Wide-Area Electric Grid Visualization Using Pseudo-Geographic Mosaic Displays

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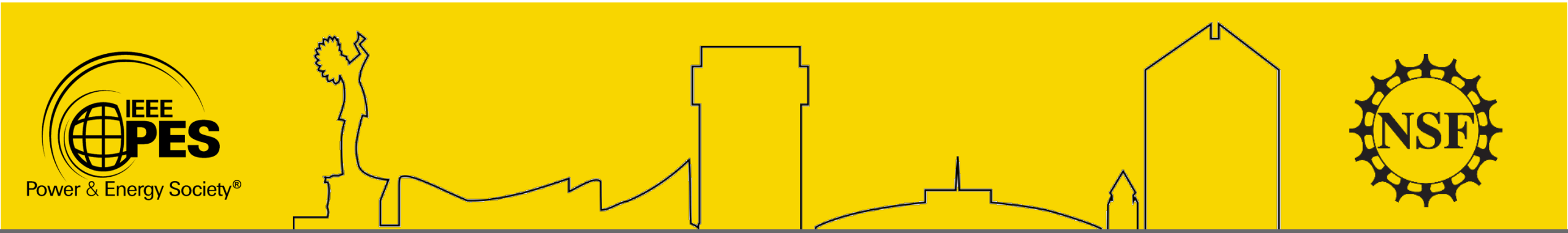


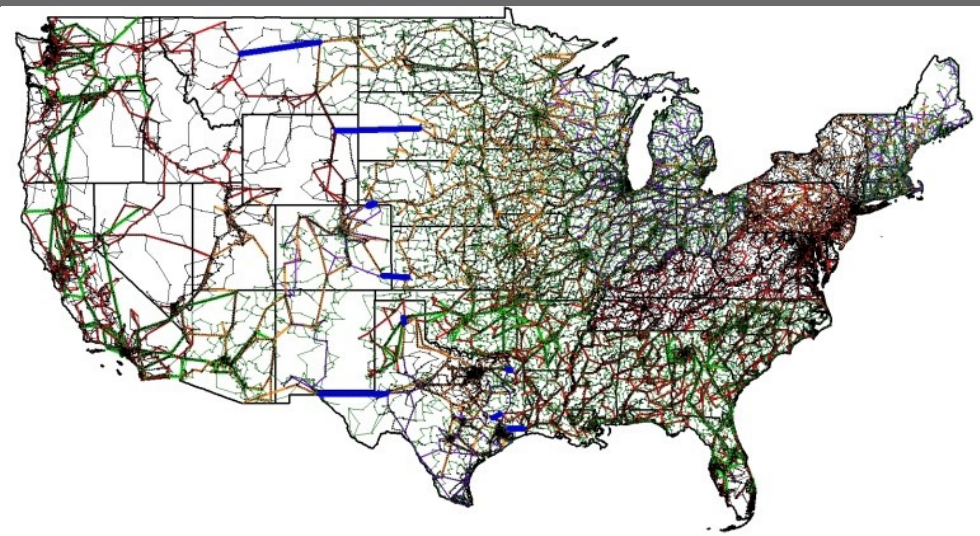
51st North American Power Symposium

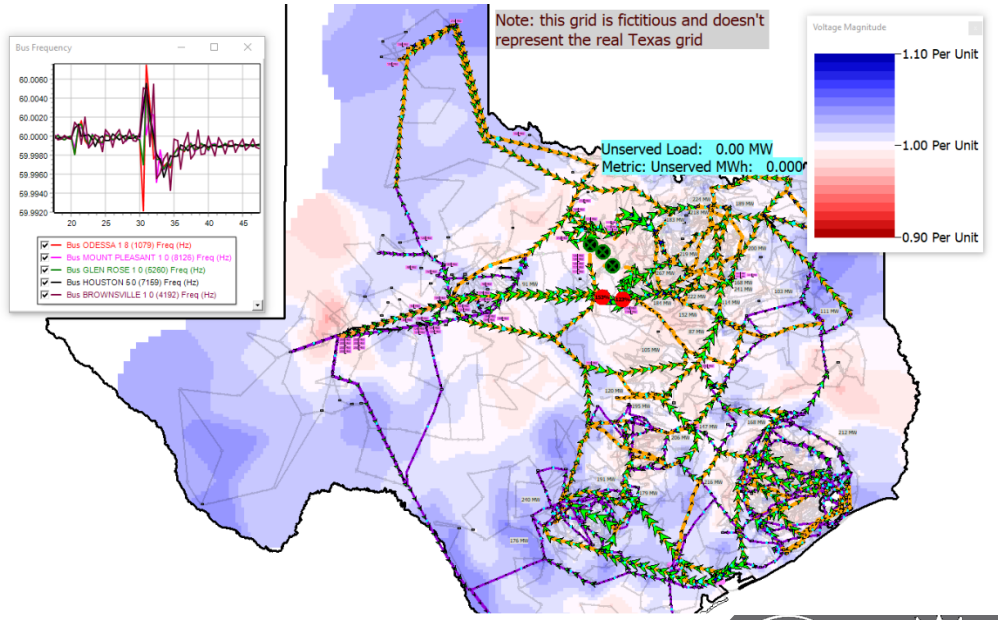
Motivation

- Maintain situational awareness by presenting system data in an informative way for system engineers and operators
  - Preserve relative geographic relationships
  - Use display space effectively

Visualization Practices

- Geographic representation of entire grid
  - Branch flows
  - Contour Maps
- However, these present challenges
  - Areas of interest may compose a small geographic footprint
  - Visualization dense with information

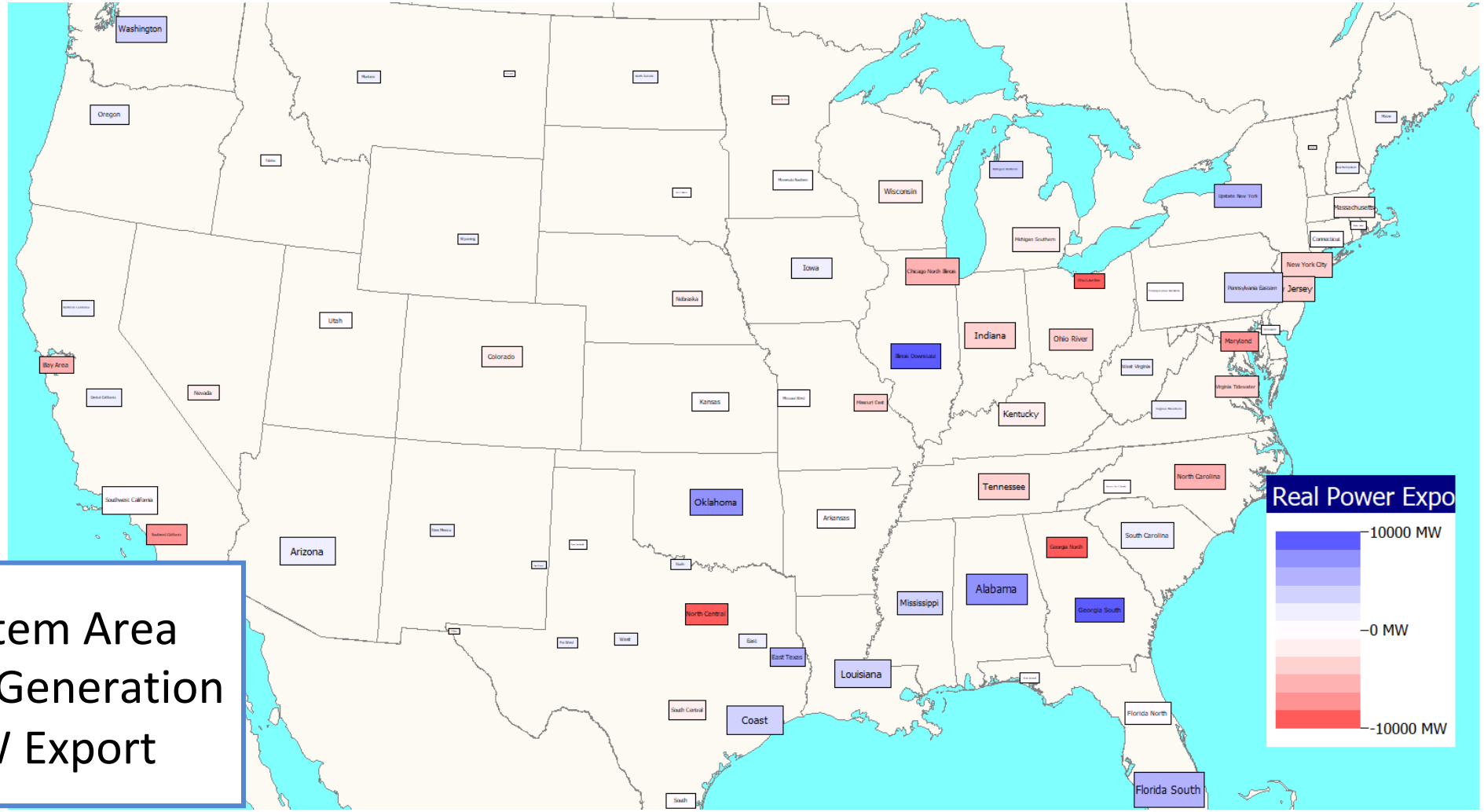




Synthetic Grid test cases publicly available at: *https://electricgrids.engr.tamu.edu/electric-grid-test-cases/*

Geographic Data Views

- Automatically update geographic display with system values of interest

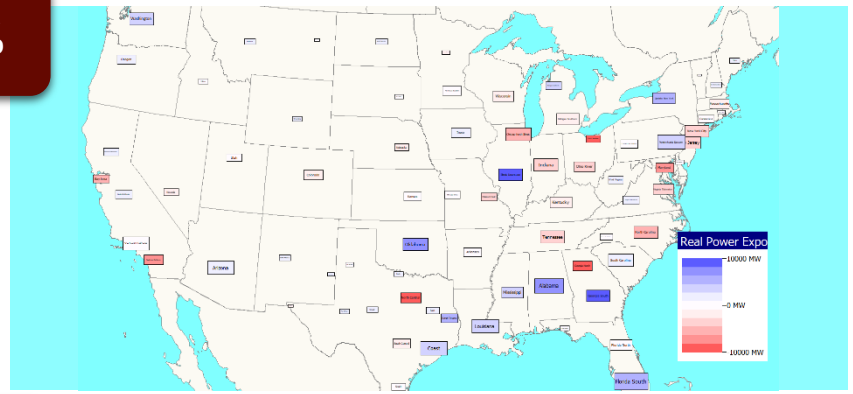


Label: System Area
Size: MW Generation
Color: MW Export

Pseudo-Geographic Mosaic Displays

- Maintains approximate geographic relationships using more display space

0%



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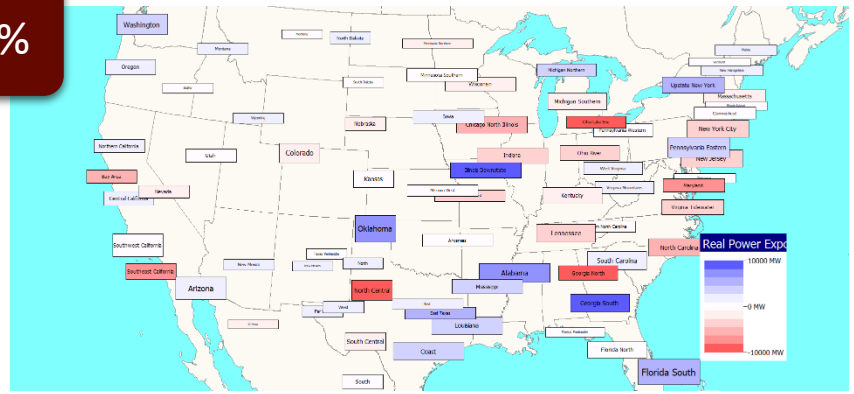

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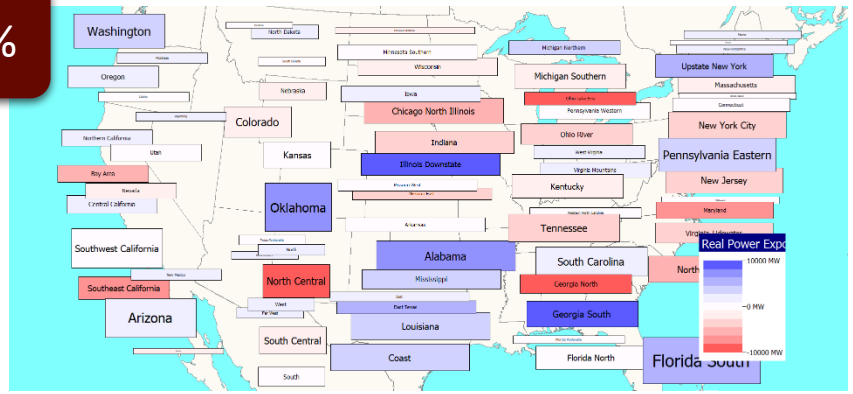

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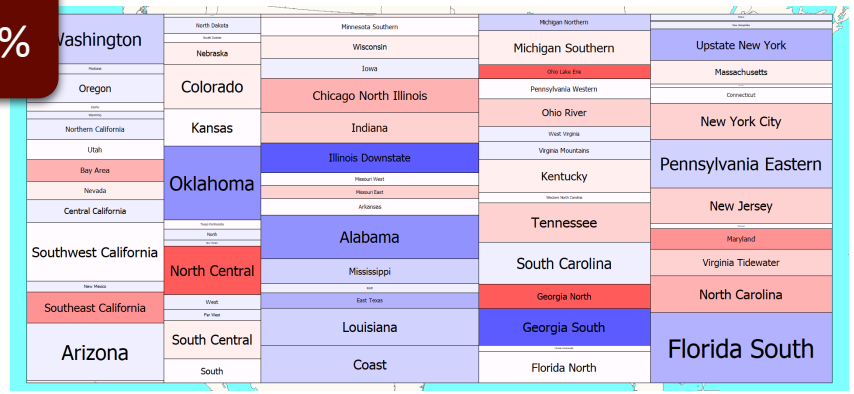


Can be used to convey:

- Element status
- System operating conditions

Can aid:

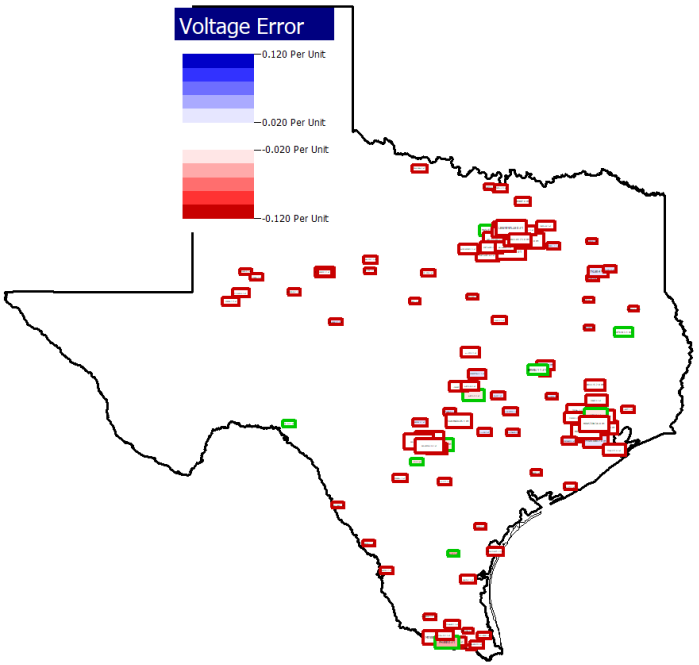
- Situational awareness
- Data interpretation
- Quick comparisons across studies

PGMD Layout Algorithm

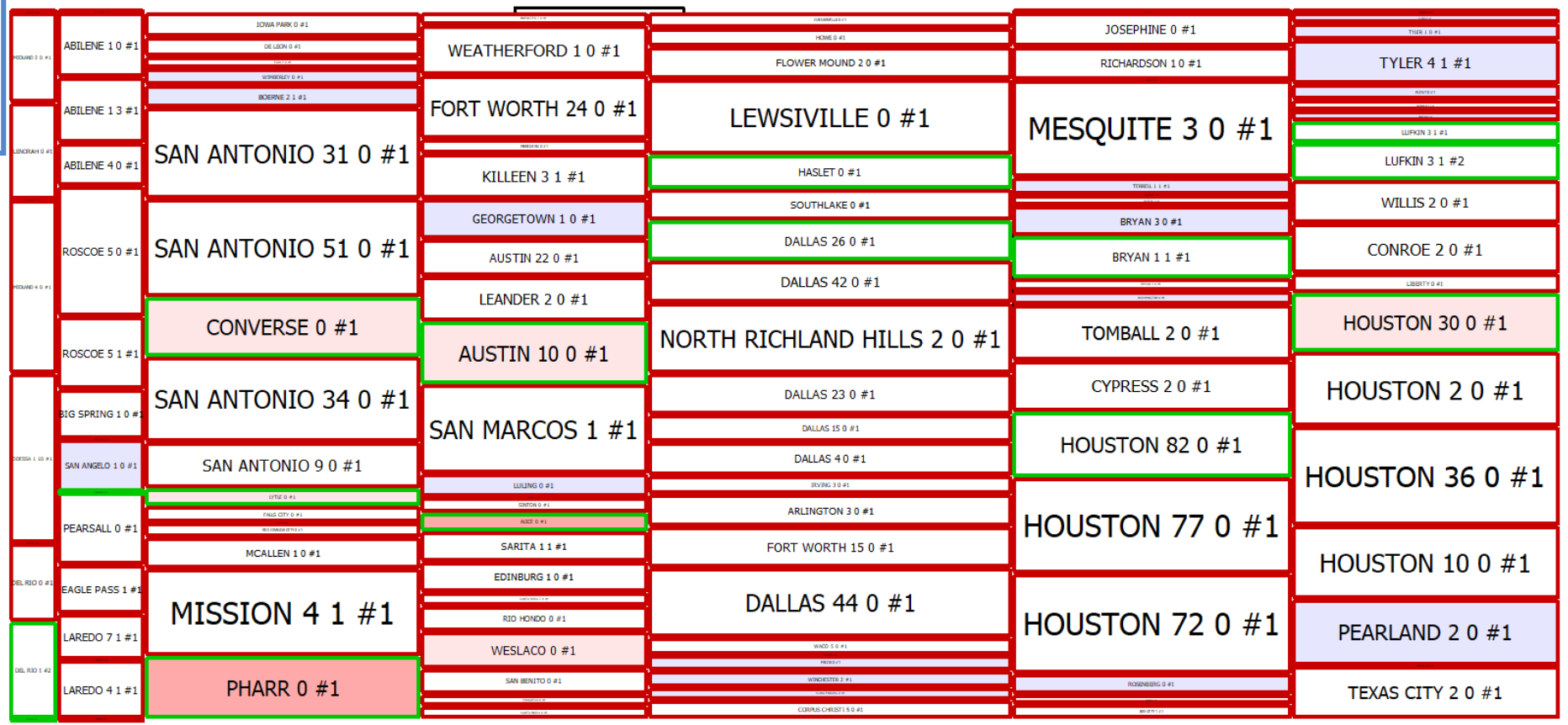
- Basis similar to treemap algorithm
  - Nested rectangles used to visualize tree structure
- Mosaic Displays based on this layout set to have uniform column width
  - Width is set to depend on the sum of size metrics of the tiles represented
  - Height dependent on size metrics relative to other column elements
- Alternate layout approach options to come!

2,000 Bus Switched Shunt Visuals

Label: Shunt Name
Size: Shunt Nominal MVAr
Fill Color:
Shunt Regulation Voltage Error
Outline Color:
Switched Shunt Status

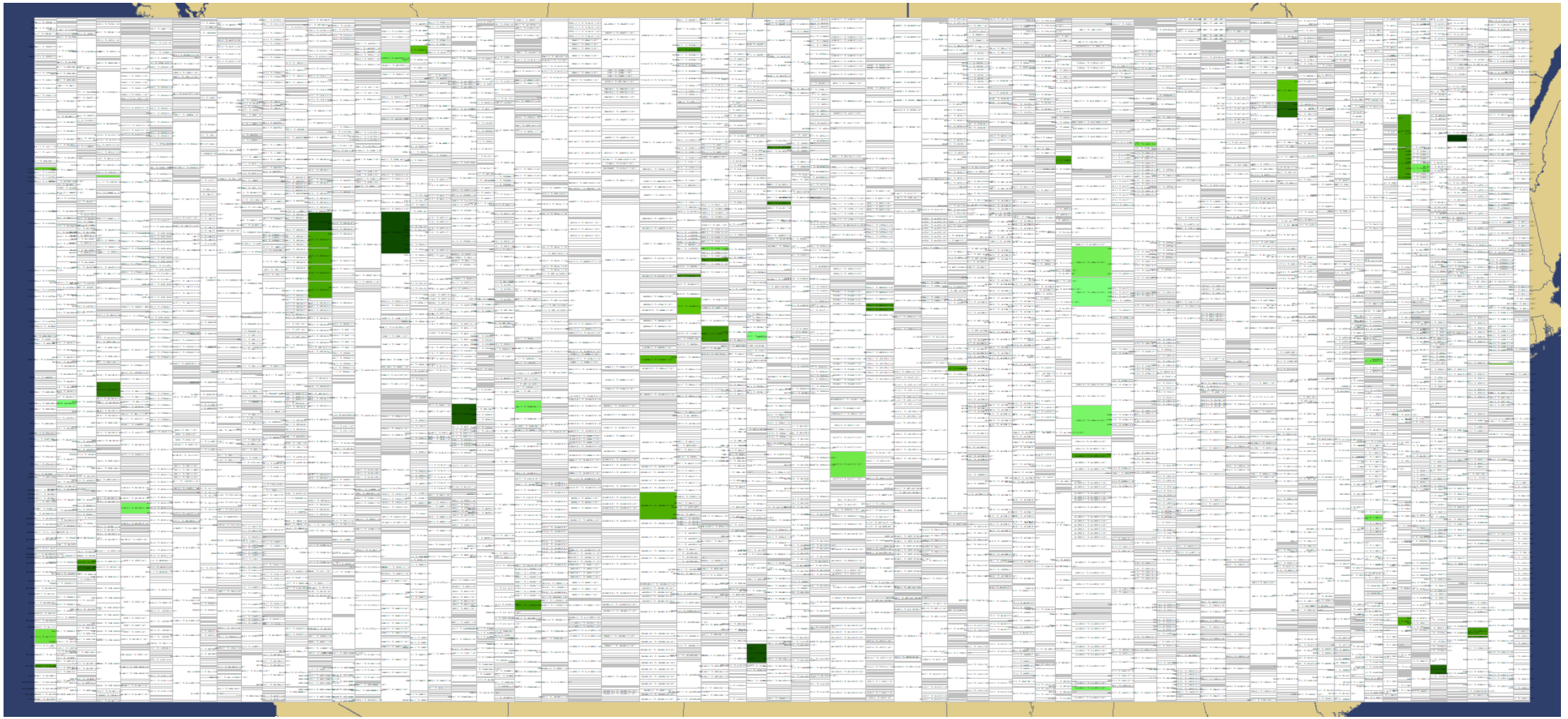


GDV

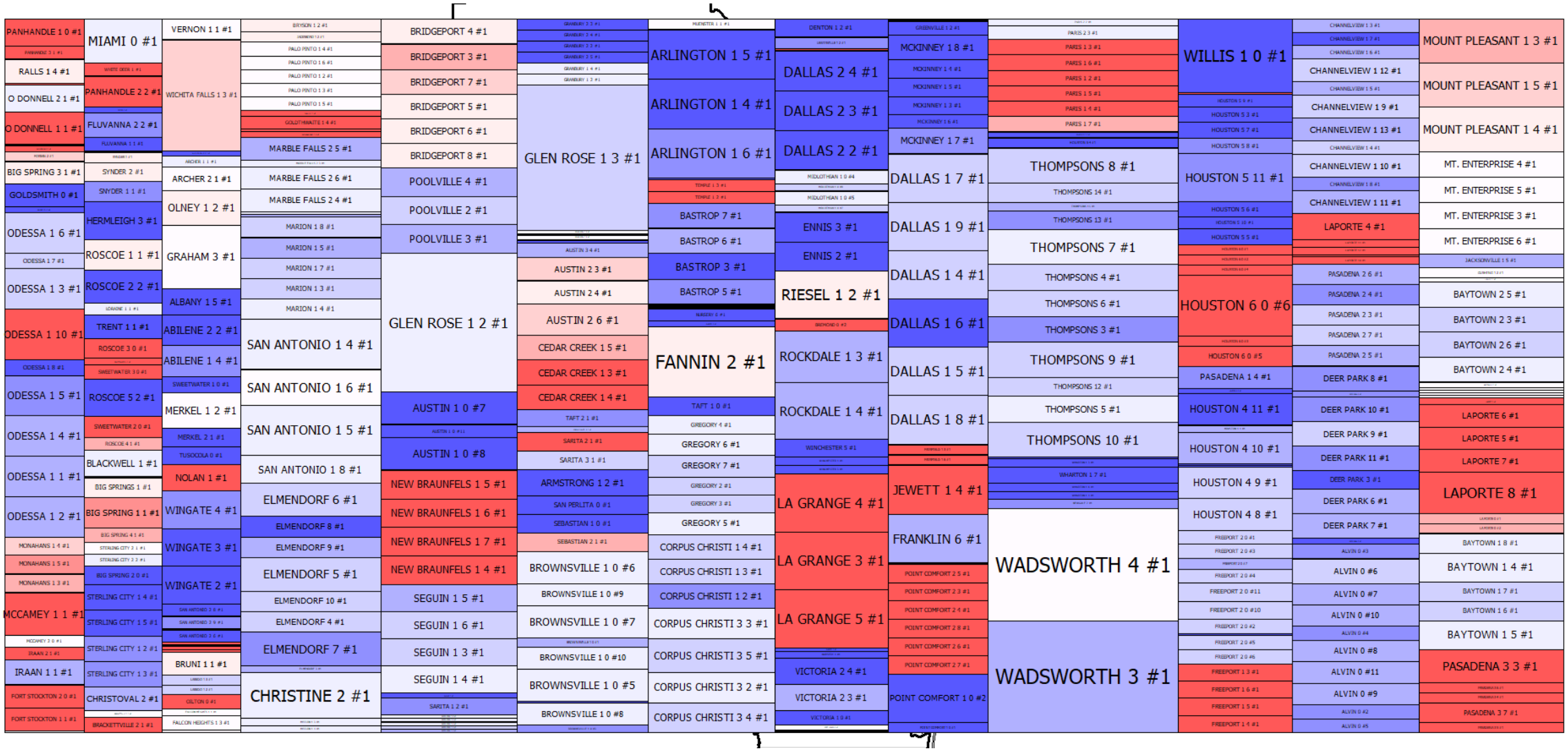


PGMD

10,000 Bus Case – Line Loading PGMD



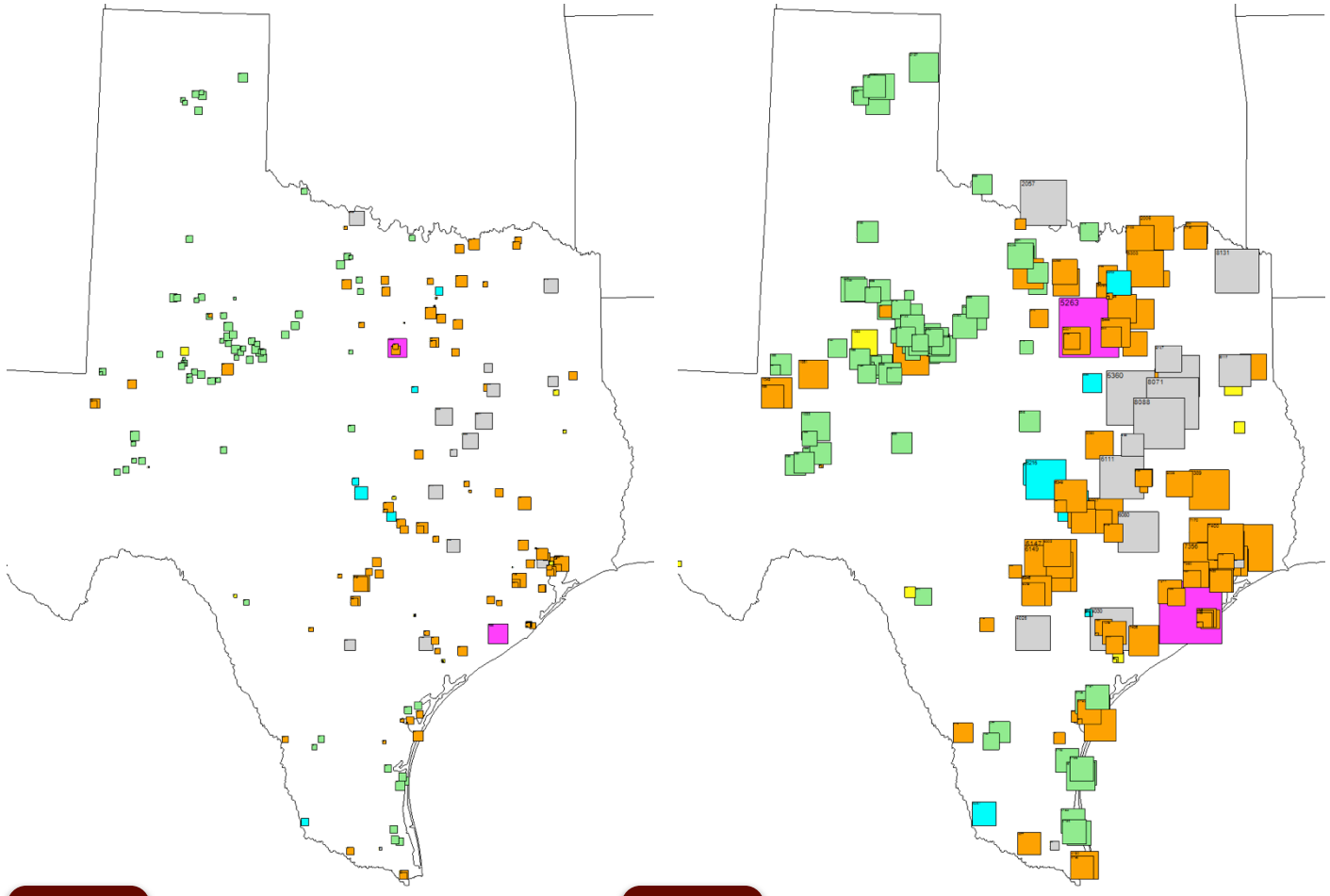
2000 Bus Case – Genereator PGMD



Design Considerations

- Who is your audience and why will they be using the displays?
  - “Snapshot” of grid
  - Long-term users
- How to depict data?
  - Tile sizing
  - Tile placement
  - Colors
- What to depict?
  - Substations
  - Generators
  - Loads
  - Shunts
  - Lines
  - …

Generator Size and Type



5%

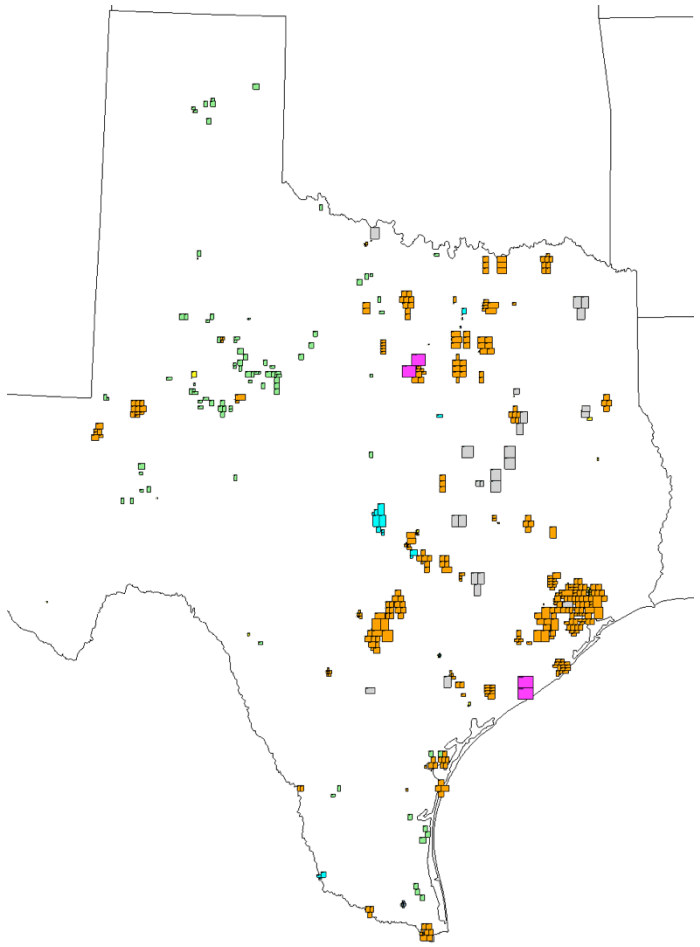
50%

Label: Generator Bus Number
Size: Max MW
Color: Fuel Type

- **Magenta = Nuclear**
- **Gray = Coal**
- **Orange = Natural Gas**
- **Blue = Hydro**
- **Green = Wind**
- **Yellow = Solar**

Note that overlapping tiles make it difficult to discern fuel mix in urban areas.

Horizontal Packing



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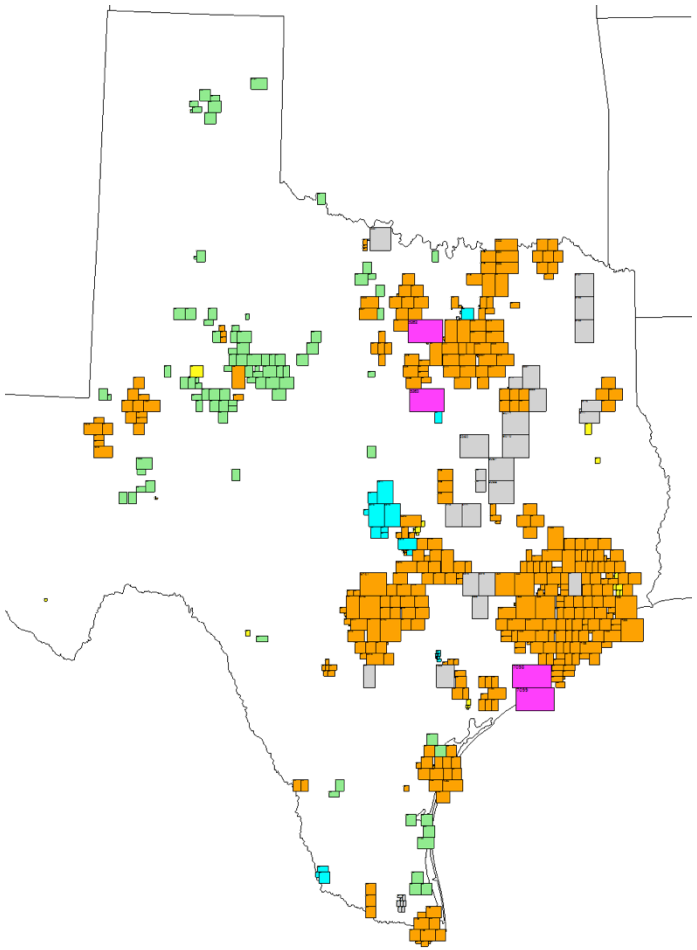

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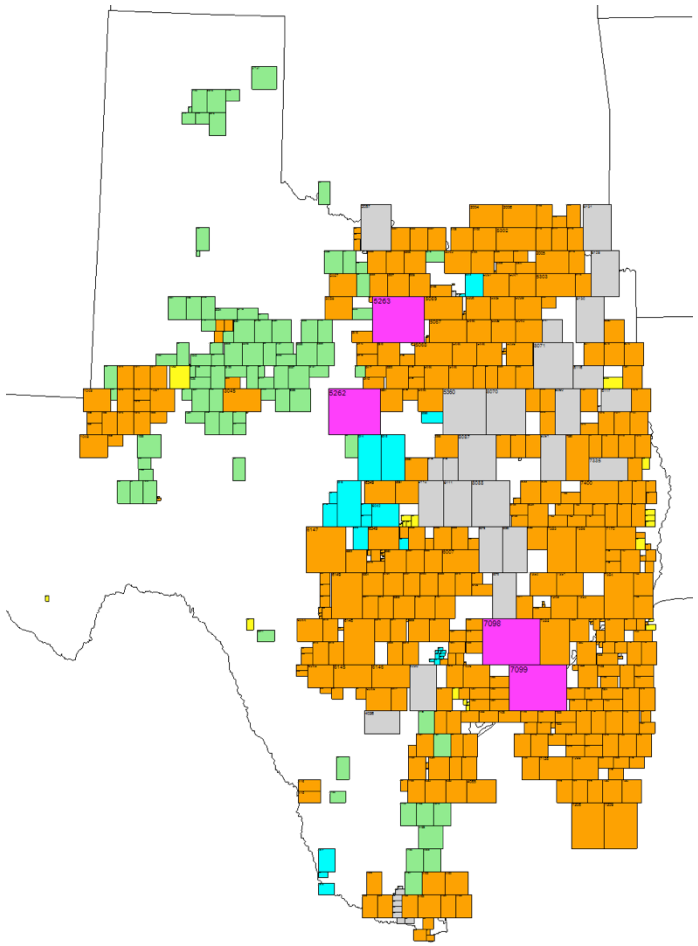
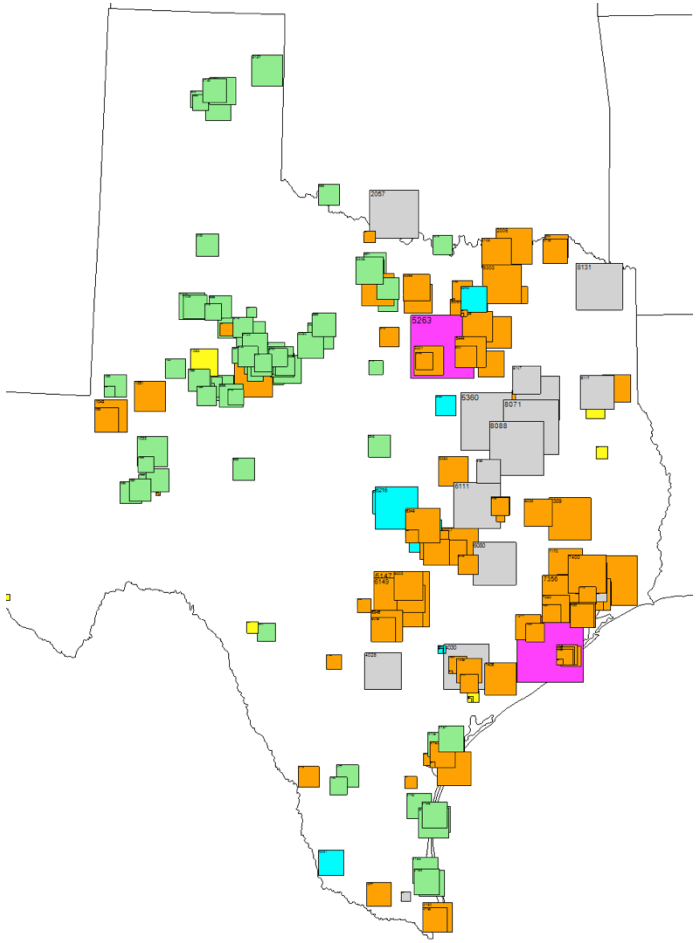


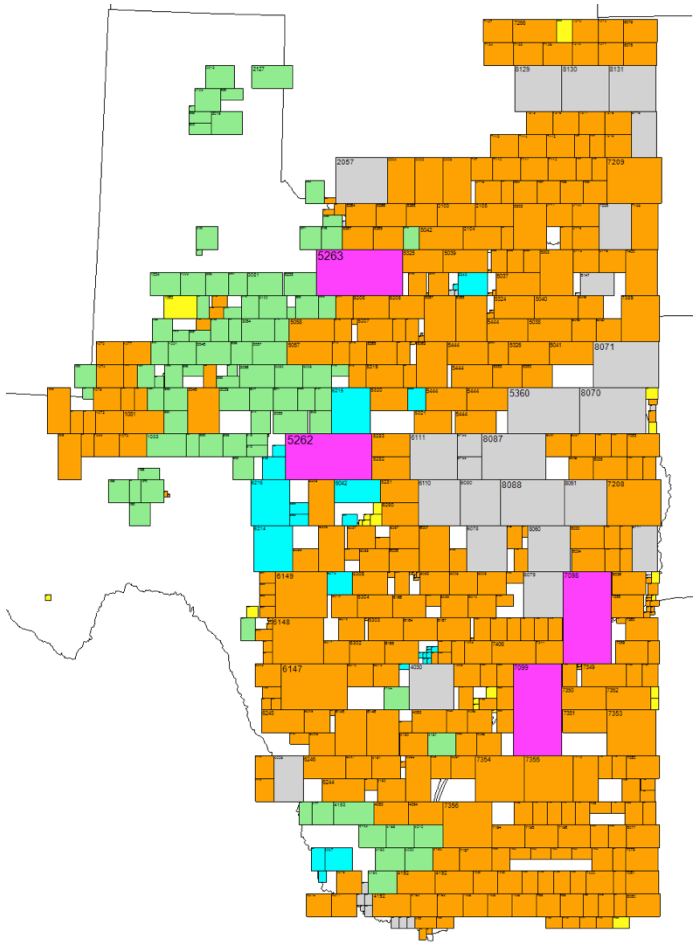
30%

Horizontal Packing Comparison, 50%

Same information, different impression.



PGMD – no Horizontal Packing

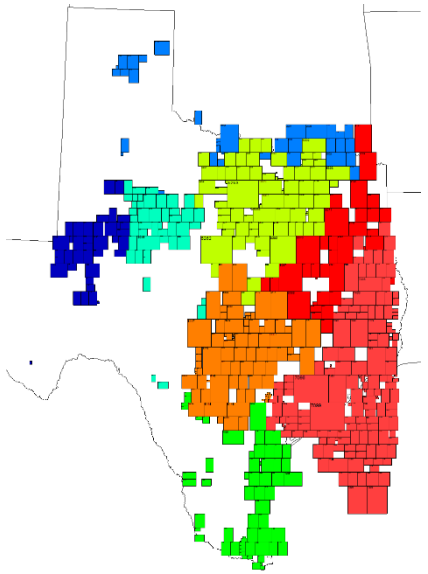


PGMD with Horizontal Packing

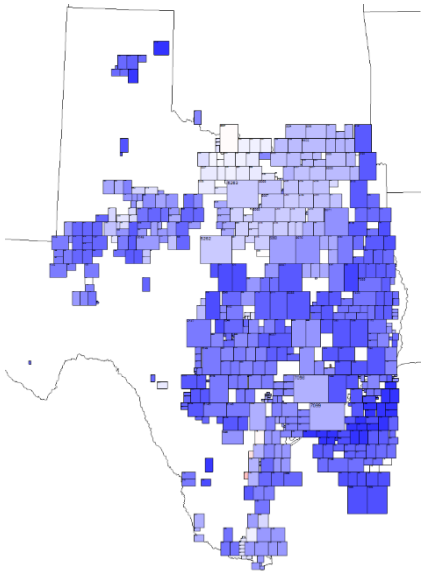
PGMD Opportunities

- Quick visual comparison across studies with changing system conditions
- Dynamic visualization loops
- Display multiple attributes or system parameters
- Various layout algorithms

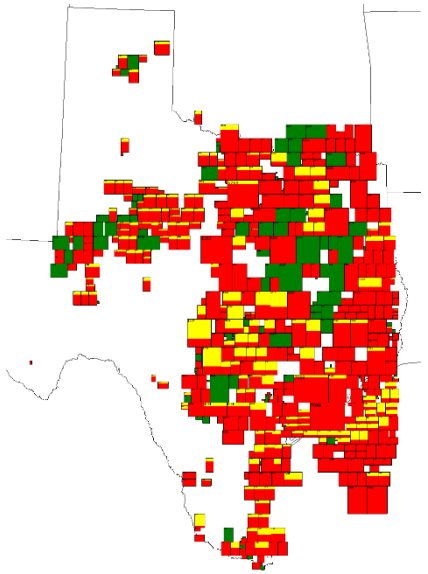
Areas



Voltage



Status & Dispatch



Questions?

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