Updated Results and Discussion: Capital Cost and Performance of New Entrant Peaking Unit

Presentation to NYISO ICAP Working Group

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Topics

- More Detail on Capital Costs
- Comparison to Capital Costs of Last Demand Curve Review
- Review of Technology Choice Issues

Comparison of EPC Costs

Comparison of EPC Capital Cost Estimates - Demand Curve Review

	Capital Cost Comparison 2 x LM6000 New York City		Capital Cost Comparison 2 x LM6000 ROS (Syracuse)		NYC Costs as a % of Upstate	
	This DC Review	Last DC Review[1]	This DC Review	Last DC Review[1]	This Review	Last Review
	Cost (2007$)	Cost (2004$)	Cost (2007$)	Cost (2004$)	NYC / Zone C	NYC / ROS
EPC Cost Components						
Equipment						
Equipment	41,502,000	40,500,000	41,502,000	40,500,000	100%	100%
Spare Parts	1,000,000	1,000,000	1,000,000	1,000,000	100%	100%
Subtotal	42,502,000	41,500,000	42,502,000	41,500,000	100%	100%
Construction						
Construction Labor & Materials	41,279,000	44,980,000	24,352,000	33,960,000	170%	132%
Electrical Connection & Substation	3,549,000	3,500,000	2,257,000	2,750,000	157%	127%
Electrical System Upgrades	500,000	2,500,000	500,000	1,250,000	100%	200%
Gas Interconnect & Reinforcement	4,000,000	4,000,000	3,400,000	3,400,000	118%	118%
Site Prep	1,526,000	2,200,000	940,000	1,300,000	162%	169%
Engineering & Design	4,755,000	4,000,000	3,738,000	3,000,000	127%	133%
Construction Mgmt. / Field Engr.	1,189,000	0	934,000	0	127%	N/A
Subtotal	56,798,000	61,180,000	36,121,000	45,660,000	157%	134%
Startup & Testing						
Startup & Training	793,000	750,000	623,000	750,000	127%	100%
Testing	-	250,000	-	250,000	N/A	100%
Subtotal	793,000	1,000,000	623,000	1,000,000	127%	100%
Contingency	9,459,000	0	7,435,000	0	127%	N/A
Subtotal - EPC Costs	109,552,000	103,680,000	86,681,000	88,160,000	126%	118%

Notes:

1. Levitan & Associates, Independent Study to Establish Parameters of the ICAP Demand Curves for the New York Independent System Operator, August 16, 2004, p. 6.

Comparison of EPC Costs to Last Review

- Equipment costs almost the same
- Certain EPC cost items treated differently:
  - *Contingency*
  - *Construction management and field engineering*
  - *Testing*
- Overall, lower upstate and higher in NYC
- Larger spread between NYC and upstate
  - *26% vs. 18% overall*
  - *57% vs. 34% on construction costs*

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Comparison of Non-EPC Costs

Comparison of Non-EPC Capital Cost Estimates - Demand Curve Review

	Capital Cost Comparison 2 x LM6000 New York City				Capital Cost Comparison 2 x LM6000 ROS (Syracuse)				NYC Costs as a % of Upstate	
	This DC Review		Last DC Review[1]		This DC Review		Last DC Review[1]		This Review	Last Review
	Cost (2007$)	Non-EPC as % of EPC	Cost (2004$)	Non-EPC as % of EPC	Cost (2007$)	Non-EPC as % of EPC	Cost (2004$)	Non-EPC as % of EPC	NYC / Zone C	NYC / ROS
Non-EPC Cost Components										
Owner's Costs										
Permitting	1,096,000	1.00%	4,050,000	3.91%	867,000	1.00%	1,050,000	1.19%	126%	386%
Legal	2,191,000	2.00%	1,285,714	1.24%	1,734,000	2.00%	1,000,000	1.13%	126%	129%
Owner's Project Mgmt. & Misc. Engr	2,191,000	2.00%	1,333,333	1.29%	1,734,000	2.00%	1,000,000	1.13%	126%	133%
Social Justice	500,000	0.46%	500,000	0.48%	125,000	0.14%	125,000	0.14%	400%	400%
Owner's Development Costs	3,287,000	3.00%	0	0.00%	2,600,000	3.00%	0	0.00%	126%	N/A
Financing Fees	2,191,000	2.00%	0	0.00%	1,734,000	2.00%	0	0.00%	126%	N/A
Financial Advisory	274,000	0.25%	0	0.00%	217,000	0.25%	0	0.00%	126%	N/A
Environmental Studies	274,000	0.25%	0	0.00%	217,000	0.25%	0	0.00%	126%	N/A
Market Studies	274,000	0.25%	0	0.00%	217,000	0.25%	0	0.00%	126%	N/A
Interconnection Studies	274,000	0.25%	0	0.00%	217,000	0.25%	0	0.00%	126%	N/A
Subtotal	12,552,000	11.46%	7,169,047	6.91%	9,662,000	11.15%	3,175,000	3.60%	130%	226%
Financing (incl. AFUDC, IDC) [2]										
EPC Portion	4,985,000	4.55%	3,169,895	3.06%	3,944,000	4.55%	1,899,500	2.15%	126%	167%
Non-EPC Portion	571,000	0.52%	0	0.00%	440,000	0.51%	0	0.00%	130%	N/A
Working Capital and Inventories	2,191,000	2.00%	0	0.00%	1,734,000	2.00%	0	0.00%	126%	N/A
Subtotal - Non-EPC Costs	20,299,000	18.53%	10,338,942	9.97%	15,780,000	18.20%	5,074,500	5.76%	129%	204%
Total Capital Investment	129,851,000	118.53%	114,018,942	109.97%	102,461,000	118.20%	93,234,500	105.76%	127%	122%

Notes:

1. Levitan & Associates, Independent Study to Establish Parameters of the ICAP Demand Curves for the New York Independent System Operator, August 16, 2004, p. 6.
2. Value for this review is estimated from a typical construction period drawdown schedule for a gas turbine peaking plant.

Comparison of Non-EPC Costs to Last Review

- Much higher non-EPC costs
  - *Almost double in NYC*
  - *Triple upstate*
- Several items considered a standard part of non-EPC costs have been included this time:
  - *Owner's costs for development, financing fees, financial advisory services, and environmental, market, and interconnection studies*
  - *Working capital and inventory*

Choice of Technology

- What is a Peaking Unit?
  - *"A peaking unit defined as the unit with technology that results in the lowest fixed costs and the highest variable costs among all other units' technology that are economically viable."*
    - *Per New York Independent System Operator, Inc., 113 FERC 61,271 P12 (2005)*
- Technologies with the highest variable cost may not have the lowest fixed costs, and vice versa
- Developers considering investments in peaking units consider the overall competitiveness of the investment

Considerations

- Lowest fixed cost:
  - *Consider both capital cost and unit size rather than just $/kW alone*
    - *Larger unit with higher upfront capital cost can have lower $/kW, but does it have the "lowest fixed cost" in terms of absolute magnitude?*
- Highest variable cost:
  - *Fuel cost is the largest component of variable cost*
  - *Comparing heat rates among technologies and to the market heat rate is one reasonable approach differentiating technologies with high variable cost*
- Economically viable:
  - *Factors that affect future utilization should be considered:*
    - *Performance characteristics of new technology*
    - *Emissions limitations on operating hours*
    - *Current choices made by project developers*

Comparison of Technologies

Comparison of Technologies Considered for NYISO Demand Curve Review

	Simple Cycle				Combined Cycle	
	7EA[1]	7FA[1]	LM6000 Sprint	LMS100	7EA 2 on 1	7FA 2 on 1
Capacity of 2-Unit Greenfield Addition (MW)	165	330	99	200	250	505
EPC Capital Cost[2] ($m)	100-130	160-200	82-104	148-182	210-280	340-440
Heat Rate HHV (Btu/kWh)[3]	12,000	10,700	9,700	9,100	8,100	7,300

Notes:
1. Cannot be fitted with SCR, requiring limitation on annual hours of operation due to emissions.
2. Costs with shaded background are rough estimates for comparative purposes. Costs without shaded background have been estimated in detail by S&L for the NYISO Demand Curve Review.
3. Average degradation with evap coolers at ISO conditions; no duct firing for Combined Cycle

- S&L views the LM6000 and LMS100 as the competitive technologies upon which to base Demand Curve estimates
  - *Low capital cost*
  - *No restriction on operating hours*
  - *Competitive heat rates among simple cycle machines*

Combined Cycle Comparison

Zone	Long Island	NYC	Hudson Valley	Capital	Central
Market Heat Rate HHV (Btu/kWh)[4]	10,700	10,500	9,000	8,800	8,000

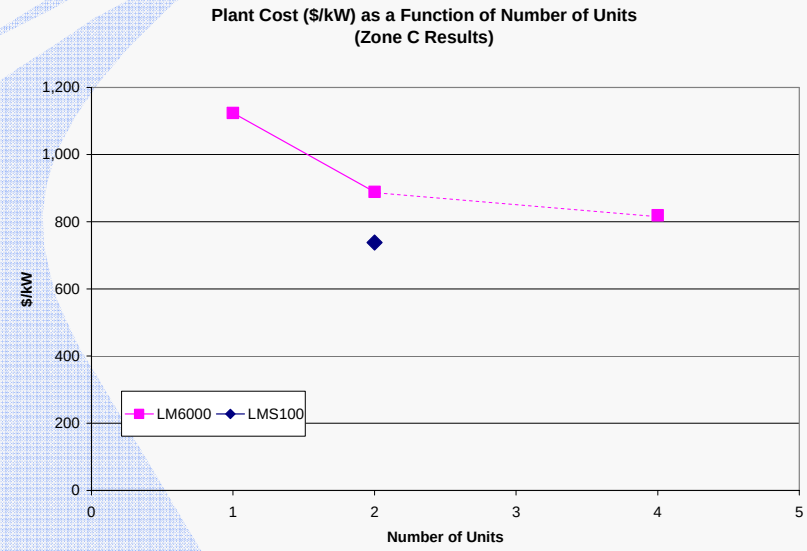
4. Defined as electricity price divided by the gas price. Based on prices modeled by NERA.

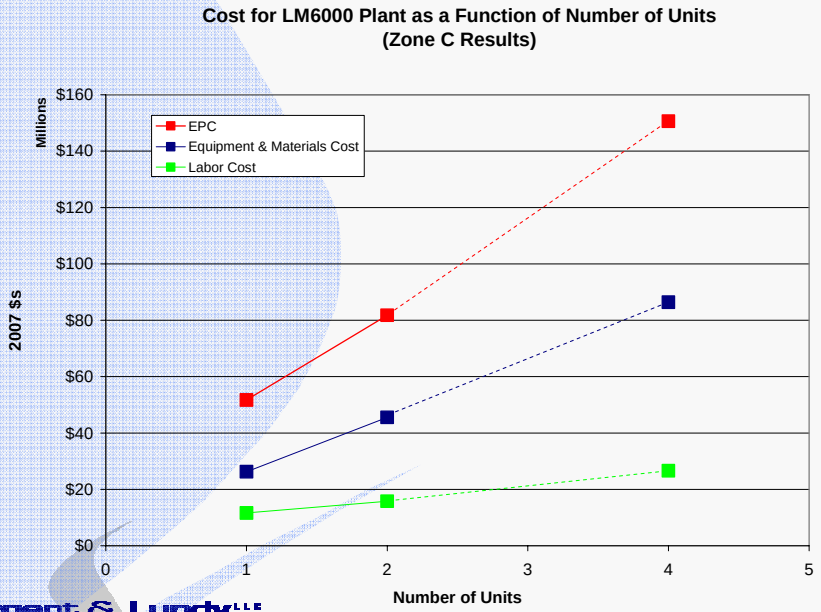
- The heat rate of combined cycle machines will likely result in higher capacity factors that are more representative of intermediate units
- The long startup times for combined cycle plants (hours) are not indicative of peaking units

Simple Cycle Frame Machines

- Simple cycle frame machines have higher heat rates, hence higher variable cost than the LM6000 or the LMS100, but….
- There are limitations on operating hours of simple cycle frame machines because of emissions
  - *Frame machines cannot be fitted with SCRs to meet NOx emissions limits*
- Frame machines have higher initial capital costs
  - *Initial capital cost of E machine is greater than the LM6000*
  - *Initial capital cost of F machine is greater than both the LM6000 and the LMS100*
- Frame machines can be lumpier additions

Two Units vs. One Unit





- Estimates assume that a developer would build a two-unit plant on greenfield site to spread common costs
- $/kW cost declines with # of units
  - *The common facilities (buildings, tanks, roads) are relatively labor intensive and built with the first unit.*
  - *Additional units don't carry the same common facility burden, so the change becomes more equipment cost intensive, showing a higher labor economy of scale.*
- One unit cost would be lower if unit was added to an existing site
  - *Existing sites with expansion capability are limited in number*

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Capital Cost Detail by Technology and Site

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	Overnight Capital Cost - 2007$s					Costs as a % of Zone C			
	K - Long Island	J - NYC	G - Hudson Valley	F - Capital	C - Central	K - Long Island	J - NYC	G - Hudson Valley	F - Capital
EPC Cost Components									
Equipment									
Equipment	41,502,000	41,502,000	41,502,000	41,502,000	41,502,000	100%	100%	100%	100%
Spare Parts	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	100%	100%	100%	100%
Subtotal	42,502,000	42,502,000	42,502,000	42,502,000	42,502,000	100%	100%	100%	100%
Construction									
Construction Labor & Materials	39,786,000	41,279,000	28,954,000	25,147,000	24,352,000	163%	170%	119%	103%
Electrical Connection & Substation	3,323,000	3,549,000	2,602,000	2,316,000	2,257,000	147%	157%	115%	103%
Electrical System Upgrades	500,000	500,000	500,000	500,000	500,000	100%	100%	100%	100%
Gas Interconnect & Reinforcement	3,400,000	4,000,000	3,400,000	3,400,000	3,400,000	100%	118%	100%	100%
Site Prep	1,487,000	1,526,000	1,124,000	966,000	940,000	158%	162%	120%	103%
Engineering & Design	4,660,000	4,755,000	4,015,000	3,785,000	3,738,000	125%	127%	107%	101%
Construction Mgmt. / Field Engr.	1,165,000	1,189,000	1,004,000	946,000	934,000	125%	127%	107%	101%
Subtotal	54,321,000	56,798,000	41,599,000	37,060,000	36,121,000	150%	157%	115%	103%
Startup & Testing									
Startup & Training	777,000	793,000	669,000	631,000	623,000	125%	127%	107%	101%
Testing	-	-	-	-	-	N/A	N/A	N/A	N/A
Subtotal	777,000	793,000	669,000	631,000	623,000	125%	127%	107%	101%
Contingency	9,270,000	9,459,000	7,987,000	7,529,000	7,435,000	125%	127%	107%	101%
Subtotal - EPC Costs	106,870,000	109,552,000	92,757,000	87,722,000	86,681,000	123%	126%	107%	101%
Non-EPC Cost Components									
Owner's Costs									
Permitting	1,069,000	1,096,000	928,000	877,000	867,000	123%	126%	107%	101%
Legal	2,137,000	2,191,000	1,855,000	1,754,000	1,734,000	123%	126%	107%	101%
Owner's Project Mgmt. & Misc. Engr.	2,137,000	2,191,000	1,855,000	1,754,000	1,734,000	123%	126%	107%	101%
Social Justice	375,000	500,000	125,000	125,000	125,000	300%	400%	100%	100%
Owner's Development Costs	3,206,000	3,287,000	2,783,000	2,632,000	2,600,000	123%	126%	107%	101%
Financing Fees	2,137,000	2,191,000	1,855,000	1,754,000	1,734,000	123%	126%	107%	101%
Financial Advisory	267,000	274,000	232,000	219,000	217,000	123%	126%	107%	101%
Environmental Studies	267,000	274,000	232,000	219,000	217,000	123%	126%	107%	101%
Market Studies	267,000	274,000	232,000	219,000	217,000	123%	126%	107%	101%
Interconnection Studies	267,000	274,000	232,000	219,000	217,000	123%	126%	107%	101%
Subtotal	12,129,000	12,552,000	10,329,000	9,772,000	9,662,000	126%	130%	107%	101%
Financing (incl. AFUDC, IDC)									
EPC Portion	4,863,000	4,985,000	4,220,000	3,991,000	3,944,000	123%	126%	107%	101%
Non-EPC Portion	552,000	571,000	470,000	445,000	440,000	125%	130%	107%	101%
Working Capital and Inventories	2,137,000	2,191,000	1,855,000	1,754,000	1,734,000	123%	126%	107%	101%
Subtotal - Non-EPC Costs	19,681,000	20,299,000	16,874,000	15,962,000	15,780,000	125%	129%	107%	101%
Total Capital Investment	126,551,000	129,851,000	109,631,000	103,684,000	102,461,000	124%	127%	107%	101%

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Capital Cost Estimates for LMS100 - Demand Curve Review

	Overnight Capital Cost - 2007$s					Costs as a % of Zone C			
	K - Long Island	J - NYC	G - Hudson Valley	F - Capital	C - Central	K - Long Island	J - NYC	G - Hudson Valley	F - Capital
EPC Cost Components									
Equipment									
Equipment	80,640,000	80,640,000	80,640,000	80,640,000	80,640,000	100%	100%	100%	100%
Spare Parts	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	100%	100%	100%	100%
Subtotal	81,640,000	81,640,000	81,640,000	81,640,000	81,640,000	100%	100%	100%	100%
Construction									
Construction Labor & Materials	64,017,000	66,355,000	47,188,000	41,239,000	40,007,000	160%	166%	118%	103%
Electrical Connection & Substation	3,564,000	3,793,000	2,825,000	2,531,000	2,470,000	144%	154%	114%	102%
Electrical System Upgrades	500,000	500,000	500,000	500,000	500,000	100%	100%	100%	100%
Gas Interconnect & Reinforcement	4,250,000	5,000,000	4,250,000	4,250,000	4,250,000	100%	118%	100%	100%
Site Prep	2,428,000	2,491,000	1,841,000	1,578,000	1,537,000	158%	162%	120%	103%
Engineering & Design	8,154,000	8,297,000	7,172,000	6,819,000	6,747,000	121%	123%	106%	101%
Construction Mgmt. / Field Engr.	2,039,000	2,074,000	1,793,000	1,705,000	1,687,000	121%	123%	106%	101%
Subtotal	84,952,000	88,510,000	65,569,000	58,622,000	57,198,000	149%	155%	115%	102%
Startup & Testing									
Startup & Training	1,359,000	1,383,000	1,195,000	1,137,000	1,125,000	121%	123%	106%	101%
Testing	-	-	-	-	-	N/A	N/A	N/A	N/A
Subtotal	1,359,000	1,383,000	1,195,000	1,137,000	1,125,000	121%	123%	106%	101%
Contingency	16,220,000	16,503,000	14,266,000	13,565,000	13,421,000	121%	123%	106%	101%
Subtotal - EPC Costs	184,171,000	188,036,000	162,670,000	154,964,000	153,384,000	120%	123%	106%	101%
Non-EPC Cost Components									
Owner's Costs									
Permitting	1,842,000	1,880,000	1,627,000	1,550,000	1,534,000	120%	123%	106%	101%
Legal	3,683,000	3,761,000	3,253,000	3,099,000	3,068,000	120%	123%	106%	101%
Owner's Project Mgmt. & Misc. Engr.	3,683,000	3,761,000	3,253,000	3,099,000	3,068,000	120%	123%	106%	101%
Social Justice	375,000	500,000	125,000	125,000	125,000	300%	400%	100%	100%
Owner's Development Costs	5,525,000	5,641,000	4,880,000	4,649,000	4,602,000	120%	123%	106%	101%
Financing Fees	3,683,000	3,761,000	3,253,000	3,099,000	3,068,000	120%	123%	106%	101%
Financial Advisory	460,000	470,000	407,000	387,000	383,000	120%	123%	106%	101%
Environmental Studies	460,000	470,000	407,000	387,000	383,000	120%	123%	106%	101%
Market Studies	460,000	470,000	407,000	387,000	383,000	120%	123%	106%	101%
Interconnection Studies	460,000	470,000	407,000	387,000	383,000	120%	123%	106%	101%
Subtotal	20,631,000	21,184,000	18,019,000	17,169,000	16,997,000	121%	125%	106%	101%
Financing (incl. AFUDC, IDC)									
EPC Portion	8,380,000	8,556,000	7,401,000	7,051,000	6,979,000	120%	123%	106%	101%
Non-EPC Portion	939,000	964,000	820,000	781,000	773,000	121%	125%	106%	101%
Working Capital and Inventories	3,683,000	3,761,000	3,253,000	3,099,000	3,068,000	120%	123%	106%	101%
Subtotal - Non-EPC Costs	33,633,000	34,465,000	29,493,000	28,100,000	27,817,000	121%	124%	106%	101%
Total Capital Investment	217,804,000	222,501,000	192,163,000	183,064,000	181,201,000	120%	123%	106%	101%

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Repeat Slides from March 12, 2007 ICAP Working Group Meeting for Reference

Selected Key Assumptions for EPC Cost Estimate

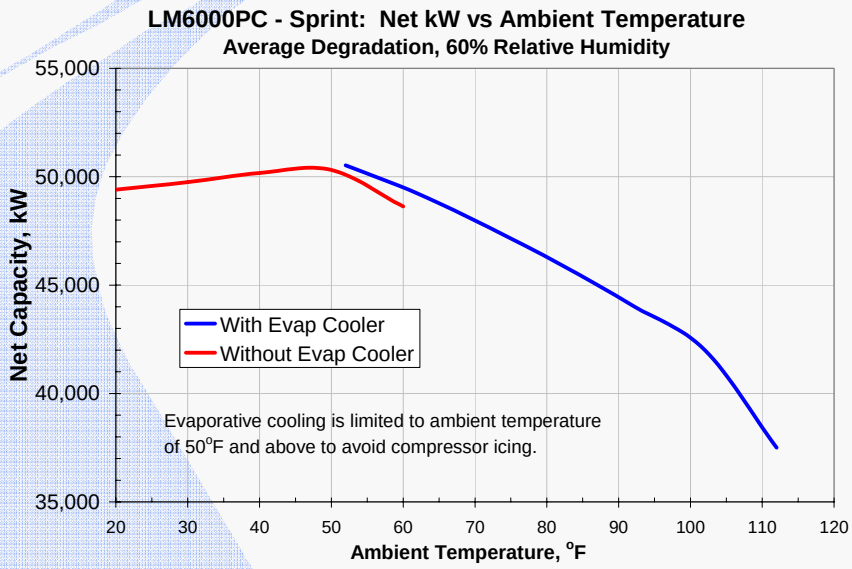
Included

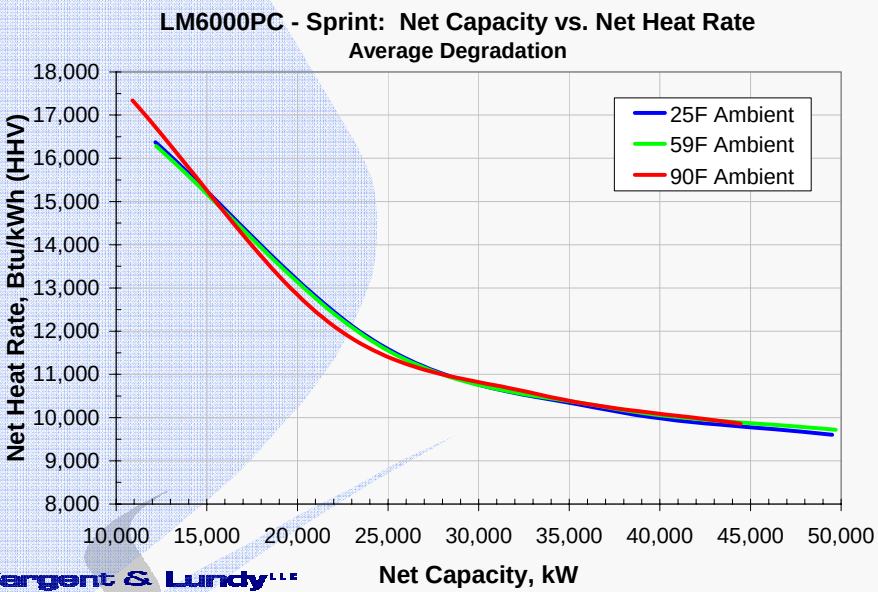
- SCR
- Inlet Air Evaporative Cooling
- Fuel Gas Compressors
  - *200 psig local supply pressure*
- Switchyard
- Allowance to Attract Labor
- Erection Contractor G&A and Profit
- EPC Contractor Fee

Not Included

- Inlet Air Chillers
- Dual Fuel Capability
- Owner's Cost
  - *Indirect Costs*
  - *Working Capital and Inventories*
  - *Interest During Construction*

Capacity and Heat Rate – LM6000





- Capacity and heat rate vary with environmental conditions (air temperature, humidity, and elevation)
- An hourly simulation could be conducted if environmental data were available, but the complexity of the calculations outweighs the value of the any insights obtained
  - *However, using one capacity and heat rate is too simplified*
- Seasonal variation in capacity and heat rate is a reasonable compromise

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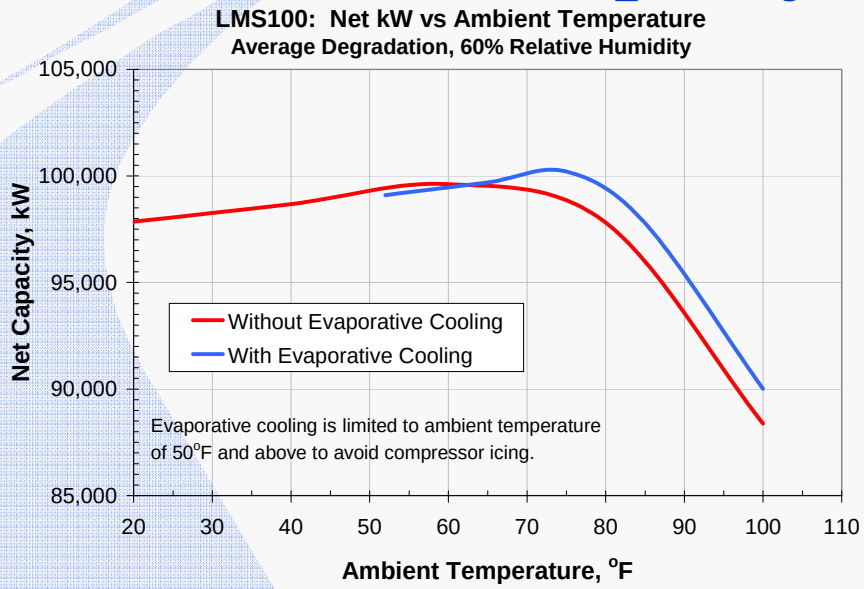
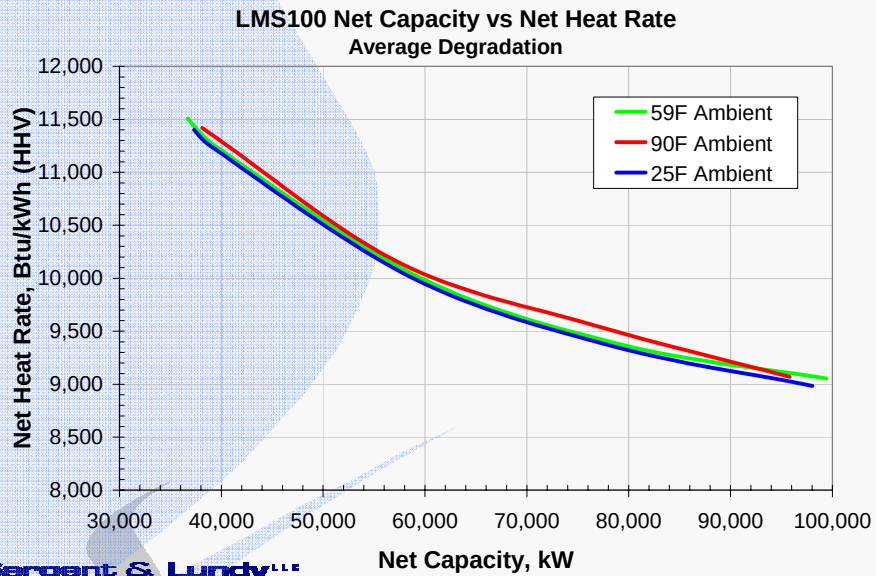
Capacity and Heat Rate – LMS100





- Shape of capacity and temperature curve is different from LM6000
- Less variation of heat rate with capacity compared to LM6000

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Capacity and Heat Rate Assumptions

						LM6000 PC Sprint		LMS100	
Load Zone	Weather Basis	Elev. (Feet)	Season	Ambient Temp.°F	Relative Humidity	Net kW	Net Btu/kWh (HHV)	Net kW	Net Btu/kWh (HHV)
C - Central	Syracuse	421	Summer	79.7	67.7	45,216	9,808	97,278	9,140
			Winter[3]	17.3	73.7	48,954	9,555	98,541	8,937
			Spring-Fall	59	60.0	48,902	9,717	100,203	9,028
			ICAP	90	70.0	43,095	9,880	92,806	9,252
F - Capital	Albany	275	Summer	80.7	67.2	45,318	9,811	97,518	9,147
			Winter[3]	15.3	70.7	49,203	9,547	98,264	8,946
			Spring-Fall	59	60.0	49,178	9,717	99,926	9,036
			ICAP	90	70.0	43,347	9,880	93,370	9,251
G - Hudson Valley	Poughkeepsie	165	Summer	82.3	77.7	44,688	9,835	96,115	9,191
			Winter[3]	19.3	74.0	49,429	9,565	98,148	8,957
			Spring-Fall	59	60.0	49,387	9,716	99,717	9,043
			ICAP	90	70.0	43,529	9,879	93,795	9,250
J - New York City	New York City	20	Summer	83	64.3	45,497	9,818	97,954	9,159
			Winter[3]	28	61.7	49,698	9,624	98,221	8,993
			Spring-Fall	59	60.0	49,660	9,715	99,445	9,052
			ICAP	90	70.0	43,778	9,878	94,360	9,248
K - Long Island	Long Island	16	Summer	80.7	69.3	45,671	9,814	98,307	9,151
			Winter[3]	28	66.2	49,697	9,624	98,222	8,993
			Spring-Fall	59	60.0	49,668	9,715	99,436	9,052
			ICAP	90	70.0	43,785	9,878	94,376	9,248

Notes

1. Includes Water Injection NOx Control (25 ppm) and Inlet Evaporative Cooling
2. Includes Average Degradation
3. Evaporative Cooler Off. Evaporative cooling is limited to ambient temperature of 50°F and above to avoid compressor icing

Other Performance Assumptions

- Variable O&M
  - *$4.80 – 4.90/MWh depending on technology and location*
  - *Based on summer capacity from previous slide*
    - *Using another basis will result in small reduction*
- Availability
  - *NYISO GADS data for 2005 shows LM6000 EFORd at 3.68%*
    - *Average capacity factor = 16.3%*
  - *Recommend 95% for both technologies*
- Startup Fuel *(20 minute start)*
  - *LM6000 = 65 MMBtu*
  - *LMS100 = 135 MMBtu*