Minnesota's Smarter Grid:

Pathways Toward a Clean, Reliable and Affordable Transportation and Energy System

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Who Are We: Vibrant Clean Energy (VCE®)





Purpose of Vibrant Clean Energy, LLC:

- Reduce the cost of electricity and help evolve economies to near zero emissions;
- Co-optimize transmission, generation, storage, and distributed resources;
- Increase the understanding of how Variable Generation impacts and alters the electricity grid and model it more accurately;
- Agnostically determine the least-cost portfolio of generation that will remove emissions from the economy;
- Determine the optimal mix of VG and other resources for efficient energy sectors;
- Help direct the transition of heating and transportation to electrification;
- License WIS:dom optimization model and/or perform studies using the model;
- Ensure profits for energy companies with a modernized grid;
- Assist clients unlock and understand the potential of high VRE scenarios, as well as zero emission pathways.



Minnesota's Smarter Grid

- Utilize the WIS:dom[®] optimization model to investigate the pathways available to Minnesota to decarbonize the economy by 80% by 2050;
 - WIS:dom[®] modeled the Minnesota electricity grid (along with the MISO and wider Eastern Interconnection) with electrification of some other sectors taken into account under baseline (BAU) and decarbonized conditions.
 - To decarbonize the economy by 80% by 2050 (meet pro-rata 2°C climate goals), the electricity sector must decarbonize by a minimum of 91% (with the consideration of strong EE, electrification of space & water heating and transportation. Note these are all referenced back to 2005.
 Essentially, the MN electricity sector has a maximum of 4.5 mm T of CO₂ emissions allowed to reach goal.
- Builds off two previous studies that VCE[®] has performed in the MISO footprint:
 - 1. A MISO commissioned study "High penetration renewable energy study for MISO" found here: <u>https://www.misoenergy.org/layouts/MISO/ECM/Redirect.aspx?ID=223249</u>
 - 2. An Energy Foundation funded project in collaboration with UMN and Strategen consulting "Modernizing Minnesota's Grid" found here: <u>http://energytransition.umn.edu/wp-content/uploads/2017/07/Workshop-Report-Final.pdf</u>



Electrification is Key To Low-Cost Decarbonization

- Electrification and decarbonization can be achieved in Minnesota (along with the Eastern Interconnection) to provide a low-cost, lowemissions economy.
- ✓ The electrification and decarbonization for Minnesota could save each household up to \$1,200 per year in direct costs.
- Electrification provides flexibility to the electricity sector that reduces the impact of resource variability (but does not eliminate it completely).
- The electrification and decarbonization mitigates over 80% of the GHG emissions from the Minnesotan economy. It also reduces the exposure risk of the economy to volatility of the price of natural gas fuel.
- ✓ Without electrification, more transmission is required, and decarbonization becomes much more difficult.



Our Approach With WIS:dom®



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The Whole Economy Needs Energy



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Electrification that WIS:dom® Considers

The WIS:dom[®] optimization model considers **electrification through**:

- Light Duty Vehicles,
 Heat pump Water Heaters (residential & commercial),
 Heat pump space heating (residential & commercial),
 Light Duty Trucks,
 H2 production for:

 Medium / Heavy Duty Trucking,
 - Industrial Demands,
 - Space heating (residential and commercial),
 - Other transportation (Sabitier, Fischer-Tropsch and Haber Processes).



Electrification Changes Electricity Needs





Electrification Changes Electricity Needs





Seasonal EV charging will likely come from existing driving patterns (unless AVs take over)





Much more heating demand occurs in the winter months and during nighttime





EV diurnal patterns may be different depending on rates





The heating diurnal patterns in aggregate smooth out





How these new loads look in MN demand profiles



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Electrification Changes Electricity Needs Everywhere





New Loads Create Demand-side Resource Flexibility





WIS:dom® Contains Detailed Wind Datasets





WIS:dom[®] Contains Detailed Solar Datasets





Advanced Screening For Rooftop PV

Note: Logarithmic Color Scale



One Scenario Deeper Dive: El Decarbonization (80x50)



Eastern Interconnection Installed Capacity





Eastern Interconnection Increased Jobs





Eastern Interconnection Emissions Change





















Generation Share For Eastern Interconnection





Dispatch For Eastern Interconnection





Dispatch For Eastern Interconnection





Avoided Emissions For Eastern Interconnection





MN Retail Cost of Electricity By Scenario



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MN Average Annual Household Savings





MN Decarbonization Becomes Clear After 2020







Thank You

Full report found here: http://www.vibrantcleanenergy.com/media/reports/

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