Locational Requirements:
Enode, Pnode and electrical location education

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Enode vs Pnode vs Address

- **Enodes (or Electrical Nodes)** are all connection points between equipment. Branches like lines, transformers, breakers, and disconnects connect between two Enodes.
  - Injections like loads, generators, and capacitors connect to an individual Enode.
  - PJM internal model contains 86,397 internal Enodes, 10,251 of which have loads.

- **Pnodes (or Pricing Nodes)** are Enodes that are priced in the market. Generally, Pnodes are Enodes that have load or generation but can also be any weighted combinations of Enodes.
  - PJM internal model contains approximately 10,000 bus Pnodes reflecting internal loads.
  - Pnodes have unique distribution factors and losses based on current topology and constraints in PJM's nodal energy markets.
  - A Pnode is not directly correlated with an address or even substation location. It is a grouping of electrically interconnected customers or suppliers.
  - PJM calculates some aggregate Pnodes for zones, hubs, RTO, and other uses but are not applicable for DERA's.

- PJM markets calculates a locational price at each Pnode, which assumes everything at that Pnode has the same impact (distribution factors) on any given constraint.

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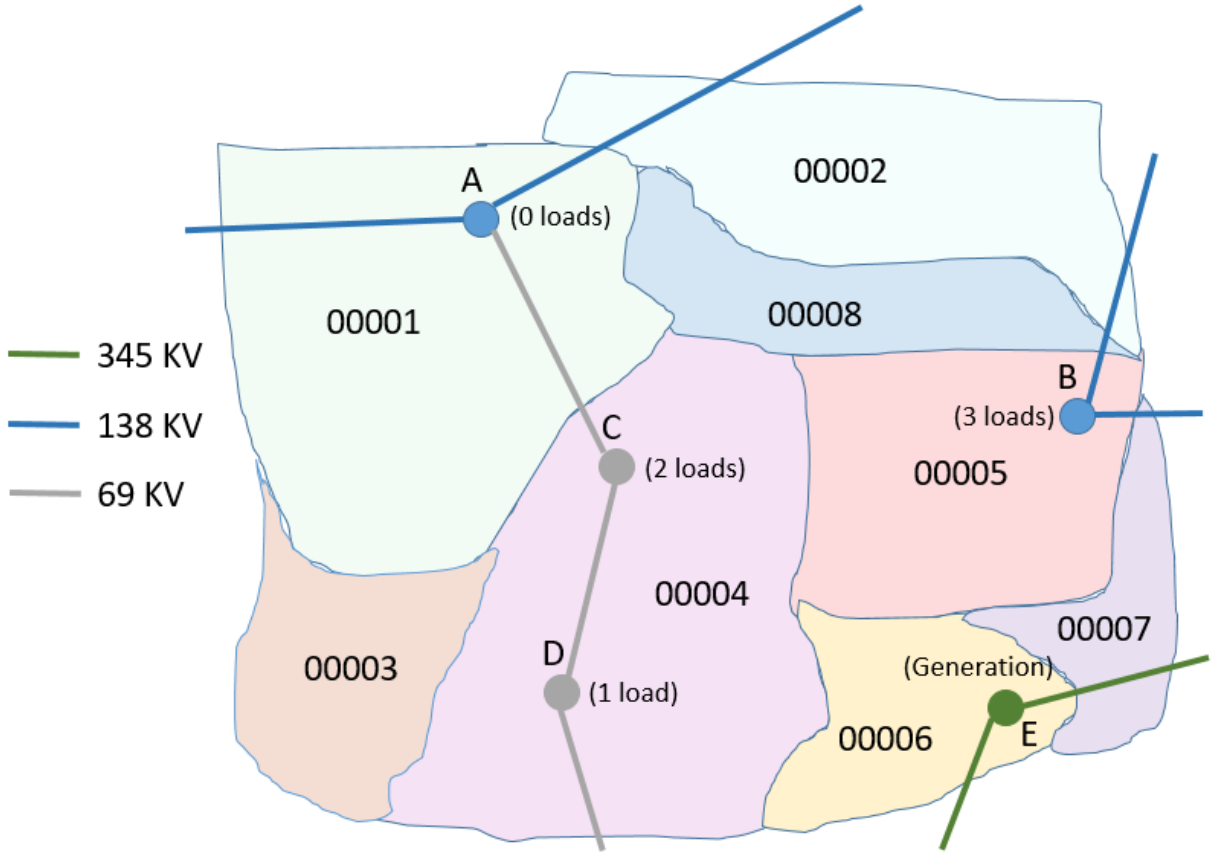
Zip Codes vs Nodes

- PJM modeled loads are “Pnodes” and have unique load, losses, and prices
- Not all zip codes have substations (00003) and some contain multiple substations (00004)
- Not all substations have load (A, E) and some substations have multiple loads (B, C)
- Nearby substations (A,E) may not serve local zip codes at all
- Loads can be modeled at varying voltage levels (B vs C)



DER Aggregators will need to work with EDC/utility to understand electrical locations of DERs

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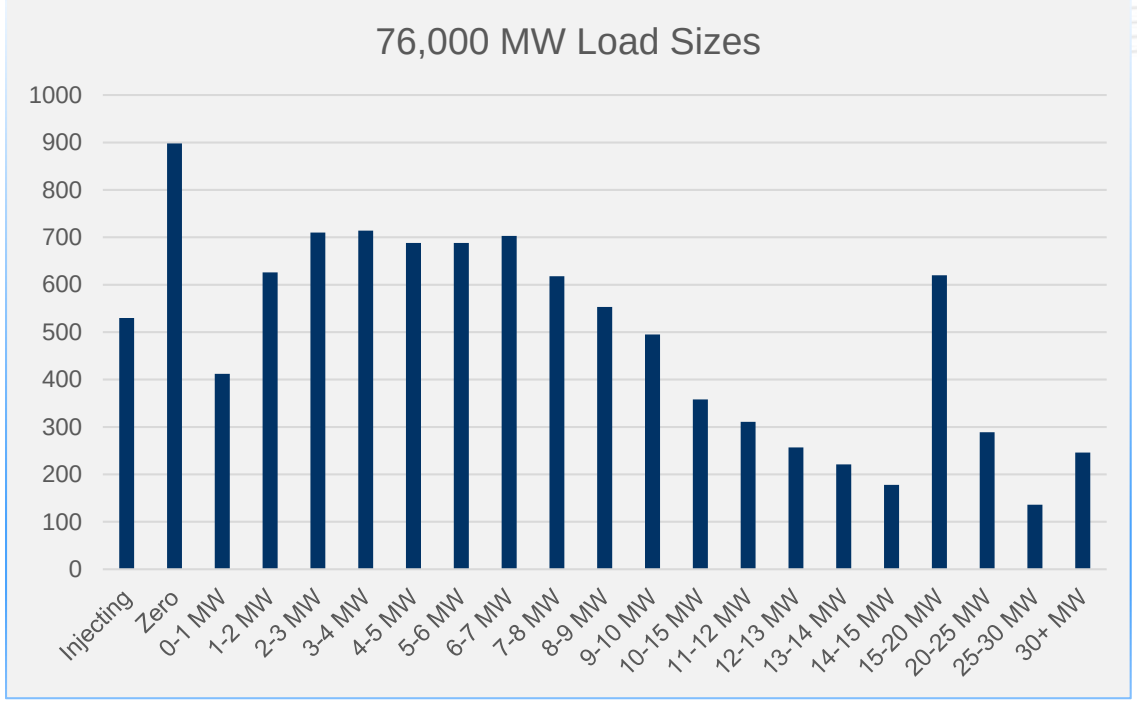
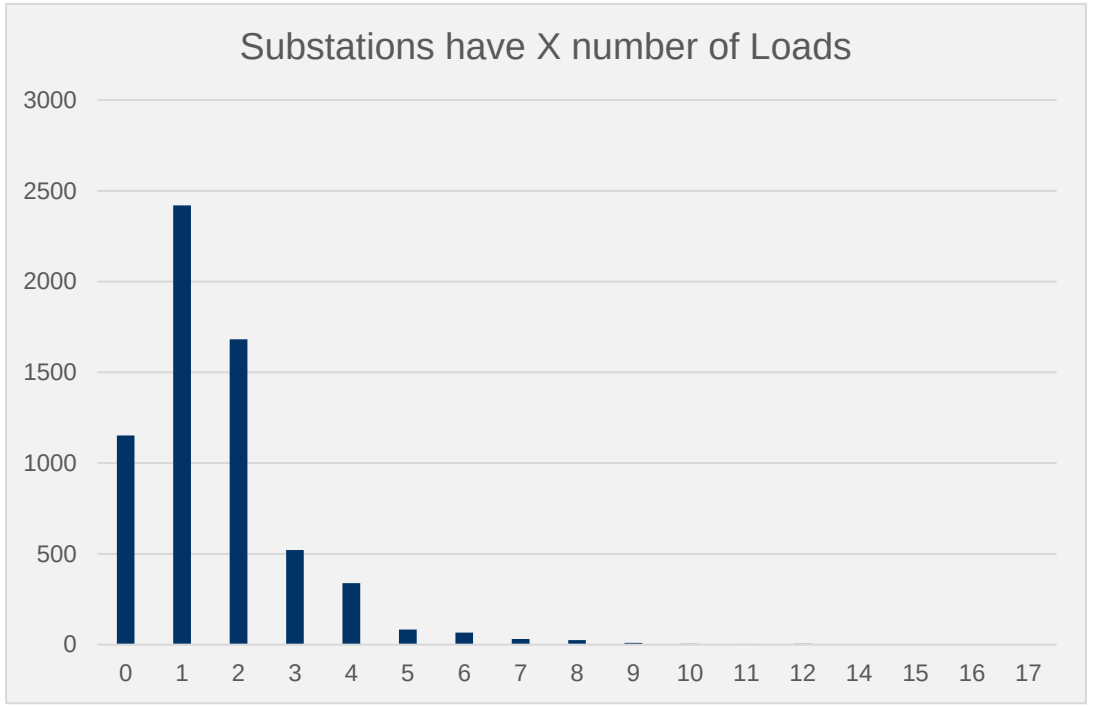
PJM Loads

- 10,251 Internal Loads in PJM



- 5196 Internal Substations



Loads are the boundary between PJM's transmission model and the distribution system

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Takeaways

- Aggregations significantly broader than PJM's existing load model would compromise locational pricing and constraint control.
  - PJM needs to require these aggregations to be separated into multiple DERAs (single location model vs. multi-nodal model)

- Aggregators will still have the ability to aggregate at a distribution level and be modeled at a single location in PJM market at the same granularity as PJM's load model.
  - Aggregators can aggregate any resources that share the same primary impacted existing PJM Pnode.
  - Average Pnode is 5-15MW of load varying on the load curve. This generally covers more than one distribution level feeder/component.

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Managing Nodal Aggregations

Single Location Requirements

DER	(Utility Review) Primary transmission location	Aggregation Definition	(Utility Review) Additional data from EDCs for modeling
DER1	Node A	DERA 1	100% Node A
DER2	Node A	DERA 1	100% Node A
DER3	Node A	DERA 1	80% Node A, 20% Node B
DER4	Node A	DERA 1	70% Node A, 30% Node D
DER5	Node B	DERA 2	70% Node B, 30% Node A
DER6	Node C	DERA 3	100% Node C

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