Think Small: Microgrids as a Method to Improve Grid Resiliency Against Climate-Caused Extreme Weather

Summary

In the coming decades, the province of Ontario will require tens of billions of dollars of investment distribution and transmission grid infrastructure. At the same time, extreme weather manifestation of climate change will exacerbate grid vulnerabilities and the potential for interruption. The province should direct grid infrastructure funding towards measures which meet emerging demands, such as decentralized generation incorporation, while enhancing resiliency against interruption. Smart microgrids are one such measure advocated here.

Energy Sector Climate Vulnerability

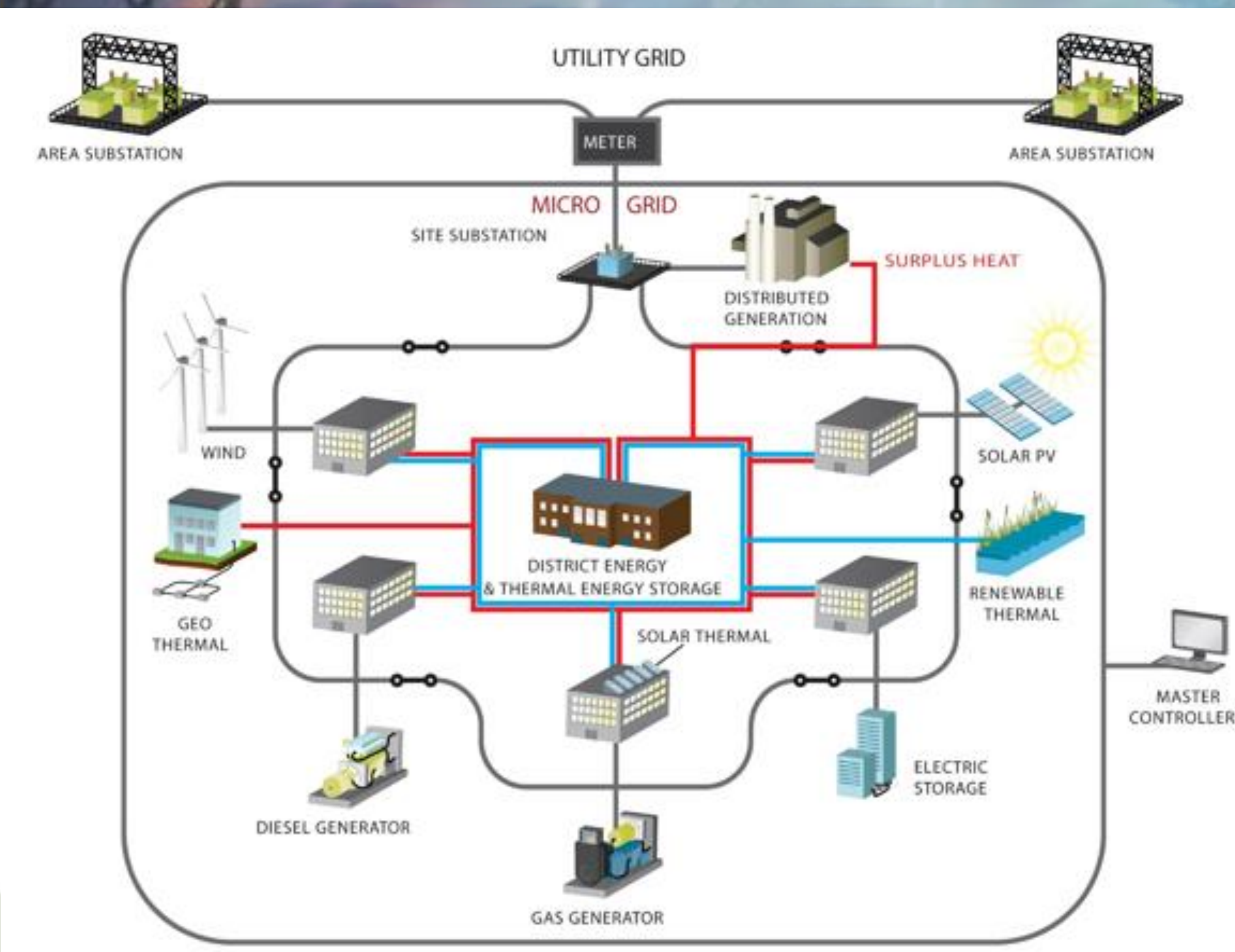
Canadian grid infrastructure is rapidly aging, and is expected to require more than $100 billion in investment in transmission and distribution lines over the next 20 years[1]

Severe weather is the primary cause of electrical grid interruptions, which result in billions of dollars per year in economic losses [2]

Increasing instances of extreme weather events are exacerbating grid interruptions, and trend projected to continue as Climate change increases magnitude and frequency of severe weather events [3]

Electrical macrogrid structure designed for sparse, high-output centralized power generation plants with one-way transmission flow of electricity. This presents significant challenges towards incorporating decentralized, renewable energy into municipal grid systems, an important strategy to combat climate change [4,5]

To address grid vulnerabilities to the significant threat of climate change-exacerbated interruptions, as well as facilitate a significant ramp-up in renewable integration, transformative change in grid structure and operations is necessary



Dustin Carey

Candidate for
Master of Climate Change
University of Waterloo

Climate-Resilient Microgrids

A new infrastructure system is needed which simultaneously enhances the resiliency of the grid against extreme events while ease of incorporation of renewable energy technologies. Smart microgrids are an example of a technology which could meet this demand.

Although there remains a lack of consensus on a standard definition, a microgrid can generally be described as a small (typically several MW or less in scale) power system structure incorporating distributed and/or decentralized generation and/or storage, and the ability to operate interconnected with or isolation from the larger utility electrical grid [6]

Smart microgrids employ far more extensive metering and monitoring than does the grid at large, as well as DC/AC distribution technology allowing duel directional flow of electricity, which aids in facilitating the incorporation of decentralized generation and energy storage technologies [7,8]

In emergency situations, microgrids may act as autonomous self-contained electrical grid systems isolated from the macrogrid, draw upon the decentralized generation and/or storage available in the isolated grid, and via predetermined prioritizations and hierarchies of needs, allocate the available electrical current to users connected to the microgrid [6]. This suggests their particularly attractive nature as a climate change adaptation option

In an interconnected system, a microgrid that receives the surplus request and has generation capacity in excess of its own vital and non-vital load requirements can export this current to another microgrid in need [6,7]. As such, multiple interconnected microgrids across a cityscape would greatly enhance the resiliency of that grid system against interruption.

Ontario is rolling out pilot project microgrids in the Northern Region, particularly because they do not require macrogrid connectivity, and Guelph to test renewable energy penetration [9,10]. While framed through energy security and climate mitigation lenses, microgrids are a key technology towards improving grid resiliency in the face of climate-driven extreme weather, and one that Ontario should embrace.

Recommendation

Pending the success of Ontario's test microgrids, the needed investment in grid infrastructure over the next 20 years should incorporate smart microgrids into the city scape to capitalize the potential synergistic benefits of enhanced resiliency against climate change impacts and ease of renewable energy integration

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