Analysis of Market Characteristics for Conversion of Liquid Fueled Turbines to Methanol

Prepared for

The Methanol Foundation

And

Methanex, Inc.

Principal Investigator:

Jerry Temchin, Project Manager

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Introduction

The development and viability of distributed generation (DG) in New York State is being driven by three factors. These are the restructuring of the electric utility industry, decreasing capacity reserves (increasing capacity requirements), and advancements in DG technologies. In New York State (NYS) the restructuring of the power industry permits generation to be procured in competitive markets, with distribution services still being provided by regulated monopolies, and transmission services provided by the New York Independent System Operator (NYISO) using transmission capacity owned by regulated utilities. In New York wholesale power markets, DG has been aggressively pursued. The deployment of DG resources for load curtailment has been successfully used in New York with the Emergency Demand Response Program (EDRP) and the Day-Ahead Demand Response Program (DADRP). The EDRP market was critical in maintaining system reliability in the summer of 2001 and 2002, and has been recognized as one of the most effective curtailment programs in the country.

The current and forecasted shortage of generating capacity in New York State is a serious problem that jeopardizes the reliability of New York's bulk power system. In a report published by the NYISO, it was noted that New York State needs an additional 7,100 MW of capacity by 2005, of which 2,000 to 3,000 MW must be located in New York City.[1] While there are a large number of emergency and back-up generators in New York City, many if not most of these are diesel fired internal combustion and turbine units. [2] This means that much of the available emergency reserve potential has high emission levels. Compounding that fact, these resources are most likely to be called during peak load periods characterized by high temperatures and humidity, thus exacerbating an already severe pollution problem.

The participation of small fuel oil fired turbine generators (emergency/backup generators) in the NYISO wholesale power markets is limited by their environmental performance. These units can participate in both EDRP and the Installed Capacity Market (ICAP), although their operation is limited to emergency conditions because of their adverse environmental impact. By converting these units to burn methanol, their environmental performance can be significantly improved, thus allowing them to play a more active role in NYISO markets, including operating more hours in the day ahead and hour ahead markets.

Currently the New York State Department of Environmental Conservation (DEC) is developing new rules regarding the operation of DG units in New York. While final rules have not yet been promulgated, the NOx emission limits for combustion turbines with a maximum heat input rating of 10 MMBTU/hour or greater is 100 ppm volume dry corrected to 15% O_2 - most of the existing emergency fuel-oil fired turbine generators in New York cannot meet this criteria, which is expected to only

[1] Power Alert II, New York's Persisting Energy Crisis; Report by the New York Independent System Operator; 27 March 2002; p. 5

[2] In New York City there are 1,323 reciprocating emergency generators having a total capacity of 291.2 MW and 62 turbine generators with a total capacity of 96.9 MW.

get stricter in the future. On the other hand, substituting methanol for existing petroleum fuels can meet these stricter emission requirements.

Tests have shown that methanol is fully feasible as a gas turbine fuel. Compared to natural gas and distillate, methanol improves heat rate, produces higher power output due to the higher mass flow, and greatly reduces NOx emissions. Since methanol contains no sulfur, there are no SO_2 emissions. Also the clean burning characteristic of methanol can be expected to reduce maintenance costs. However, there are capital outlays for modifications to current stationary turbine power plants to accommodate the higher mass and volumetric flow of methanol relative to natural gas and distillate and to accommodate methanol storage.

Methanol has an additional advantage as well over currently utilized turbine fuels such as liquefied natural gas. With domestic natural gas pipelines reaching near their capacity, it is projected that the demand for imported LNG will increase. Because methanol is in liquid form at ambient conditions, it can be shipped much more easily and less expensively than LNG.

Although methanol appears to be an attractive fuel for stationary turbines for the reasons cited above, original equipment manufacturers have been reluctant to commit their engineering resources without a determination of the potential market for methanol-fired turbines. In an effort targeted at determining the market potential of using methanol in turbine generators, Electrotek was asked by the Methanol Institute and the Methanex Corporation to conduct an assessment of the economic benefits to generator owners and overall market potential in New York State, for converting existing gas turbines to burn methanol.

Approach

Two of the principal NYISO markets are the day-ahead (DA) market and the installed capacity (ICAP) market. The DA market is based on a daily auction where the bid price for each hour is accepted at equal or greater than the zonal location based marginal price (LBMP). The ICAP market is also an auction which is a reservation payment which commits capacity either monthly or for one of two six monthly strips (summer and winter).

As cited above, substituting methanol as a fuel allows standby generators to run a greater number of hours and thus have a far greater participation in the market than the use of current fuels. The result is a larger consumption of methanol on a Btu basis compared to existing petroleum-based fuels. (See results section below)

A spreadsheet was developed which calculates the profit based on participating in both the DA and ICAP markets[1]. Two of the NYISO zones, New York City (NYC)

[1] For a sample calculation page, see Appendix.

and Long Island (LI) were evaluated for 2 x 750kW[1] and 1 x 2,500kW gensets corresponding to Solar Saturn and Centaur units.

Gross revenue is composed of the higher of the monthly and strip ICAP auctions plus the revenue earned in the DA market during the hours run based on the accepted bids. Gross revenue is reduced by the total running cost for the hours run to yield net revenue.

Net revenue is based on participation in the NYISO DA and ICAP markets for two years. Performance in the DA market is based on the bid price[2] exceeding the hourly clearing LBMP for the years 2001 and 2002.[3] The ICAP market is based on some actual and forecasted six month strip values based on the years 2002 and 2003.[4]

The required price for methanol to achieve a two year payback is calculated for a range of conversion costs[5]. Three and five year internal rates of return are also calculated for a nominal price of methanol of $7.73 per million Btu ($0.50 per gallon).[6] In these cases, data for the second year were carried forward to complete the remaining years.

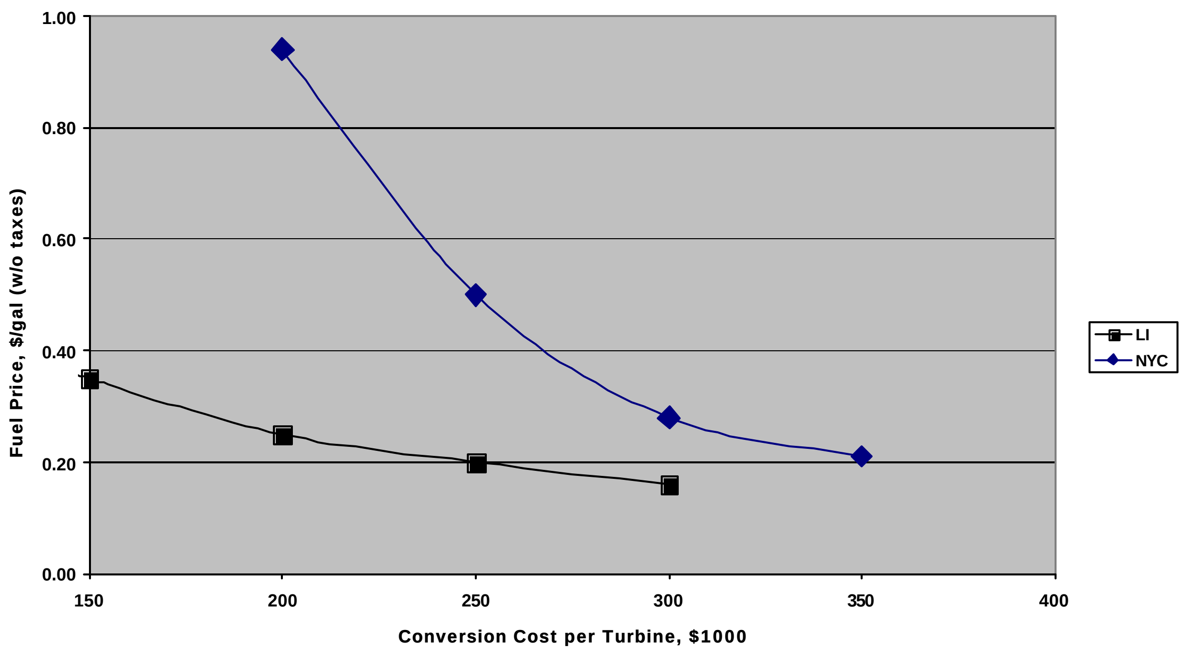
Results

2 x 750 kW Gensets

Methanol fuel price required to achieve a two year payback for various conversion costs are shown in Figure 1 for the NYC and LI zones. Methanol prices higher than shown will require a longer payback period.

[1] The minimum capacity bid in the NYISO market is one megawatt.
[2] In this report, bid price is equal to running cost/MW plus a minimum $10/MWH profit margin.
[3] These are the last two years with complete hourly LBMP data.
[4] The year 2003 was selected over 2001 because there were was no ICAP market in Long Island Zone until the summer of 2002.
[5] Our experience with demand side price response programs indicates that a maximum payback period of two years is required to justify participation.
[6] This is equivalent on a heat content basis of $1.06 per gallon for kerosene-type jet fuel (exclusive of taxes). Since January 2002, prices have ranged from a low of $0.60/gal to a high of $1.11/gal in March 2003 in New York State. Reference: Petroleum Market Monthly, Table 36, U.S. Energy Information Administration.

Figure 1. Required Fuel Price for Two-Year Payback
2 x 750 kW



The NYC zone, being a more transmission congested area and consequently having higher LBMP, will support plant conversion costs as high as $250K per turbine ($333/kW) at $0.50/gal ($7.73/mmBtu)[1]. Total run time would be average about 120 hours/year and 75 hours/year, respectively.[2] If all the installed capacity of standby turbine generators in the NYC zone were running on methanol, they would consume nearly 18,000 gallons/hour (54 tonnes/hour).

If the price for case cited above with conversion costs of $350,000 per turbine ($467/kW) were to be $0.60/gal ($9.27/mmBtu) vs. $0.50/gal, the run time would drop in half (~55 hours/year) while the payback period would slightly greater than three years.

The LI zone, being slightly less congested, would support a conversion cost no greater than $125K per turbine ($167/kW) at a price of $0.42/gal ($6.49/mmBtu). Total run time at this fuel price is 329 hours and 211 hours, respectively for the two years simulated for this analysis. If all the installed capacity of standby turbine generators in the LI zone were running on methanol, they would consume a little over 5,000 gallons/hour (16 tonnes/hr).

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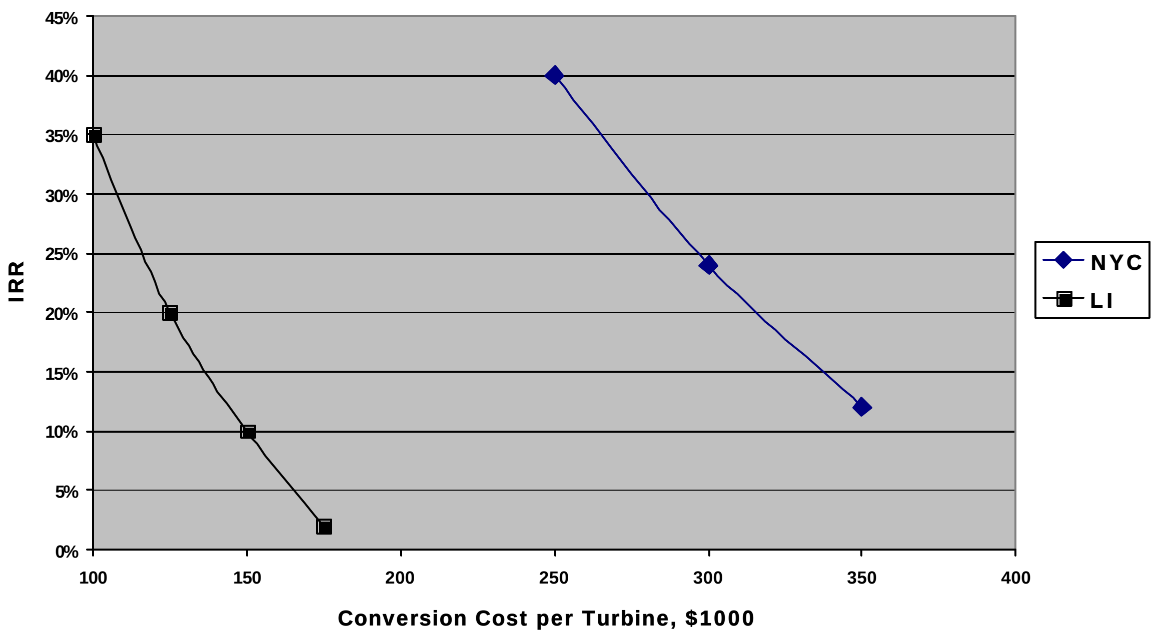
[1] All fuel cost are without tax.

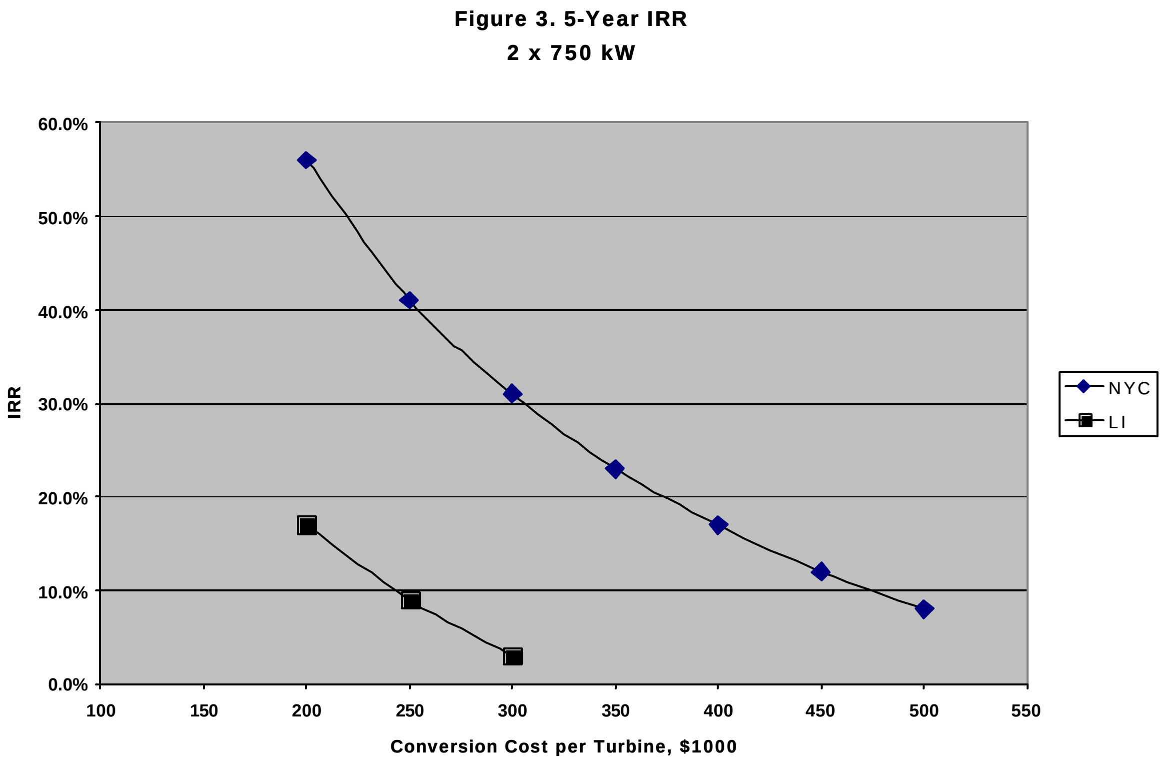
[2] The number of hours in any given day may vary widely. In this simulation there were run times anywhere from four to fourteen hours per day. The highest run times would occur during peak demands for electricity.

The three year internal rates of return for the two year payback cases were about 25%/year.

For a nominal price for methanol of $0.50/gal. ($7.73/mmBtu) three and five year internal rates of return are shown in Figures 2 and 3 for various conversion costs.

Figure 2. Three-Year IRR
2 x 750 kW





Notwithstanding the two year payback requirement cited above, there may be some willingness to convert to methanol if the return on investment is considered attractive by turbine/generator owners. As shown in Figure 2, a $285K ($380/kW) conversion cost in the NYC zone yields a 12% internal rate of return over three years. A similar rate of return in the LI zone allows a conversion cost no greater than $138K (167/kW). However, a 5-year rate of return of 15% would allow $420K ($160/kW) to be spent on conversion in the NYC zone and $210K ($280/kW) in the LI zone. Of course lower conversion costs may attract additional investment for converting to methanol- fired turbines even if a two year payback is insufficient to attract initial capital outlays for conversion.

1 x 2,500 kW

Similar analysis is presented for a 2,500 kW turbine. For the NYC zone, conversion cost of up to $800K ($320/kW) would still provide a two year payback at a fuel price over $0.50/gal ($7.73/mmBtu) essentially justifying conversion for any conceivable values

of fuel price and conversion cost. For the LI zone, a conversion cost of $400K ($175/kW) could provide a two year payback at a methanol fuel price of about $0.52/gal ($8.04/mmBtui) If methanol could be supplied at $0.41/gal ($6.34/mmBtu), a conversion cost of up to $450K ($180/kW) would provide a two year payback period (see Figure 4).

Figures 5 and 6 indicate that the NYC zone could provide an attractive IRR for a $500K ($200/kW) cost of conversion. Even at that cost level, the LI zone yields a 15% IRR for a three year rate of return.

Figure 4. Required Price for Two-Year Payback
1 x 2500 kW

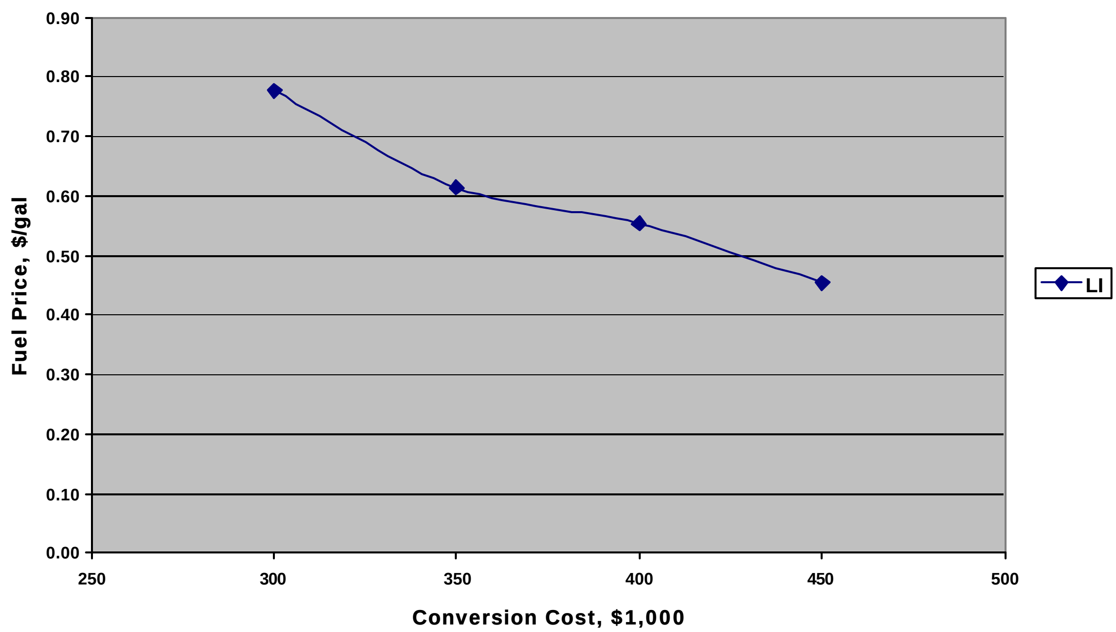


Figure 5. Three-Year IRR
1 x 2500 kW

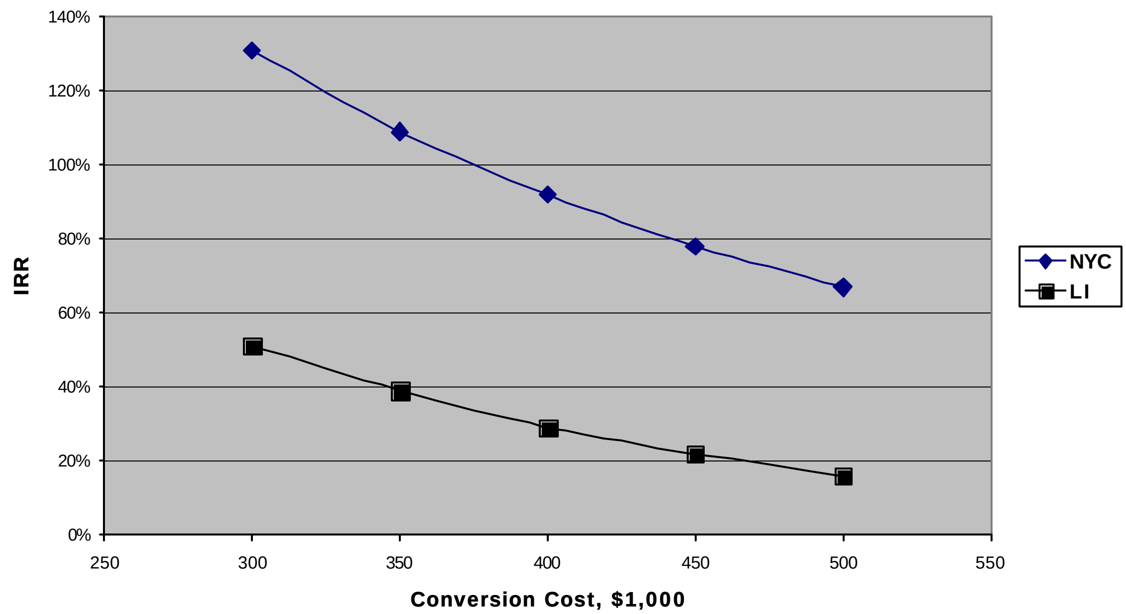
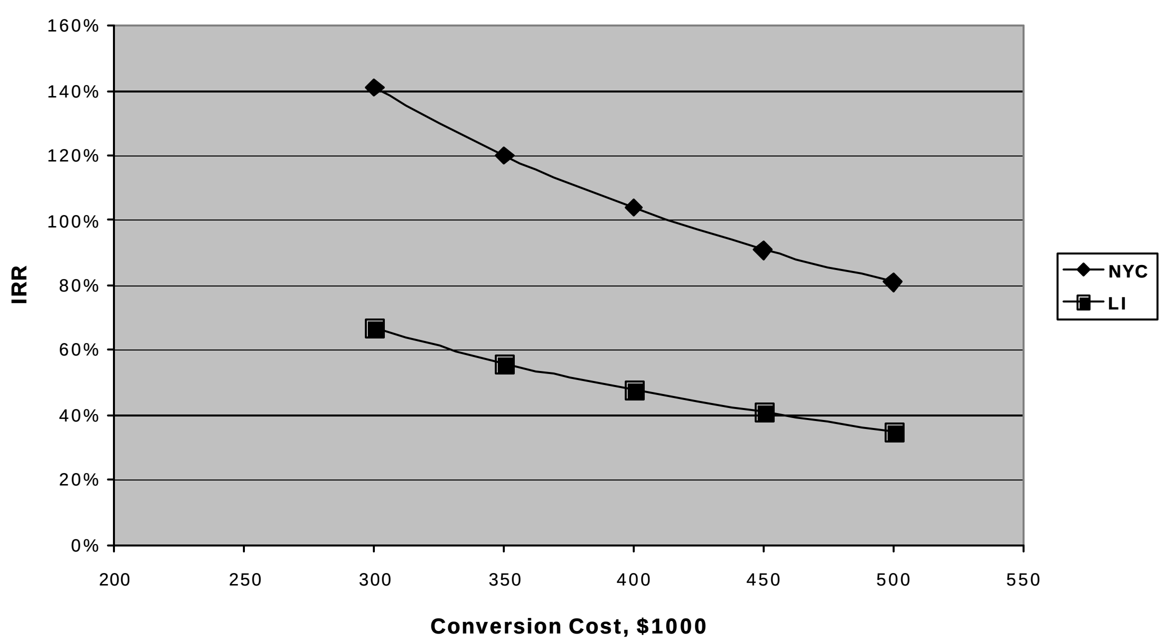


Figure 6. 5-Year IRR
1 x 2,500 kW



Conclusions and Recommendations

Results of this analysis indicate that the conversion of existing standby turbine gensets to run on methanol fuel is potentially economically feasible especially for the larger size turbines due to the their lower conversion cost per kW at a given price of fuel.[1] The New York Research and Development Authority (NYSERDA) have indicated their interest in sponsoring a demonstration of a methanol-fired turbine. Also, Verizon has identified a site with an existing 750kW Solar turbine that could be used for demonstration of a methanol-fired turbine.

The price of methanol along with the cost of conversion are the principal components contributing to economic feasibility. If relatively low conversion costs can be realized, than the price for methanol can be maintained close to current market levels with commensurate savings in electricity costs when participating in available demand response programs. However, more information is needed to estimate the potential market for conversion to satisfy an OEM's commitment of their engineering resources. This information includes the population of existing turbines by location, rated capacity and model and vintage along with the estimated cost of conversion for each model represented.

Effort needs to be directed toward obtaining the required market information from OEMs so that a demonstration of a converted unit to methanol firing can be realized. With the advent of more stringent emission standards, methanol has the promise to be a desirable alternative fuel for stationary turbine power plants.

[1]Depending on model vintage, the best estimate for conversion of a Solar Saturn (750 kW) unit is from $200,000 to $400,000 ($267/kW to $533/kW) and $200,000 to $350,000 ($80/kW to $140/kW) for the Centaur. The higher cost is mainly due to the lack of programmable controls for the fuel system on older models. There are Solar Turbines estimates that there are only nine of their Centaur (2,500 kW) units in New York State and 56 total in the U.S.

Appendix
Sample Calculation Page

Turbine Characteristics

Capacity (kW)	2500			
Full Load Fuel Flow (Gal/Hr)	273.6			
Fuel	**Total**	**Fuel**		**Sales Tax**
Methanol:				
Fuel Price ($/Gal)	0.54125		0.5	$0.04
Fuel Price ($/mmBtu)	6.29	5.66		0.64
Kerosene:				
Adjusted Fuel Price ($/Gal)	1.15	1.06		0.08734544
Adjusted Fuel Price ($/mmBtu)	8.37	7.73		0.64
Heating Value (Btu/Gal)				
Kerosene	137,000			
Methanol	64,700			
Heating Value Adj. (Kero/Meth)	2.117			
	Unit	**Total**		
Conversion Costs ($/Unit)	450,000	450,000		

Inputs

Units	1
Total Capacity (kW)	2,500
Profit ($/MWh)	10.00
Capacity Factor (%)	83%
Unit Fuel Flow (gals/hr)	521.1
Bid Capacity (MW)	2.075
Unit Running Cost ($/h)	282.04
Total Running Cost ($/MWh)	112.82
Bid Price ($/MWh)	122.82

NYISO ICAP Summary	**Monthly**		**Strip**	
	2002	**2003**	**2002**	**2003**
ICAP - NYC	147,408	173,034	221,624	226,839
ICAP - LI	58,059	49,800	0	117,155

NYISO Financial Summary

	2002	**2003**
DA Markets - NYC	41,457	21,537
DA Markets - LI	85,443	57,334
Total Rev - NYC - Monthly	188,865	194,571
Total Rev - NYC - Strip	263,081	248,376
Total Rev - LI - Monthly	143,501	107,134
Total Rev - LI - Strip	85,443	174,488
Running Cost - NYC	11,507	7,784
Running Cost - LI	26,512	16,020
Profit - NYC - Monthly	177,358	186,786
Profit - NYC - Strip	251,574	240,591
Profit - LI - Monthly	116,989	91,114
Profit - LI - Strip	58,931	158,468

				2-yr IRR			
NYC	-450,000	428,931	427,378	56%			
LI	-450,000	175,920	249,582	-3.46%			
					3-yr IRR		
NYC	-450,000	428,931	427,378	427,378	78%		
LI	-450,000	175,920	249,582	249,582	22%		
							5-yr IRR
NYC	-450,000	428,931	427,378	427,378	427,378	427,378	91%
LI	-450,000	175,920	249,582	249,582	249,582	249,582	41%