Research Brief: Nodal Pricing in Ontario

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Traditionally, large power stations have usually been located outside of concentrated load centres in modern electricity systems. In Ontario, for example, the three largest power stations, in terms of rated capacity, are the Bruce nuclear power station (4,700 MW), the Nanticoke coal-fired power station (3,920 MW) and the Darlington nuclear power station (3,524 MW). They are, however, 250, 128 and 70 kilometers, respectively, away from the largest load centre in the province – that is, Toronto and the surrounding 'Golden Horseshoe'. While these arrangements have traditionally served Ontario well, it is now being increasingly recognized that they also lead to significant power losses and transmission congestion challenges – that is, difficulties in ensuring that sufficient power reaches the province's largest urban areas, particularly during the summer peak demand periods. As a result, a particularly salient research question is: Would alternative pricing systems for electricity encourage increased deployment of distributed generation options (including solar-photovoltaics (PV) mounted on urban buildings) in areas of high congestion? With the support of the Solar Buildings Research Network (SBRN), researchers at the University of Waterloo are investigating this issue.

As part of the SBRN's project on the *Investigation of Load Management in Restructured Electricity Systems*, Dr. Ian Rowlands, an Associate Professor in the Faculty of Environmental Studies at the University of Waterloo (UW), has been working with Sarah Brown, a senior undergraduate student in Environment and Business at UW. For the past year, they have been investigating the extent to which a 'nodal pricing system' would offer increased rewards in Ontario for building-based solar electricity.

At present, electricity markets in Ontario operate under a uniform pricing system that is reflected in the Hourly Ontario Energy Price (HOEP) – a single price for electricity across the province, irrespective of where that electricity is produced. Operating under such a system, the electricity market does not generally serve to recognize the additional benefits of generation options that are located in congested areas. By contrast, a nodal pricing system is one that takes into account the locational factors and marginal costs of energy production and consumption at any given location on the grid; thus, prices are different across the jurisdiction.

Brown and Rowlands have been exploring the extent to which the value of solar electricity would be higher under a nodal pricing system, as compared to a more traditional uniform pricing system. To do this, they examined the relationship between the amount of solar electricity potentially generated at a southern Ontario location and Ontario electricity prices in 2006. More specifically, hourly global solar radiation data were obtained from

a weather station in Mississauga, Ontario. These data were quality-controlled as required for input into HOMER, a PV simulation program developed by the United States National Renewable Energy Laboratory (NREL). Simulated solar electricity output was generated for this same location based on a three kilowatt (kW) grid-connected solar PV system with panels at a tilt angle of 30 degrees and an azimuth of 0 (due south).

Hourly nodal prices were obtained from the Independent Electricity System Operator in Ontario for the location closest to the Mississauga weather station. This location was the natural gas-fired combined cycle cogeneration facility located at the Toronto Pearson International Airport. Along with other large load centres in southern Ontario, the city of Toronto was identified in 2006 by the Ontario Power Authority (OPA) as an area that already has transmission-related reliability and supply adequacy challenges.

The total monthly value of solar electricity generated was calculated under two different pricing schemes: a uniform pricing system (that is, the HOEP) and a locational pricing system (that is, the reported nodal value at the Toronto Pearson International Airport). The total monthly value of solar electricity based on nodal prices was consistently higher than the value based on HOEP, with the most considerable spread occurring in the summer months. Full results are presented in Figure 1. Indeed, between May and August 2006, inclusive, the total value of the 1,796 kWh estimated to be generated at this location would have received 80 per cent more revenue under a nodal pricing system than under a uniform pricing system ($201.78 versus $112.69).

Focusing more specifically upon the summer months, Figure 2 presents the relationship among average solar electricity generation, nodal prices and HOEP, on an

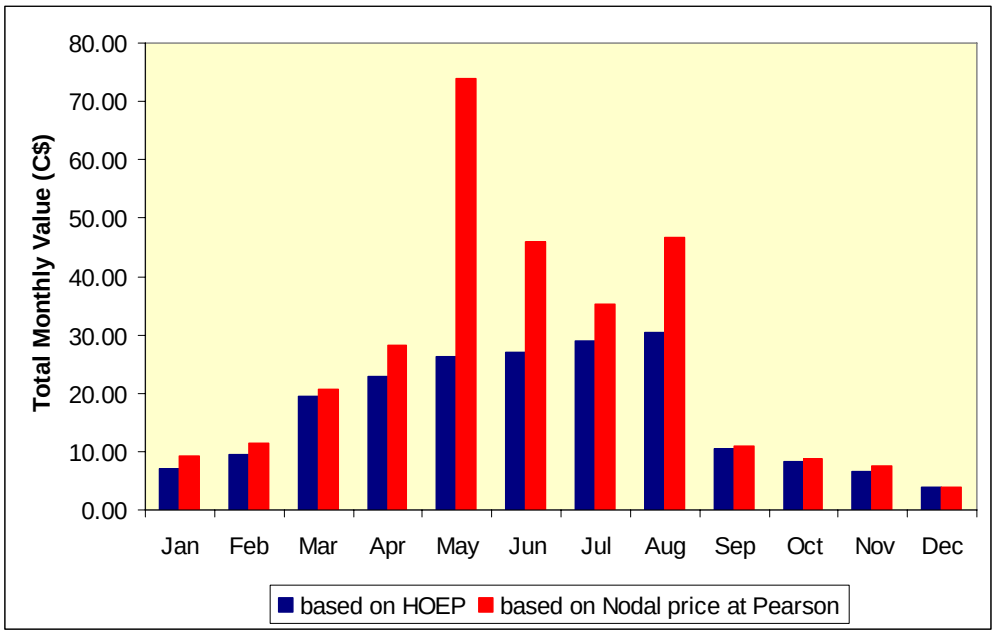

Figure 1 Total Monthly Value of solar electricity, Mississauga, Ontario, 2006

hour-by-hour basis. Peak solar electricity values coincide with peak nodal prices – particularly, that is, during the midday hours of approximately 12:00 to 15:00 (EST).

In summary, there was a consistently higher value under a nodal pricing system for solar electricity produced in this area of high congestion, as compared to a uniform pricing system. Solar electricity is advantageous in helping to alleviate congestion most importantly because it can be generated in close proximity to loads, thus avoiding line losses and transmission costs. Solar electricity is also ideal due to the fact that its times of high production correspond with times of high demand and congestion. These conditions occur generally in the midday hours during the summertime. Interim results from this study (which considered additional locations in Ontario) were presented at the 2007 Solar Buildings Research Network Conference (Calgary, AB, June 2007) and can also be found in a research paper developed by Brown and Rowlands, which is available from the University of Waterloo's Sustainable Energy Research Website at http://www.fes.uwaterloo.ca/research/greenpower/projects/solar.html

Debate regarding the most appropriate pricing system for solar electricity continues. Indeed, in Ontario, much of the discussion is currently dominated by consideration of the Renewable Energy Standard Offer Program (RESOP). Regardless of how this debate proceeds, it is clear that the need to understand better how solar electricity can be properly valued and rewarded in electricity systems will remain high. Work on this, and related, issues continues in the Solar Buildings Research Network.

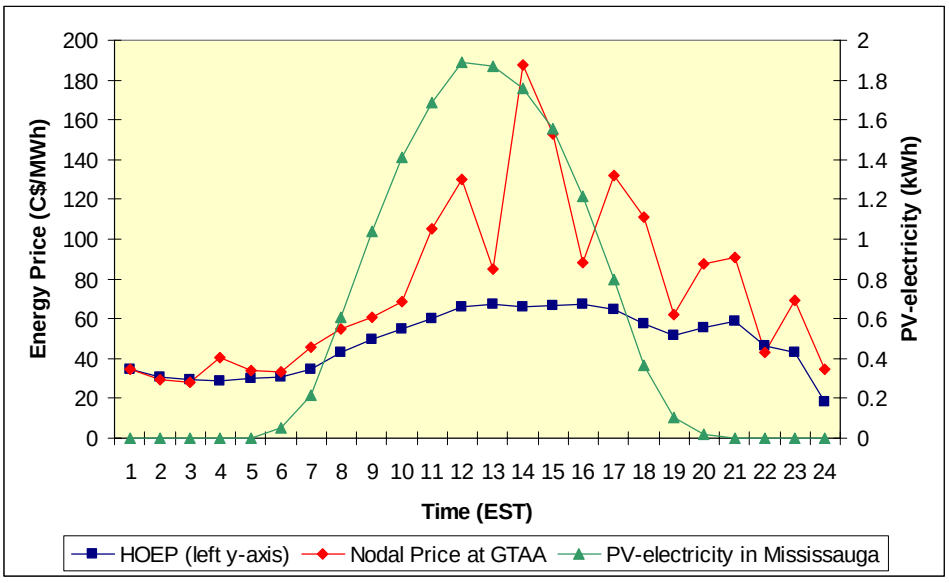

Figure 2 Average hourly solar electricity output, HOEP and nodal prices, Mississauga, May – August 2006

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