How Do Distributed Energy Resources Affect Electricity Distribution Networks?

A Method to Evaluate Hosting Capacity of Electricity Distribution Networks

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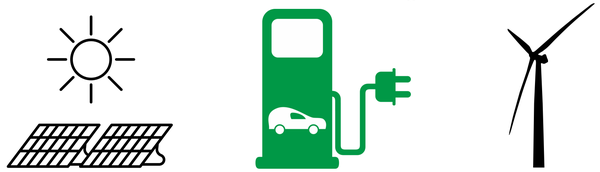
Context & Motivation

What are DERs and why are they relevant?

- DER (Distributed Energy Resources): energy resources that are placed within the distribution network, i.e near the consumers. [1]
  - Ex: Rooftop Solar Panels, EV Chargers



- They can decrease the cost of energy use for consumers [1] and potentially "reduce the environmental impact of centralized generation" [2].

Are there any concerns that must be addressed when integrating DERs into a network?

- Ensure safety of consumers when introducing new technologies into the network.
- Hosting Capacity can help quantify the effect of DERs on the electricity distribution network.
- Hosting Capacity: "The amount of new production or consumption [DERs] that can be connected to the grid without endangering the reliability or voltage quality for other customers" [3].

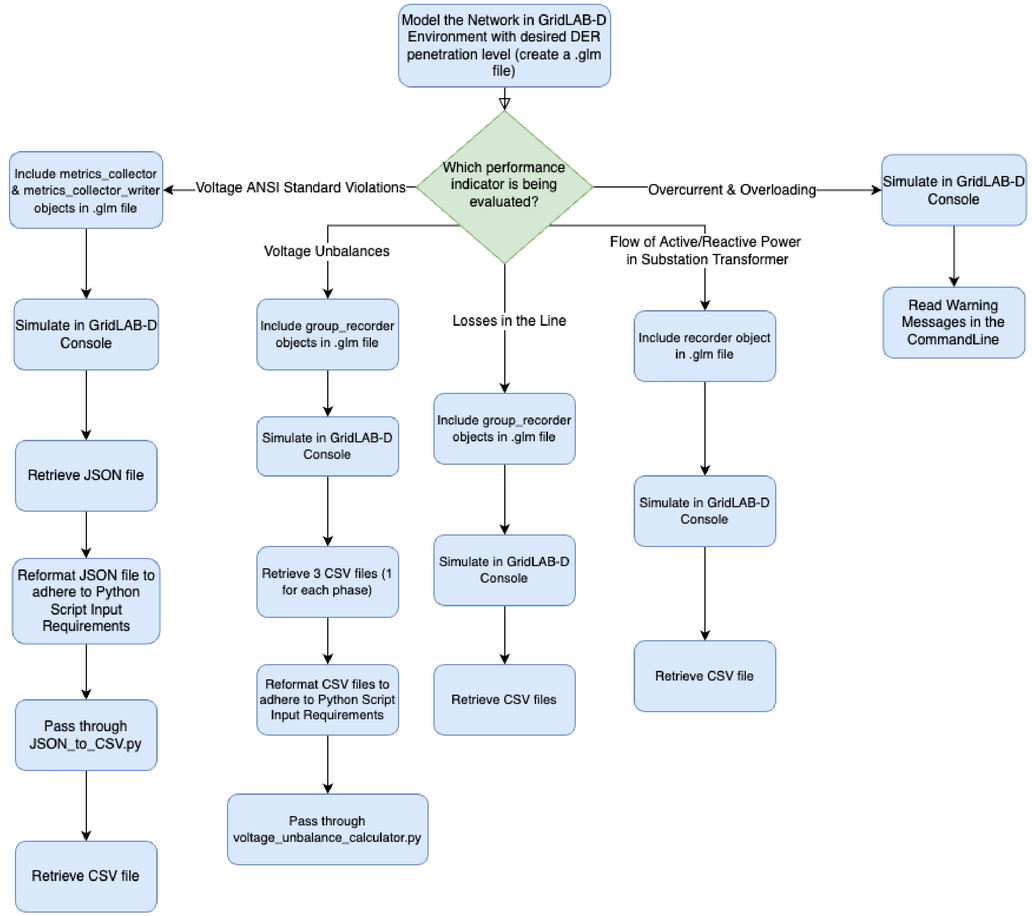
What we have worked on this summer:

- There already exists many methods that aim to quantify hosting capacity.
- **Develop a step-by-step protocol** to follow in order to help quantify the effect that DERs can have on different networks.
- **Support and facilitate subsequent research** that would require quantifying the hosting capacity of a network, as we have detailed how to use the chosen softwares to evaluate network hosting capacity.

Software & Tools

Performance Indicator	GridLAB-D Object Used	Output Format	Python Script
Voltage ANSI Standard Violations	metrics_collector & metrics_collector_writer	JSON file	JSON → CSV
Overcurrent & Overloading (Thermal Violations)	N/A	Warning messages in CommandLine	N/A
Voltage Unbalance Across Phases	group_recorder	CSV file	CSV → python dict
Losses in the Line	group_recorder	CSV file	N/A
Flow of Active/Reactive Power in Substation Transformer	recorder	CSV file	N/A

The Proposed Protocol/Method



Conclusions & Future Work

Conclusions:

- Using this proposed protocol, researchers who wish to test the hosting capacity of their networks in a simulated environment can do so with more knowledge about which tools to use and how to use them.
- When performing hosting capacity analysis using this protocol, the performance indicators and their limits may be modified to fit the research context.

Future Work:

- The proposed protocol must be tested out. Please refer to Ralph Younan's poster for the case study.
- Modifications to the Python Scripts to account for larger input file sizes

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References

1. "Distributed energy resources." AEMC.gov.au. https://www.aemc.gov.au/energy-system/electricity/electricity-system/distributed-energy-resources#:~:text=Distributed%20energy%20resources%20(DER)%20refers,battery%20storage (accessed Aug. 8, 2022) .
2. "Distributed Generation of Electricity and its Environmental Impacts." EPA.gov. https://www.epa.gov/energy/distributed-generation-electricity-and-its-environmental-impacts#:~:text=Distributed%20generation%20refers%20to%20a,and%20combined%20heat%20and%20power. (accessed Aug. 8, 2022)
3. M. Bollen and S. Rönnberg, "Hosting Capacity of the Power Grid for Renewable Electricity Production and New Large Consumption Equipment," *Energies*, vol. 10, no. 9, p. 1325, Sep. 2017, doi: 10.3390/en10091325.

Note: images on the poster are from Canva. https://www.canva.com/ (accessed Aug. 8, 2022)