THE IMPACT OF PV SOLAR ON PEAK ELECTRIC DEMANDS, by Willem Post; January 20, 2011

http://www.coalitionforenergysolutions.org/

INTRODUCTION

The Independent System Operator-New England, ISO-NE, administers the regional wholesale electric market. ISO-NE currently operates two demand management programs designed to reduce peak demands and thus limit the adverse rate impacts of peak demands. The adverse rate impacts are due to the costs of owning and operating spinning reserve power plants and standby power plants and the increased capacity T & D systems required during peak demand periods.

At all times some power plants are in spinning reserve mode, i.e., producing enough power to keep themselves running; they provide power to the grid in a fraction of a second in the event a power plant has an unscheduled outage. Other power plants are in standby mode; they usually are started and stopped each day to provide power during peak demand periods.

This study aims to quantify the impact of PV power during peak demand periods.

PV solar proponents often claim because PV solar power "is there" during peak demand periods when higher spot prices are likely to occur, PV solar power should be evaluated against the higher spot prices for all hours of peak demand.

PV solar proponents often claim because summer PV solar power will reduce peak demand of the ISO-NE region, the costs of owning and operating spinning reserve power plants and standby power plants and T & D systems will be reduced.

STUDY SUMMARY

In the referenced federal report is a graph of the "Daily Average of ISO-NE Day-Ahead Prices-All Hours" for the January 07-October 08 period which shows a few short duration spikes of spot prices at about $0.10/kWh-$0.14/kWh during January and February of 2008 and a few short duration spikes of spot prices at about $0.15/kWh-$0.20/kWh during June, July and August of 2008. This pattern of spot prices likely prevailed after October 2008 and will likely prevail in future years as grids get "smarter" at managing demand.

According to ISO-NE records, the peak demand management hours typically occur for 5% or less of the year, or 8,760 hrs/yr x 0.05 = 438 hrs/yr, of which about 290 hours occurred during the October 2008-March 2009 period when demand is lower; power plant SCHEDULED outages usually occur during lower demand periods. As about 290 hrs of demand management hours occurred during the October 2008-March 2009 period, about 438-290 = 148 hrs may be assumed to occur during an April-September period.

http://www.ferc.gov/market-oversight/mkt-electric/new-england/2008/11-2008-elec-ne-archive.pdf

Studies by Dr. Richard Perez of SUNY, Albany, indicate an about 80% coincidence of summer peak demands and strong sunshine, i.e., high outputs of PV systems, for a May-September period. This means there are 148 hrs x .80 = 118 hrs of coincident demand management for an April-September period, slightly less, say 110 hours, for the shorter May-September period. Dr. Perez also found the "high summer outputs of PV systems" are at about 80% of rated output.

The claim that PV solar power should be evaluated against higher spot prices for all hours of peak demand appears invalid.

The participating customers in ISO-NE demand management programs are paid based on spot prices at the time. According to ISO-NE records, the average payment for customers who reduced their demand was about $0.089/kWh during the winter period of October 2008-March 2009. The average payment will be about 50% higher because of higher summer spot prices during a summer period of April-September

If, for example, Green Mountain Coffee Roasters, GMCR, Waterbury, VT, were a participating customer in the ISO-NE demand management programs, its 100 kW PV solar system would produce 8,800 kWh during the 110 hrs of coincident demand management hours of a May-September period for which GMCR would receive a credit of $1174.80; a plus for GMCR.

Because of the variability and intermittency of PV solar power, it cannot be 100% relied on by ISO-NE during demand management hours (and any other hours). Fossil-fueled, CO_2-producing, spinning reserve power plants and standby power plants, possibly with less capacity than without PV systems, would be required when PV solar power is lacking.

Some weather events affecting PV solar output in areas with changeable weather, such as the UK, Germany, New England, etc., are:

- summer weather events when on a sunny day, clouds appear, rain falls and, after an hour or so, it is sunny again as before.

- winter weather events when snow covers PV panels, sometimes for days, as happens in Germany when after a significant snowfall its PV solar output maybe reduced to about 2% of its installed capacity.

- during hot, cloudy days (air conditioners on, little PV solar power) and during hot nights (air conditioners on, no PV solar power).

The PV solar power output appears to imply less output from spinning reserve power plants and standby power plants during demand management periods (and other periods of the year) and less future investments in such power plants and T & D systems.

ISO-NE estimates an overall rate reduction of $0.002/kWh-$0.003/kWh due to the PAST operation of the two programs when little, or no PV solar power was present; a plus for ratepayers. Adding small quantities of PV solar power to the ISO-NE system will not materially affect this rate reduction.

Adding large quantities may adversely affect this rate reduction, because the variability and intermittency of PV solar power will require grid modifications, increased grid management efforts, and increased output variation and inefficient operation of spinning reserve power plants and standby power plants which produces more CO_2/kWh delivered.

The claim by PV solar proponents that the costs of owning and operating spinning reserve power plants and standby power plants and T & D systems will be reduced due to the presence of PV solar power may have some validity. Because of the present low penetration of PV solar power not enough data exist to quantify the claim.

STUDY ANALYSIS

ISO-NE Demand Management Programs

ISO-NE currently operates two demand management programs designed to reduce peak electric demands and thus limit the adverse rate impacts of peak demands.

One program allows participating customers to agree to limit their demand in the real-time market for those periods when the forecast hourly price is $0.10/kWh or more, AND when ISO-NE has transmitted instructions to participating customers that the eligibility period is open.

The other program operates in the ISO-NE “day-ahead” market, in which power generators and other energy suppliers submit bids to meet the following day's demand.

The programs enroll just under 2,000 MW of demand, about 8% of the peak demand. The ISO-NE peak demand has been declining; it was 28,130 MW in 2006, 25,081 MW in 2009. In New England peak demand occurs during the summer.

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Demand Management Hours

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Studies by Dr. Richard Perez of SUNY, Albany, indicate an about 80% coincidence of summer peak demand and strong sunshine, i.e., high outputs of PV systems, for a May-September period which reduces the demand management hours to 148 hrs x 0.8 = 118 hrs for an April-September period, slightly less, say 110 hours, for a May-September period. Dr. Perez also found the "high outputs of PV systems" are at about 80% of rated output.

The claim that PV solar power should be evaluated against higher rates for all hours of high demand appears invalid.

Spot Prices

In the referenced federal report is a graph of the "Daily Average of ISO-NE Day-Ahead Prices-All Hours" for the January 07-October 08 period which shows a few short duration spikes of spot prices at about \$0.10/kWh-\$0.14/kWh during January and February of 2008 and a few short duration spikes of spot prices at about \$0.15/kWh-\$0.20/kWh during June, July and August of 2008. These spot prices occurred for only a few hours of the 20-month period. This pattern of spot prices likely prevailed after October 2008 and will likely prevail in future years as grids get "smarter" at managing demand.

http://www.ferc.gov/market-oversight/mkt-electric/new-england/2008/11-2008-elec-ne-archive.pdf

Utility Power Sales and Purchases

Utilities buy almost all of their power needs at fixed schedules of prices under long-term contracts and very little, if any, on the spot market. Because of the Great Recession which has reduced projected power demand, they buy even less at spot prices. If they have contracted for more power than their needs, they will sell the excess power at prevailing spot prices. Spot prices vary hour by hour and can be below or above their contract prices.

The presence of PV solar systems within a utility's service area allows a utility to buy less on the spot market. This is also true for any other power generator in its service area operating during the higher priced hours.

Value of PV Solar Power to the Utility

PV solar power is generated at the load level making it 10-12% more valuable to the utility than at the grid level during peak demand periods.

For PV solar power generated at the load level, the PV solar evaluation rate should be (\$0.089 x 1.11)/kWh + about \$0.06/kWh for utility costs, overhead, profit, etc., or \$0.159/kWh during coincident winter demand management hours, (\$0.089 x 1.11 x 1.5)/kWh + about \$0.06/kWh for utility costs, overhead, profit, etc., or \$0.208/kWh during coincident summer demand management hours, and (\$0.06 x 1.11)/kWh + about \$0.06/kWh, or \$0.127/kWh for all other hours.

Financial Benefit of ISO-NE Demand Management Program to a PV System Owner.

For this study, we will use as an example the 100 kW, 572-panel, roof-mounted PV solar system for GMCR, capital cost \$790,000, or \$7,900/kW, received \$250,000 in grants from the Clean Energy Development Fund and \$50,000 from Green Mountain Power. It is expected to produce 100 kW x 8,760 hrs/yr x capacity factor 0.143 = 125,268 kWh/yr which GMCR could have bought from GMP for about \$15,000 in 2009.

GMP buys power from the ISO-NE grid and distributes it its consumers. This process has various losses which makes PV solar power produced at the load level during demand management hours about 10-12% more valuable to GMP than at the grid level (source: VT-DPS); this is one reason for GMP, a publicly traded company with stockholders who may object such grants by GMP, to justify a financial grant to GMCR.

If GMCR were a participating customer in the ISO-NE demand management programs, its PV solar system would produce 100 kW x 110 hours of coincident summer demand management x PV solar output factor 0.8, as per Perez) = 8,800 kWh/yr for which GMCR would receive a credit of 8,800 kWh x \$0.089/kWh x 1.5 = \$1,174.80/yr; a plus for GMCR.

However, GMCR will likely not be a participating customer, because it has a much better deal. GMP has agreed to buy the entire output of the GMCR PV solar system at \$0.16/kWh. The extra costs of about 125,268 kWh/yr x (\$0.16/kWh-\$0.06/kWh) = \$12,526.80 will be folded into the GMP rate base to place an extra burden on other ratepayers who will likely curtail their spending on other items ultimately leading to less work or job losses somewhere. Subsidies usually take from Peter to pay politically well-connected Paul; there is little, if any, net economic benefit.

PV Solar Power Variability and Intermittency

Because of the variability and intermittency of PV solar power, it cannot be 100% relied on by ISO-NE during demand management hours (and any other hours). Fossil-fueled, CO2-producing, spinning reserve power plants and standby power plants, possibly with less capacity than without PV systems, would be required to provide power when PV solar power is lacking.

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PV Solar Power Impact on Utilities and T & D Systems

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http://www.cga.ct.gov/2009/rpt/2009-R-0455.htm
http://www.asrc.cestm.albany.edu/perez/directory/LoadMatch.html
http://www.asrc.cestm.albany.edu/perez/publications/Utility%20Peak%20Shaving%20and%20Capacity%20Credit/Papers%20on%20PV%20Load%20Matching%20and%20Economic%20Evaluation/Towards%20reaching%20consensus-08.pdf
http://www.asrc.cestm.albany.edu/perez/2009/peak%20shaving/perez-2007-forecast-PV-capacity-credit.pdf
http://www.timesargus.com/article/20090224/NEWS02/902240357/0/FRONTPAGE

PV SOLAR POWER AND ELECTRIC DEMANDS OF LARGE BUILDINGS

PV solar systems produce most of their power during summer, less during spring and fall, very little during winter and is not available at night and on cloudy days, requiring year-round purchases from the grid. Daily variations in cloud cover, such as in New England, cause daily variations in PV solar output. Daily PV solar output peaks usually occur earlier, around noon, than daily demand peaks.

Big buildings with large flat roofs equipped with PV solar systems and demand management systems can adjust their hr-by-hr daily profiles of heating, cooling and electricity usages to maximize daily PV solar power utilization, thereby reducing utility demand charges, electricity purchases, the variability of PV solar power on the grid and increasing CO2 reductions. A large number of such buildings will flatten the daily demand profile of a utility, reduce the outputs of spinning reserve power plants and standby power plants and their CO2 emissions.

http://www.cleanpower.com/research/customerPV/SLC_CPE_Validation.pdf

As GMCR reduces its peak demand with its PV solar system, its GMP demand charges will be reduced. Under Rate Schedule 63, GMP looks at demands during any 15 min period between 6 am and 11 pm (the Peak hours), Monday-Friday, for a month and takes the highest demand as the billing demand for that month. All other hours are Off-Peak. Peak demand charge is $12.04/kW/month, Off-Peak demand charge is $3.11/kW/month (source: GMP).

High PV solar system output would need to coincide with the GMP selected 15 minute period of a month to significantly reduce demand charges. If the PV system output were 50 kW during that 15 minute period, the reduction in demand charges would be 50 kW x $12.04/kW = $602 for that month. Because of the variability and intermittency of PV solar power, demand charge reductions will vary accordingly. The GMP T & D charges, not quantified here, may also be reduced.

http://www.nrel.gov/docs/fy08osti/42923.pdf

PV SOLAR POWER AND NET CO2 REDUCTIONS

In general, spinning reserve power plants and standby power plants usually operate at part load which is less fuel efficient than at full load and produces more CO2/kWh delivered. This is especially the case for the open cycle gas turbine plants that are commonly used as standby power plants, because they can be quickly started and their outputs can be quickly varied with demand (a maximum of about 4%/min) without damaging equipment.

An analogy most people understand: Cars are most fuel efficient/least polluting at steady highway speeds, but least fuel efficient/most polluting in stop-and-go traffic. Airplane jet (gas turbine) engines are most fuel efficient/least polluting at cruising speeds, but least fuel efficient/most polluting during takeoffs and landings. As a result, the net CO2 reductions from variable, intermittent PV solar power will be less than claimed by proponents, but not as much as less as for wind power.

Because penetration of PV solar power is minor relative to wind power, data is less available than for wind power to perform valid studies that quantify the net CO2 reductions from PV solar power. However, the penetration of wind power is significant in some US states and nations, data IS available and studies have been performed regarding the net CO2 reductions from wind power.

For example, if wind penetration is 15%, proponents would claim a reduction in CO2 emissions equivalent to the CO2 quantity produced by the displaced fossil fuel power, but studies using New York and California data show the net CO2 reduction is only 5%, a third of what wind power proponents claim.

The lesser CO2 reduction is due to having in operation a much greater capacity of spinning reserve power plants that produce CO2 year-round while adding little power to the grid.

Studies performed in Germany, a big wind and solar nation, yielded similar results, i.e., big investments and subsidies in wind and solar projects created expensive jobs, produced little, but expensive power and much less CO2 reduction than anticipated.

http://arxiv1.library.cornell.edu/pdf/1002.2243>>.
http://www.rwi-
essen.de/pls/portal30/docs/FOLDER/PUBLIKATIONEN/GUTACHTEN/P_RENEWABLE+ENERGY+REPORT+RWI+FORMAT.PDF