Assessment of High Penetration of Photovoltaics on Peak Demand and Annual Energy Use

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Small scale distributed solar photovoltaic (PV) installations have increased dramatically in recent years as a result of decreased cost and federal and local subsidies. Solar PV is sought after as a source of electricity due to no fuel costs, no emissions associated with operation, and the ability to provide power during times of peak electricity load. At current low penetration rates, PV generated electricity has little noticeable impacts on the electricity grid as a whole. As the penetration rate increases, issues of coincidence with electricity load, short-term transients, intermittency, and nondispatchable power become more important.

The project investigates distributed solar PV as a significant resource for electricity generation in the state of Wisconsin. The project evaluates the affects of a high penetration of distributed solar photovoltaics in five main areas:

1) the limit to which solar PV can be integrated into the existing Wisconsin electricity grid
2) the degree to which solar PV electrical generation coincides with utility peak loads
3) the effect of short-term transients in solar radiation on utility load
4) the economics of varying penetration rates
5) the impact (reductions) in emissions associated with PV electricity generation displacing traditional fossil fuel power generation

The analysis utilizes the 5-parameter PV model within the Transient System Simulation (TRNSYS) program to predict the hourly performance of a solar photovoltaic module. Hourly solar radiation and meteorological data are used as inputs into the model. Solar radiation and meteorological data for individual years and long term averages are used to predict the performance of PV systems under varying conditions and locations throughout Wisconsin. Hourly electric utility data is obtained for a base year and used in conjunction with the hourly modeled PV performance to determine the coincidence of PV generated electricity and peak utility loads.

The results of the project are intended to provide quantitative results for the level of PV penetration that can be achieved in Wisconsin. The evaluation will also investigate what, if any, subsidies should be provided to promote this renewable resource and at what level. A computer-based tool will be developed that incorporates the TRNSYS PV simulation for use by state regulators for their own analysis.