Assumptions and Input Data for Localized, Levelized Cost of Peaking Units

Design of Units:

Item	Base	Options	Comments
Technology	LM6000PC-Sprint 7EA 7FA		LM6000 (50,512 kW) and 7EA (85,970 kW) are the best peaking duty selections. The LM6000 combustion turbine generators were introduced for commercial applications in 1992 and have an excellent reputation in the power generation industry for efficiency and reliability. The LM6000 is the first industrial combustion turbine with simple-cycle efficiency in excess of 40%. All of the 2001 PowerNow! LM6000 gas turbines installed by NYPA and installed for LIPA in their Fast Track Summer 2002 Project incorporate Sprint technology. 7EA combustion turbine unit has been on the market since 1976 with over 750 units in service. The 7EA fleet has accumulated tens of millions of service hours and is recognized for high reliability and availability in both simple cycle and combined cycle operation. The 7FA (171,700 kW) is more suited for base-load and combined cycle applications. Note the maximum NY gas turbine size, out of 169 simple cycle gas turbines, is 81,100 kW (re: Existing Generating Facilities As Of April 1, 2005; NYISO Planning Data and Reference Documents)
Fuel	Primary – Natural Gas Secondary – No. 2 Fuel Oil	Natural Gas Only Or Fuel Oil Only	Dual fuel capability provides more flexibility. Increased capital expenditure is a disadvantage for dual fuel capability. Note out of the 169 NY simple cycle gas turbines 60 are dual fuel, 32 natural gas only, 68 fuel oil only, and 9 kerosene only. S&L Environmental staff is evaluating requirements related to dual fuel capability.
Inlet Air Conditioning	Evaporative Cooler	None	Evaporative cooler provides 3 – 4 MW of additional power output during high ambient temperature conditions, which is typical peaking unit operating time.
Natural Gas Compressors	None	New Compressors	Assumed natural gas pressure at supply point meets OEM minimum pressure requirements (675 psig for LM6000 and 290 psig for 7EA). The need for gas compression will depend on available supply pressure at a specific site. In the absence of site specifics, a pressure could be assumed for which gas compressors can be specified and a cost estimate

Item	Base	Options	Comments
			developed. Need a source of data for supply pressure.
Natural Gas Treatment	Fuel Gas Heater	Media Filtration, Inertial Separation, Coalescing	Fuel gas heater to provided minimum of 50°F (28°C) of superheat to compensate for temperature reduction due to pressure drop across the gas fuel control valves. Assumed natural gas is pipeline quality and additional treatment is not required.
Switchyard	Existing	New	If a switchyard is identified for a NYC location and information available on its configuration, an estimate can be prepared. In the absence of a basis for switchyard costs, continue to assume an existing switchyard is available.
Transmission Voltage	345 kV	138 kV	Assumed 345 kV transmission voltage.
Foundation	Mat	Piling	Assumed mat foundation is sufficient.
Emission Controls	SCR, CO Catalyst	Emission Reduction Credits	S&L Environmental staff is investigating emission requirements applicable to sites. Selective catalytic reduction (SCR) and oxidation catalysts are used to control NOx and CO emissions.
Ancillary Services	TMNSR for LM6000 (under review) TMOR for 7EA	No Ancillary Service	LM6000 unit allows it to achieve full load operation within 10 minutes. The selective catalytic reduction system takes around 15-35 minutes, depending on ambient temperature, to become operational. Assuming the air permit conditions incorporate provisions to accommodate potential short-term exceedances of applicable emission standards during start-up, the LM6000 can provide Ten-Minute Non-Spinning Reserve (TMNSR) in the NYISO ancillary services market. S&L Environmental staff is investigating requirements for SCRs. If an LM6000 needs an SCR, it will not be eligible for TMNSR. Continually preheating ammonia for an SCR requires a heat source with associated capital costs (package boiler?) and operating costs (fuel). Do not anticipate that TMNSR revenues would justify the cost, but could calculate it if necessary. The 7EA is an industrial frame unit that requires approximately thirty minutes to achieve full load, enabling it to provide Thirty-Minute Operating Reserve (TMOR).

Item	Base	Options	Comments
Performance	See table		LM6000 performance calculated with GE Application for Packaged Power Solutions (APPS) software Version 3.5.0 7EA performance calculated with GE Gas Turbine Performance Simulation Version 3.5.1 Performance will be calculated for each at ISO and Average Low Conditions for New and Clean Condition, and for Average High Conditions and Maximum High Temperatures for both New and Clean Conditions and with Degradation Prior to Major Maintenance.

Plant Performance Assumptions

	New York City	Long Island	Albany		Syracuse		Hudson Valley		
Combustion Turbine Technology	**LM6000 PC Sprint**	**LM6000 PC Sprint**	**7EA**	**7FA**	**7EA**	**7FA**	**LM6000 PC Sprint**	**7EA**	**7FA**
Site Conditions:									
Elevation, Feet	131	16	275		421		165		
Average High Temperature, ^{o}F[1]	85	83	83		82		85		
Average Humidity @ Average High Temperature	64%	69%	65%		67%		74%		
Average Low Temperature, ^{o}F	26	26	13		15		18		
Average Humidity @ Average Low Temperature	61%	66%	71%		73%		78%		
Highest Recorded Temperature, ^{o}F	104	104	100		98		102		

[1] Based on National Oceanic and Atmospheric Administration data 1971 – 2000

	New York City	Long Island	Albany		Syracuse		Hudson Valley		
Combustion Turbine Technology	**LM6000 PC Sprint**	**LM6000 PC Sprint**	**7EA**	**7FA**	**7EA**	**7FA**	**LM6000 PC Sprint**	**7EA**	**7FA**
Performance: Natural Gas, New and Clean Condition, No Inlet Conditioning									
Maximum Net Generation at ISO Conditions[2], kW	49,114		83,596	169,983	83,596	169,983	49,114	83,596	169,983
Net Heat Rate at ISO Conditions, Btu/kWh (HHV)	9,564		11,750	10,495	11,750	10,495	9,564	11,750	10,495
Maximum Net Generation at Average High Conditions, kW	43,738	44,338	75,705	155,529	75,587	155,331	43,586	75,408	154,737
Net Heat Rate at Average High Conditions, Btu/kWh (HHV)	9,719	9,697	12,008	10,719	12,010	10,708	9,711	12,042	10,752
Maximum Net Generation at Highest Temperature, kW	37,879	38,167	70,706	143,550	70,904	144,441	38,697	70,379	142,065
Net Heat Rate at Highest Temperature, Btu/kWh (HHV)	9,980	9,961	12,244	10,993	12,221	10,954	9,922	12,300	11,066
Maximum Net Generation at Average Low Conditions, kW	49,886	49,817	95,763	185,526	94,684	184,041	49,801	94,713	184,932
Net Heat Rate at Average Low Conditions, Btu/kWh (HHV)	9,418	9,422	11,425	10,378	11,436	10,378	9,372	11,459	10,378
Performance: Natural Gas, With Degradation Prior to Major Maintenance, No Inlet Conditioning									
Power Degradation Prior to Major Maintenance[3]	3%	3%	4%	4.5%	4%	4.5%	3%	4%	4.5%
Heat Rate Degradation Prior to Major Maintenance	2%	2%	2%	2.5%	2%	2.5%	2%	2%	2.5%
Maximum Net Generation at Average High Conditions, kW	42,426	43,008	73,434	150,863	73,319	150,671	42,278	73,176	150,095

[2] At 59°F, 60% Relative Humidity, 14.7 psia
[3] 48,000 fired hours for LM6000 and LM100; 400 starts for 7EA and 7FA

	New York City	Long Island	Albany		Syracuse		Hudson Valley		
Combustion Turbine Technology	**LM6000 PC Sprint**	**LM6000 PC Sprint**	**7EA**	**7FA**	**7EA**	**7FA**	**LM6000 PC Sprint**	**7EA**	**7FA**
Net Heat Rate at Average High Conditions, Btu/kWh (HHV)	9,913	9,891	12,248	10,933	12,250	10,922	9,905	12,283	10,967
Maximum Net Generation at Highest Temperature, kW	36,742	37,021	67,877	137,090	68,068	137,941	37,536	67,563	135,672
Net Heat Rate at Highest Temperature, Btu/kWh (HHV)	10,180	10,160	12,489	11,267	12,465	11,228	10,124	12,546	11,342
Other Performance Assumptions									
Equivalent Forced Outage Rate	2%	2%	2%	3%	2%	3%	2%	2%	3%
Equivalent Availability Factor	95%	95%	95%	93%	95%	93%	95%	95%	93%
Startup Natural Gas, MMBtu	35	35	200	450	200	450	35	200	450
Start Time to Full Load	10 minutes[4]	10 minutes[4]	30 minutes	30 minutes	30 minutes	30 minutes	10 minutes[4]	30 minutes	30 minutes

Cost Estimate of Peaking Unit Designs at Three Locations:

Labor:

1) Quantities: Internally generated, based on S&L data, plant design, and/or cost estimating staff experience
2) Labor Rates: R.S. Means "Labor Rates for the Construction Industry 2007"
   a) Issue: Labor rates are published for NYC, Long Island City, and nine other cities: Albany, Binghamton, Buffalo, Elmira, Rochester, Schenectady, Syracuse, Utica, and Yonkers; which of these should be used or averaged for the ROS rate?
3) Labor Productivity: Aspen Technology "Aspen Richardson Cost Factors" labor productivity factors
   a) Issue: Labor productivity rates are published for NYC and Syracuse; will Syracuse suffice for ROS? Should the labor rate for ROS be for Syracuse to match the labor productivity rate?
4) Cost to Attract Labor: $50/day, ranging from $25 to $150
   a) Ideally, this is based on a survey performed at the beginning of the project, which assesses the demand and supply of each labor category

[4] Under review

b) Generally, will be a function of economic activity—for example, if construction for the World Trade Center site is very active in the 2008-11 time period, a higher value may be justified

Materials:

1) Quantities: Internally generated, based on S&L data, plant design, and/or cost estimating staff experience
2) Cost: Source will be chosen depending on type of material, date of pricing, availability of data, and other factors.
   a) Potential sources include R.S. Means "Construction Cost Data," Aspen Technology "Aspen Richardson Cost Factors," internal S&L project data (if not client confidential), vendor data, or available publications.
3) Material cost will be assumed to be the same at all three locations.
   a) Means publishes data for locational differences, but is specific to building construction.
   b) Most engineered items will likely come from the same sources rather than locally, so locational differences should not be significant
   c) Non-engineered items, such as concrete, rebar, sand, earthfill, etc., are purchased locally. Shipping costs can be a large component of the cost of non-engineered materials. S&L has state factors and/or area factors that can be used to adjust the cost of non-engineered materials to reflect location. S&L will search for a credible source of local factors that could be applied to reflect site differences. In the absence of a credible source, the same material costs may have to be used for each site.

Equipment:

1) Two approaches will used for major equipment (in terms of cost):
   a) Obtain vendor quotes:
      i) Generally can be obtained as a courtesy from vendors
      ii) Not as rigorous or defensible as a firm bid supplied for a specific set of specs in an RFP process where the vendor puts itself at risk if the bid is accepted.
   b) Translate equipment costs from an actual project to each site:
      i) For equipment costs, project does not have to be in the same geographic region.
      ii) Confidentiality agreements with clients may eliminate ability to use this approach
      iii) Specs tend to be tailored to the project and the owner—hard to generalize costs from specific bids.
   c) S&L will attempt to obtain both vendor quotes and translate specific project data to each site.
2) Best available internal S&L or external data will be used for BOP

Contracting Scheme

1) Choose EPC over Multiple Lump Sum
   a) Construction management and owner's cost will vary with contracting scheme
2) Contingency costs are typically the owner's preference
   a) Typically based on Monte Carlo simulation of construction scenarios
   b) Simple and combined cycle tend to be lower than other technologies
   c) Assume 8%, ranging from 3% to 10%

Financial Analysis to Determine Levelized Cost at Each Location:

Economic Parameter Inputs	Likely Value	Mimimum	Maximum	Source
Equity Fraction	0.50	0.50	0.50	(1)
Debt Fraction	0.50	0.50	0.50	(1)
Return on Equity (nominal)	12.0%	12.0%	12.0%	(1)
Cost of Debt (nominal)	6.5%	6.5%	6.5%	(1)
Return on Equity (real)	9.06%	9.38%	8.74%	(2)
Cost of Debt (real)	3.70%	4.00%	3.40%	(2)
Federal Tax Rate	35%	35%	35%	
State Tax Rate	7.5%	7.5%	7.5%	NY state corporate tax rate (flat rate).
Composite Tax Rate	39.88%	39.88%	39.88%	(3)
Weighted Average Cost of Capital (WACC, nominal)				
Before-Tax	9.25%	9.25%	9.25%	Calculated from above data.
After-Tax (Discount Rate)	7.95%	7.95%	7.95%	Calculated from above data.
Weighted Average Cost of Capital (WACC, real)				
Before-Tax	6.38%	6.69%	6.07%	(2)
After-Tax (Discount Rate)	5.64%	5.89%	5.39%	(2)
Property Tax Rate	2.0%	1.0%	5.4%	Percent of initial capital cost. Value escalates each year with inflation.
Insurance Rate	0.3%	0.0%	0.7%	Percent of initial capital cost. Value escalates each year with inflation.
Depreciation Schedule	15- year MACRS	15- year MACRS	15- year MACRS	Federal tax code schedule for a simple cycle combustion turbine.
Debt Repayment Period (years)	20	30	10	(1)
Equity Recovery Period (years)	20	30	10	(1)
Levelization Period (years)	20	30	10	(1)
Inflation	2.7%	2.4%	3.0%	
Levelized Fixed Charge Rate (nominal)	15.98%	12.79%	27.16%	Calculated from above data and applied to the all-in capital cost (directs, indirects, IDC, and working capital and inventories).
Levelized Fixed Charge Rate (real)	12.82%	10.05%	23.62%	(2)

Economic Parameter Inputs	Likely Value	Mimimum	Maximum	Source
Indirect Capital Cost Components	11%	5%	15%	Percent of direct capital costs
Owner' Development Costs				
Oversight				
Legal Fees				
Financing Fees				
Startup and Testing				
Training				
Construction Duration (months)	24	20	30	
Interest During Construction (IDC)	6.38%	5.57%	7.58%	Before-tax WACC applied to mid-point of construction duration as a percent of direct plus indirect capital costs. (4)
Working Capital and Inventories	2.0%	1.5%	2.5%	Percent of direct capital costs

Notes:
1. Assumptions are illustrative to show how assumptions translate to the Levelized Fixed Charge Rate. NERA to address equity fraction, debt fraction, return on equity, cost of debt, and periods for debt repayment, equity recovery, and levelization.
2. Real rates are derived by removing inflation from the cost of debt and equity.
3. Federal Tax Rate + State Tax Rate - (Federal Tax Rate x State Tax Rate), to account for deductibility of state taxes from federal taxable income. New York City would be subject to an additional city income tax of 8.85%.
4. For example, a before-tax real WACC of 6.07%/year for 15 months (half of a 30-month construction duration) equals 7.58%.

Operation and Maintenance Cost Assumptions	NYC	Long Island	Albany	Albany	Syracuse	Syracuse	Hudson Valley	Hudson Valley	Comments
Combustion Turbine Model	**LM6000**	**LM6000**	**GE 7EA**	**GE 7FA**	**GE 7EA**	**GE 7FA**			
				Plant Performance					
Net Plant Capacity - Summer (MW)	43.738	44.338	75.705	155.529	75.587	155.331			New and clean conditions.
Average Degraded Value	43.082	43.673	74.191	152.030	74.075	151.836			
Net Plant Heat Rate - Summer (100% load, Btu/kWh, HHV)	9,719	9,697	12,008	10,719	12,010	10,708			New and clean conditions.
Average Degraded Value	9,816	9,794	12,128	10,853	12,130	10,842			
Maximum Capacity Degradation Prior to Major Maintenance	3.0%	3.0%	4.0%	4.5%	4.0%	4.5%			
Maximum Heat Rate Degradation Prior to Major Maintenance	2.0%	2.0%	2.0%	2.5%	2.0%	2.5%			
Major Maintenance Interval (Operating Hours)	50,000	50,000	48,000	48,000	48,000	48,000			(1)
Major Maintenance Interval (Factored Starts)	n/a	n/a	2,400	2,400	2,400	2,400			(1)
Equivalent Forced Outage Rate	2.0%	2.0%	2.0%	3.0%	2.0%	3.0%			Long-term average.
Equivalent Availability Factor	95%	95%	95%	93%	95%	93%			Long-term average.
Natural Gas Consumed During Start (mmBtu/start)	35	35	200	450	200	450			

Notes:
1. The major maintenance interval for the 7EA and 7FA is the earlier of the hours-based or starts-based threshold. The LM6000 uses only an hours-based threshold. Factored starts include weighting factors for trips.

Fixed Operation and Maintenance Costs	NYC	Long Island	Albany	Albany	Syracuse	Syracuse	Hudson Valley	Hudson Valley	Comments
Combustion Turbine Model	**LM6000**	**LM6000**	**GE 7EA**	**GE 7FA**	**GE 7EA**	**GE 7FA**			
				Fixed O&M Assumptions					
Average Labor Rate, incl. Benefits ($/hour)	62	62	50	50	50	50			
Number of Operating Staff (full-time equivalents)	3	3	3	3	3	3			
Number of Maintenance Staff (full-time equivalents)	2	2	2	2	2	2			
				Fixed O&M ($/year)					
Labor - Routine O&M	644,800	644,800	520,000	520,000	520,000	520,000			
Materials and Contract Services - Routine	185,000	185,000	195,000	225,000	195,000	225,000			(1)
Administrative and General	196,000	196,000	196,000	196,000	196,000	196,000			(1)
Total Fixed O&M	1,025,800	1,025,800	911,000	941,000	911,000	941,000			
Fixed O&M ($/kW-year)	23.81	23.49	12.28	6.19	12.30	6.20			

Notes
1. Electric Power Research Institute, State-of-the-Art Power Plant Combustion Turbine Workstation, v 7.0.

Other Fixed Costs	NYC	Long Island	Albany	Albany	Syracuse	Syracuse	Hudson Valley	Hudson Valley	Comments
Combustion Turbine Model	**LM6000**	**LM6000**	**GE 7EA**	**GE 7FA**	**GE 7EA**	**GE 7FA**			
				Other Fixed Cost Assumptions					
Site Leasing Costs	n/a	n/a	n/a	n/a	n/a	n/a			(1)
Property Tax Rate	12.007%	2.0%	4.0%	4.0%	4.0%	4.0%			Unadjusted rate as quoted by local jurisdiction.
Assessment Ratio	45%	100%	50%	50%	50%	50%			Percent of market value.
Effective Property Tax Rate	5.4%	2.0%	2.0%	2.0%	2.0%	2.0%			Property Tax Rate x Assessment Ratio, applied to Assumed Market Value. (2)
Insurance Rate	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%			Percent of initial capital cost. Value escalates each year with inflation.
Assumed Market Value ($/kW)	690	690	460	390	460	390			
				Other Fixed Costs ($/year)					
Property Taxes	1,606,169	602,686	682,556	1,185,831	681,492	1,184,321			
Insurance	89,180	90,403	102,383	177,875	102,224	177,648			
Total Fixed O&M	1,695,349	693,089	784,940	1,363,705	783,716	1,361,969			Could be included in the fixed O&M rate.
Other Fixed Costs ($/kW-year)	39.35	15.87	10.58	8.97	10.58	8.97			

Notes
1. The cost of land is included in the capital cost estimate.
2. If facility is a Qualified Empire Zone Enterprise, a property tax credit may apply, based on a formula that considers job creation, wages and benefits or investments made in the zone.

Variable Operation and Maintenance Costs	NYC	Long Island	Albany	Albany	Syracuse	Syracuse	Hudson Valley	Hudson Valley	Comments
Combustion Turbine Model	**LM6000**	**LM6000**	**GE 7EA**	**GE 7FA**	**GE 7EA**	**GE 7FA**			
				Variable O&M Assumptions.					
Cost of Parts Req'd for Major Maintenance Interval	5,257,000	5,257,000	10,775,683	26,359,898	10,775,683	26,359,898			(1)
Man-Hours Req'd for Major Maintenance Interval	2,496	2,496	10,650	17,760	10,650	17,760			(1)
Unscheduled Maintenance ($/MWh)	0.75	0.75	0.52	0.51	0.52	0.51			(2)
SCR Catalyst Repl & Disposal ($/MWh)	0.90	0.90	0.90	0.90	0.90	0.90			
Chemicals and Consumables ($/MWh)	0.17	0.17	0.02	0.02	0.02	0.02			(2)
Water ($/MWh)	0.07	0.07	0.01	0.01	0.01	0.01			(2)
				Variable O&M based on Operating Hours, excluding start fuel					
Major Maintenance Parts	2.44	2.41	3.03	3.62	3.03	3.62			
Major Maintenance Labor	0.07	0.07	0.15	0.12	0.15	0.12			
Unscheduled Maintenance	0.75	0.75	0.52	0.51	0.52	0.51			
SCR Catalyst Repl & Disposal	0.90	0.90	0.90	0.90	0.90	0.90			
Chemicals and Consumables	0.17	0.17	0.02	0.02	0.02	0.02			
Water	0.07	0.07	0.01	0.01	0.01	0.01			
Total Variable O&M ($/MWh)	4.40	4.37	4.63	5.18	4.63	5.18			For all items
				Variable O&M based on Number of Starts, excluding start fuel					
Major Maintenance Parts	n/a	n/a	4,490	10,983	4,490	10,983			
Major Maintenance Labor	n/a	n/a	222	370	222	370			
Total ($/factored start)	n/a	n/a	4,712	11,353	4,712	11,353			For Major Maintenance Parts and Labor
Variable O&M ($/MWh)	n/a	n/a	1.45	1.44	1.45	1.44			For items other than Major Maintenance

Notes
1. Includes combustion inspections, hot gas path inspections, and major inspection required, on average, for one complete interval.
2. Electric Power Research Institute, State-of-the-Art Power Plant Combustion Turbine Workstation, v 7.0.

Operation and Maintenance Cost Assumptions	NYC	Long Island	Albany	Albany	Syracuse	Syracuse	Hudson Valley	Hudson Valley	Comments
Combustion Turbine Model	**LM6000**	**LM6000**	**GE 7EA**	**GE 7FA**	**GE 7EA**	**GE 7FA**			
			Fuel Transportation Charges ($/mmBtu)						
ConEd PSC No. 9 - Gas Transportation Service									
System Cost Component	0.100	n/a	n/a	n/a	n/a	n/a			
Marginal Cost Component	0.092	n/a	n/a	n/a	n/a	n/a			
Pipeline Demand Charges	1.000	1.000	0.400	0.400	0.400	0.400			
Pipeline Commodity Charges	0.000	0.000	0.002	0.002	0.002	0.002			