Distributed Energy Resource Hosting Capacity

ComEd An Exelon Company — powering lives

What is it and why?

The challenge

Distributed energy resources (DERs) are a fundamental component of the Grid of the Future. They enable the development of a sustainable, efficient, resilient, microgrid capable network; however**, if not adequately managed, they can also compromise the performance of the grid**. As such it is important for utilities to proactively manage DERs as they proliferate.

Hosting capacity is one of the many proactive planning tools that will play a key role in managing the sustainable uptake of DERs.

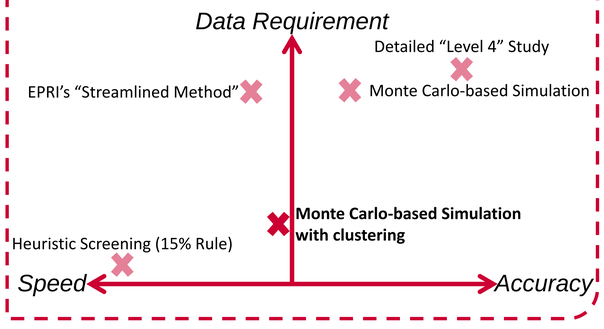
An overview

Hosting capacity quantifies (in kW or MW) **the total DER capacity that can be accommodated on a distribution feeder** without negatively impacting system operation, power quality, and reliability with existing system control infrastructure.

There are a number of existing methods for quantifying hosting capacity, each of which has its own inherent compromise. They include:

- Heuristic screening techniques,
- Detailed engineering studies, and
- Advanced modelling techniques that balance speed, accuracy, and data requirements to improve scalability.

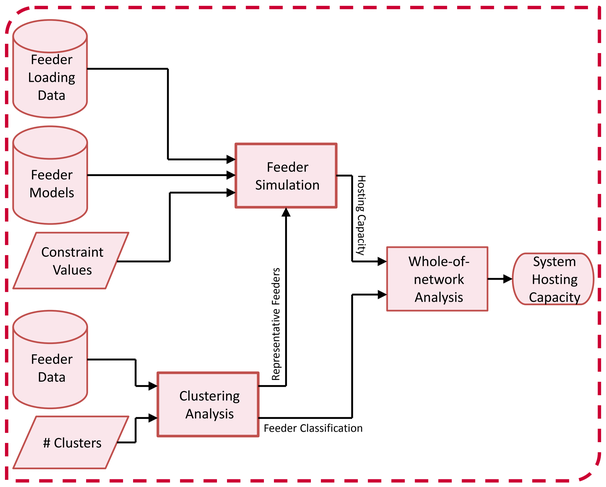
The compromise



How does it work?

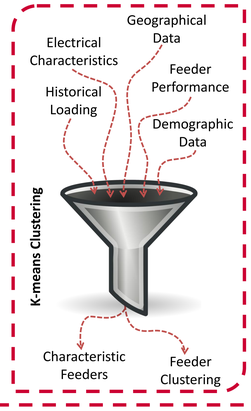
The algorithm

The selected method **combines detailed Monte Carlo simulations** with **Big Data analysis techniques** to estimate the hosting capacity of each feeder in ComEd’s distribution network.

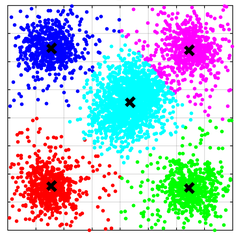


Clustering

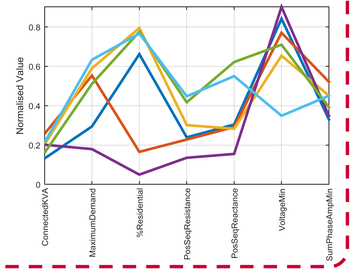
A total of **76 different feeder characteristics** are compiled from different sources (CYME, CEGIS, DLMP) and are input to a clustering algorithm. This technique known as K-means clustering, takes this data and identifies mathematical clusters and their associated centers (centroids). These centroids can then be used to identify characteristic feeders that are representative of the network as a whole.



Clustering Example

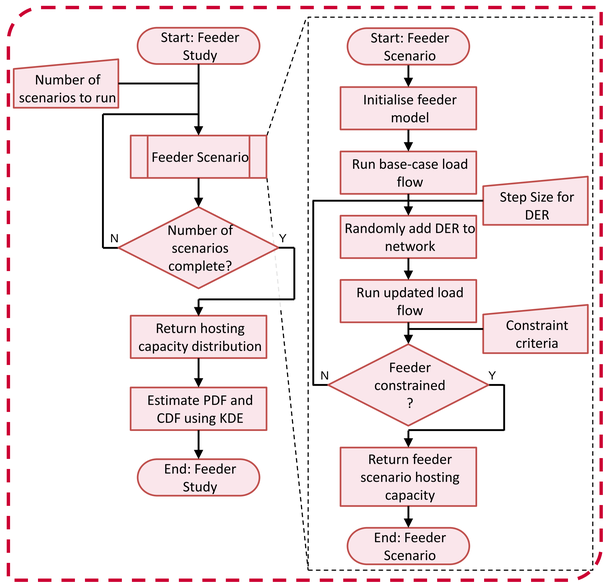


Characteristic Feeders



Feeder simulation

The stochastic Monte Carlo feeder simulation algorithm consists of: a **feeder study** component that manages the Monte Carlo simulation, and many **feeder scenarios** that model hosting capacity permutations.



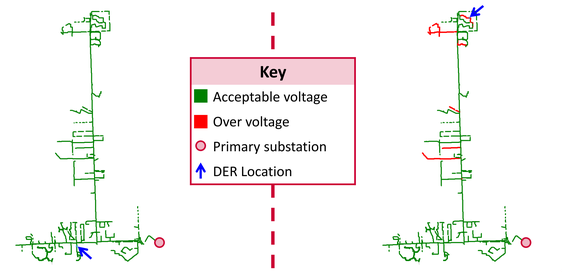
What’s next?

Applications

Once quantified the hosting capacity metric may find use in a number of current and future applications, such as:

- Providing a high-confidence **screen for assessing DER interconnection requests**
- Identifying **optimal locations for DER installation**
- **Tracking the impact of DERs** on our system
- As a tool to **support proposals for network investment**
- Assisting in the development of **targeted incentive schemes** for the deployment of DERs
- Understanding the **cost and potential benefit of high-penetration DER deployment**.

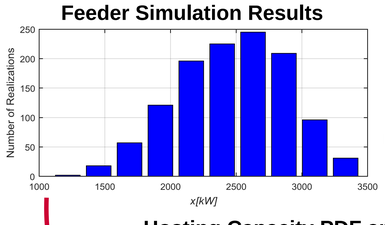
Locational Impact of DERs



Results

This modelling technique produces a hosting capacity distribution for the characteristic feeders, which can in turn be used to calculate the feeder’s hosting capacity probability density function (PDF) $f_{HC}(x)$ and cumulative density function (CDF) $F_{HC}(x)$.

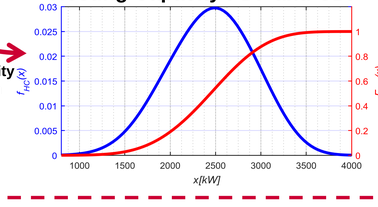
Feeder Simulation Results



Hosting Capacity = $F_{HC}^{-1}(p)$

Hosting Capacity PDF and CDF

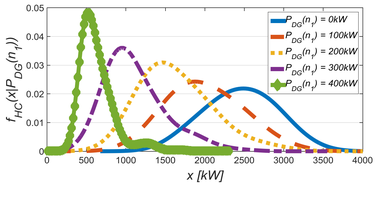
Kernel Density Estimation (KDE)



Future work

We are currently investigating an extension to the current stochastic feeder simulation algorithm that would enable studying the “locational marginal hosting capacity”. This would provide an understanding of the impact adding DER at a node on the network would have on the overall feeder hosting capacity.

DER installed at a “weak” node



DER installed at a “strong” node