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**Subject:** Final Ryerson CUE white paper: Using Demand Response to Lower Electricity Prices during Natural Gas Shortages  
**Attachments:** 3-White Paper 6 - Conservation.pdf

Hi,

Please find attached the latest white paper, *Using Demand Response to Lower Electricity Prices during Natural Gas Shortages*, from Jessie Ma, the IESO's Integrated Delivery of Electricity, Gas, and Water Conservation Research Fellow at the Ryerson University Centre for Urban Energy. While not indicated by the title, the paper includes a discussion of how US ISOs and utilities used DR to respond to natural gas shortages during the "Polar Vortex" winter and Aliso Canyon incident and lessons applicable to Ontario. Please feel free to share internally.

*Abstract: A new method for optimizing the procurement of Demand Response (DR) to minimize electricity prices for remaining consumers is proposed in this paper. While this method can be applied anytime electricity prices are positive, its greatest impact occurs during times of extreme peak prices, such as during natural gas shortages. Independent System Operators (ISOs) need to determine the optimal quantity of DR resources to procure and the optimal price to pay DR resources. Traditional market settlement methods are designed for the procurement of only one commodity: generation. DR services are a second commodity that is not captured fully by traditional methods. Furthermore, the procurement of DR and generation are interdependent, and this relationship is not fully understood. In order to optimally settle both the generation and DR markets simultaneously, a new method is proposed: (1) The concept of actual price is explained. Actual price comprises the costs for both generation and DR services, and it accounts for the smaller paying consumer base after DR services are procured. (2) A new demand curve for DR is constructed to minimize the actual price to remaining consumers. (3) Both the DR and generation markets are settled at their respective Nash equilibrium points. This method ensures that remaining consumers benefit from the lowest possible actual prices through the procurement of DR services. This method was applied to Ontario's electricity system using both historical patterns and future patterns.*

*The collective savings to remaining consumers due to DR increased as the percentage of extreme prices due to climate change grew.*

**This white paper marks the completion of the IESO-Ryerson contract for the Integrated Delivery of Electricity, Gas, and Water Conservation Research Fellowship.**

Below is the full list of papers produced through this Research Fellowship and available to IESO staff:

- 6. Using Demand Response to Lower Electricity Prices during Natural Gas Shortages*
- 5. Implementing the Future of Integrated Delivery of Electricity, Gas, and Water Conservation*
- 4. Using Conservation to Maximize Societal Benefit: A Refinement of the Past-Present-Future Conservation Model*
- 3. Models for the Integrated Delivery of Electricity, Gas, and Water Conservation*
- 2. Demand Response Literature Review*
- 1. Conservation and Demand Management: Where We Are Today*

All the best,

**Tom Aagaard** | Senior Specialist, Policy, Engagement and Innovation

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