed for Maintainability and Quick Installation

Engine weighs less than 11 tonnes and is air freight transportable
Small footprint (~220 m²)
Installation possible <75 days
Engine change-out within <48 hours

Weights
- GT Skid: 75,000 kg
- GT Package Roof: 18,000 kg
- GT Engine: 14,000 kg
- Filter: 21,300 kg
- Generator Skid: 107,000 kg
SGT-A45 TR Mobile Unit –

Key benefits

- 44 MWₑ (ISO) – highest power density
- 2-weeks installation
- Delivered by road, air or sea
- Performance optimized for hot climates
- 50 Hz or 60 Hz
- Liquid and gas fuel
- Emissions as low as 25 vppm NOₓ
- Proven turbomachinery
- Minimal site interfaces and preparation
Conclusion & Outlook

**Conclusion**

BEC is a successful plant for grid support in a weather driven, highly volatile grid due to
- Fast start and operational flexibility
- High full and part load efficiency
- High reliability and availability

Bayonne recently extends the plant by two more units due to good experience and great performance

The concept can be applied to other volatile grids – e.g. with high share of renewables

**Outlook**

**Flexible Combine Cycle Plants**
with up to 53.6% efficiency

**Hybrid plants**
- SGT-A65 TR with heavy duty large gas turbine (using the same boiler)
- SGT-A65 TR combined with battery storage for back start and quick response
- SGT-A65 TR with CSP plant (using the same boiler)

**Mobile Power**
SGT-A45 TR Mobile Unit with 44MW launched
Thank you for your attention

Tobias Aschoff
Power and Gas Division
Distributed Generation
PG DG SPM
Mobile: +49 173 5133163
E-mail: tobias.aschoff@siemens.com

Tom Scarinci
Power and Gas Division
Distributed Generation
PG DG GCS
Mobile: +1 514 4636283
E-mail: thomas.scarinci@siemens.com

siemens.com
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