# Capacity Benefit of Ties (CBOT) Update

RAAS

November 4, 2024

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# Overview

- PJM has been gathering data on
  - Historical loads of PJM neighbors to determine levels of load-correlation
  - Projected reserve margin levels of PJM neighbors
- Both factors, alongside correlated and uncorrelated resource unavailability, play a role in the potential for emergency assistance that PJM can rely on
- At this point, we do not have actionable conclusions

# Historical Load Data

- PJM requested hourly load data from NYISO, MISO, TVA and VACAR for the period DY 2008 – DY 2023.
- The data was assigned to each season based on:
  - Summer: June, July, August
  - Fall: September, October, November
  - Winter: December, January, February
  - Spring: March, April, May

# Seasonal Correlation, 2008 - 2010

## Summer

### 2008

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 83.13% | 1 | | | |
| MISO | 90.33% | 82.45% | 1 | | |
| TVA | 85.26% | 51.78% | 79.99% | 1 | |
| VACAR | 82.89% | 49.13% | 63.46% | 85.86% | 1 |

### 2009

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 93.48% | 1 | | | |
| MISO | 92.58% | 79.76% | 1 | | |
| TVA | 87.37% | 71.33% | 91.89% | 1 | |
| VACAR | 92.01% | 84.49% | 88.31% | 87.64% | 1 |

### 2010

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 95.01% | 1 | | | |
| MISO | 93.62% | 86.36% | 1 | | |
| TVA | 90.07% | 78.75% | 92.29% | 1 | |
| VACAR | 91.71% | 84.10% | 91.61% | 90.97% | 1 |

## Winter

### 2008

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 83.13% | 1 | | | |
| MISO | 90.33% | 82.45% | 1 | | |
| TVA | 85.26% | 51.78% | 79.99% | 1 | |
| VACAR | 82.89% | 49.13% | 63.46% | 85.86% | 1 |

### 2009

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 86.64% | 1 | | | |
| MISO | 88.47% | 78.81% | 1 | | |
| TVA | 73.67% | 42.97% | 78.83% | 1 | |
| VACAR | 75.76% | 42.43% | 63.46% | 83.22% | 1 |

### 2010

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 84.28% | 1 | | | |
| MISO | 88.19% | 79.59% | 1 | | |
| TVA | 73.86% | 43.54% | 79.68% | 1 | |
| VACAR | 76.22% | 40.72% | 63.37% | 83.14% | 1 |

# Seasonal Correlation, 2011 - 2013

## Summer

**2011**

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 96.89% | 1 | | | |
| MISO | 93.56% | 89.28% | 1 | | |
| TVA | 87.73% | 80.33% | 89.67% | 1 | |
| VACAR | 90.73% | 87.18% | 89.57% | 89.45% | 1 |

**2012**

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 95.52% | 1 | | | |
| MISO | 94.85% | 87.50% | 1 | | |
| TVA | 90.47% | 81.64% | 90.98% | 1 | |
| VACAR | 91.92% | 88.73% | 89.35% | 89.50% | 1 |

**2013**

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 96.05% | 1 | | | |
| MISO | 93.15% | 86.14% | 1 | | |
| TVA | 87.50% | 75.82% | 89.75% | 1 | |
| VACAR | 87.94% | 81.34% | 86.51% | 88.26% | 1 |

## Winter

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 88.16% | 1 | | | |
| MISO | 87.55% | 83.59% | 1 | | |
| TVA | 73.35% | 47.49% | 73.39% | 1 | |
| VACAR | 78.93% | 49.47% | 58.77% | 80.31% | 1 |

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 87.66% | 1 | | | |
| MISO | 84.72% | 81.94% | 1 | | |
| TVA | 77.44% | 54.37% | 79.96% | 1 | |
| VACAR | 79.49% | 53.66% | 54.36% | 72.85% | 1 |

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 83.52% | 1 | | | |
| MISO | 88.78% | 80.13% | 1 | | |
| TVA | 84.35% | 53.06% | 83.28% | 1 | |
| VACAR | 83.14% | 52.01% | 65.97% | 82.19% | 1 |

# Seasonal Correlation, 2014 - 2016

## 2014

**Summer**

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 95.11% | 1 | | | |
| MISO | 93.34% | 86.63% | 1 | | |
| TVA | 90.79% | 81.21% | 91.91% | 1 | |
| VACAR | 89.59% | 85.10% | 87.36% | 86.51% | 1 |

**Winter**

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 83.61% | 1 | | | |
| MISO | 86.51% | 81.88% | 1 | | |
| TVA | 87.45% | 58.09% | 79.34% | 1 | |
| VACAR | 84.50% | 53.23% | 65.25% | 87.76% | 1 |

## 2015

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 94.66% | 1 | | | |
| MISO | 92.61% | 86.77% | 1 | | |
| TVA | 90.06% | 79.27% | 88.51% | 1 | |
| VACAR | 91.54% | 83.14% | 86.68% | 92.74% | 1 |

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 83.74% | 1 | | | |
| MISO | 86.15% | 82.25% | 1 | | |
| TVA | 86.21% | 55.90% | 79.46% | 1 | |
| VACAR | 88.64% | 58.78% | 66.80% | 86.68% | 1 |

## 2016

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 95.69% | 1 | | | |
| MISO | 91.31% | 82.77% | 1 | | |
| TVA | 88.46% | 79.28% | 90.46% | 1 | |
| VACAR | 91.26% | 85.78% | 87.48% | 91.62% | 1 |

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 85.22% | 1 | | | |
| MISO | 89.41% | 81.39% | 1 | | |
| TVA | 84.03% | 56.42% | 82.87% | 1 | |
| VACAR | 84.23% | 56.17% | 67.01% | 83.33% | 1 |

# Seasonal Correlation, 2017 - 2019

| | Summer | | | | | Winter | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **2017** | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* |
| PJM | 1 | | | | | 1 | | | | |
| NYISO | 95.40% | 1 | | | | 84.70% | 1 | | | |
| MISO | 94.56% | 87.64% | 1 | | | 86.25% | 79.58% | 1 | | |
| TVA | 92.07% | 83.58% | 91.33% | 1 | | 86.58% | 58.85% | 84.15% | 1 | |
| VACAR | 90.89% | 83.53% | 89.91% | 92.38% | 1 | 87.29% | 59.45% | 67.57% | 84.68% | 1 |
| **2018** | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* |
| PJM | 1 | | | | | 1 | | | | |
| NYISO | 94.64% | 1 | | | | 84.89% | 1 | | | |
| MISO | 92.75% | 82.58% | 1 | | | 83.30% | 79.73% | 1 | | |
| TVA | 87.88% | 75.00% | 90.31% | 1 | | 80.21% | 56.11% | 79.51% | 1 | |
| VACAR | 89.51% | 78.29% | 89.28% | 91.19% | 1 | 81.03% | 54.74% | 57.40% | 78.98% | 1 |
| **2019** | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* | *PJM* | *NYISO* | *MISO* | *TVA* | *VACAR* |
| PJM | 1 | | | | | 1 | | | | |
| NYISO | 96.76% | 1 | | | | 85.72% | 1 | | | |
| MISO | 94.66% | 88.94% | 1 | | | 86.03% | 79.13% | 1 | | |
| TVA | 89.28% | 81.01% | 90.22% | 1 | | 78.91% | 53.12% | 77.54% | 1 | |
| VACAR | 92.23% | 85.23% | 92.10% | 93.22% | 1 | 77.81% | 50.72% | 54.02% | 76.67% | 1 |

# Seasonal Correlation, 2020 - 2023

## 2020

### Summer

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 93.69% | 1 | | | |
| MISO | 93.31% | 82.53% | 1 | | |
| TVA | 92.22% | 82.23% | 90.27% | 1 | |
| VACAR | 92.64% | 84.60% | 87.03% | 92.57% | 1 |

### Winter

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 86.26% | 1 | | | |
| MISO | 80.35% | 68.24% | 1 | | |
| TVA | 66.46% | 37.18% | 75.37% | 1 | |
| VACAR | 70.30% | 40.85% | 47.94% | 73.36% | 1 |

## 2021

### Summer

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 94.55% | 1 | | | |
| MISO | 90.28% | 78.37% | 1 | | |
| TVA | 88.72% | 76.59% | 89.83% | 1 | |
| VACAR | 92.12% | 83.02% | 88.59% | 92.08% | 1 |

### Winter

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 84.25% | 1 | | | |
| MISO | 79.85% | 74.22% | 1 | | |
| TVA | 84.36% | 56.67% | 78.96% | 1 | |
| VACAR | 83.38% | 57.55% | 52.54% | 75.49% | 1 |

## 2022

### Summer

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 92.53% | 1 | | | |
| MISO | 90.74% | 76.23% | 1 | | |
| TVA | 90.76% | 75.36% | 91.93% | 1 | |
| VACAR | 91.50% | 79.34% | 88.81% | 92.34% | 1 |

### Winter

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 81.36% | 1 | | | |
| MISO | 82.68% | 73.24% | 1 | | |
| TVA | 81.60% | 47.23% | 78.38% | 1 | |
| VACAR | 82.59% | 48.56% | 57.22% | 80.99% | 1 |

## 2023

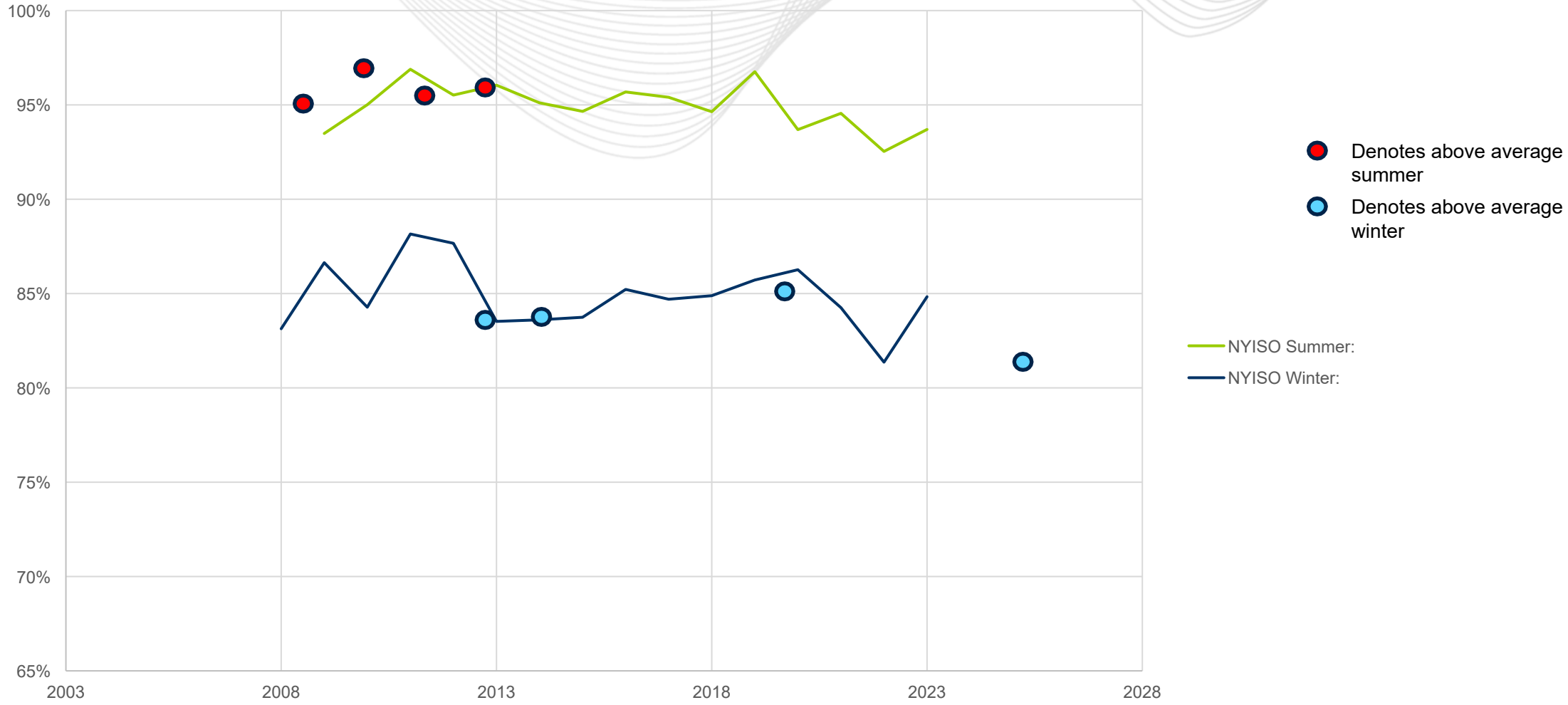
### Summer

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 93.70% | 1 | | | |
| MISO | 90.26% | 75.42% | 1 | | |
| TVA | 91.07% | 77.48% | 90.76% | 1 | |
| VACAR | 93.91% | 85.63% | 86.07% | 91.61% | 1 |

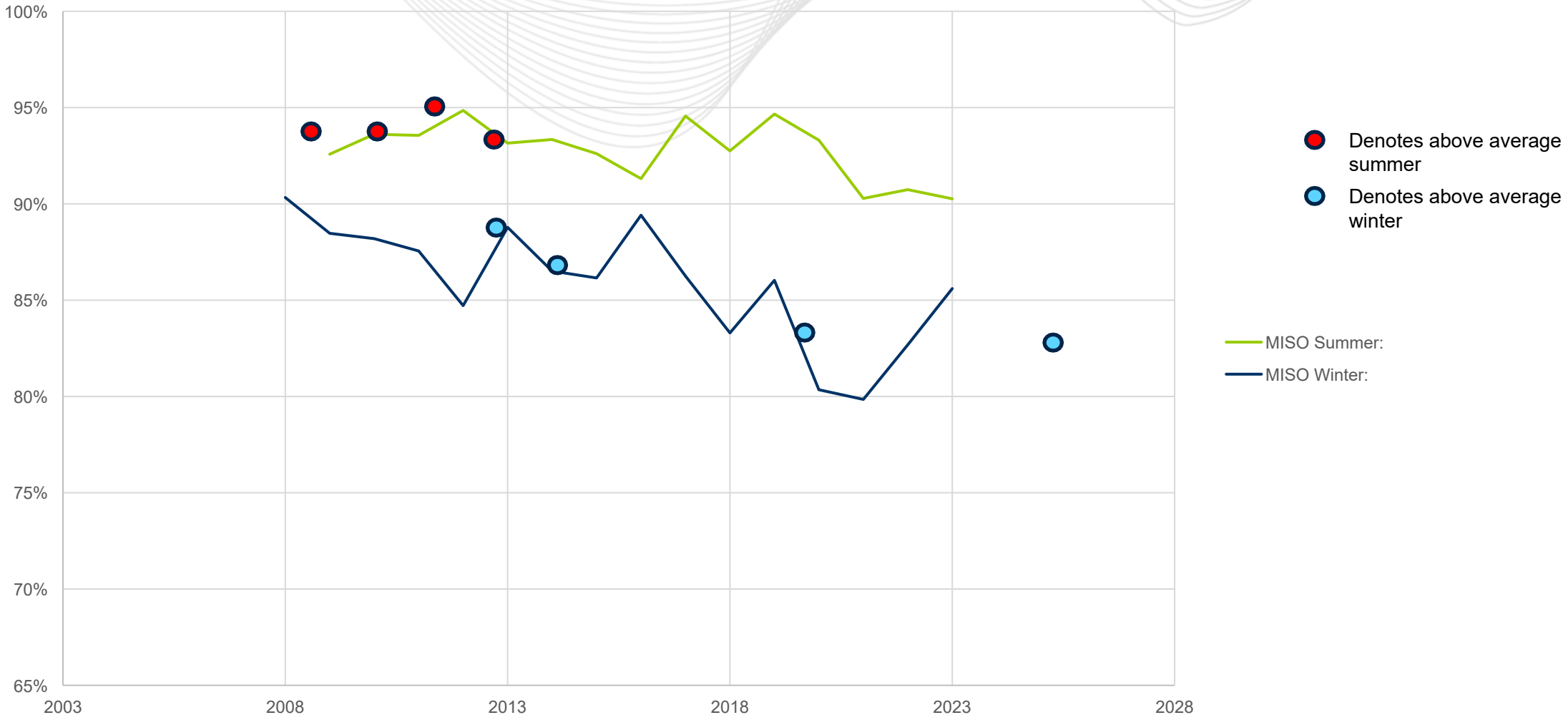
### Winter

| | PJM | NYISO | MISO | TVA | VACAR |
|---|---|---|---|---|---|
| PJM | 1 | | | | |
| NYISO | 84.83% | 1 | | | |
| MISO | 85.60% | 74.22% | 1 | | |
| TVA | 81.19% | 47.84% | 81.32% | 1 | |
| VACAR | 80.14% | 44.86% | 59.82% | 85.15% | 1 |

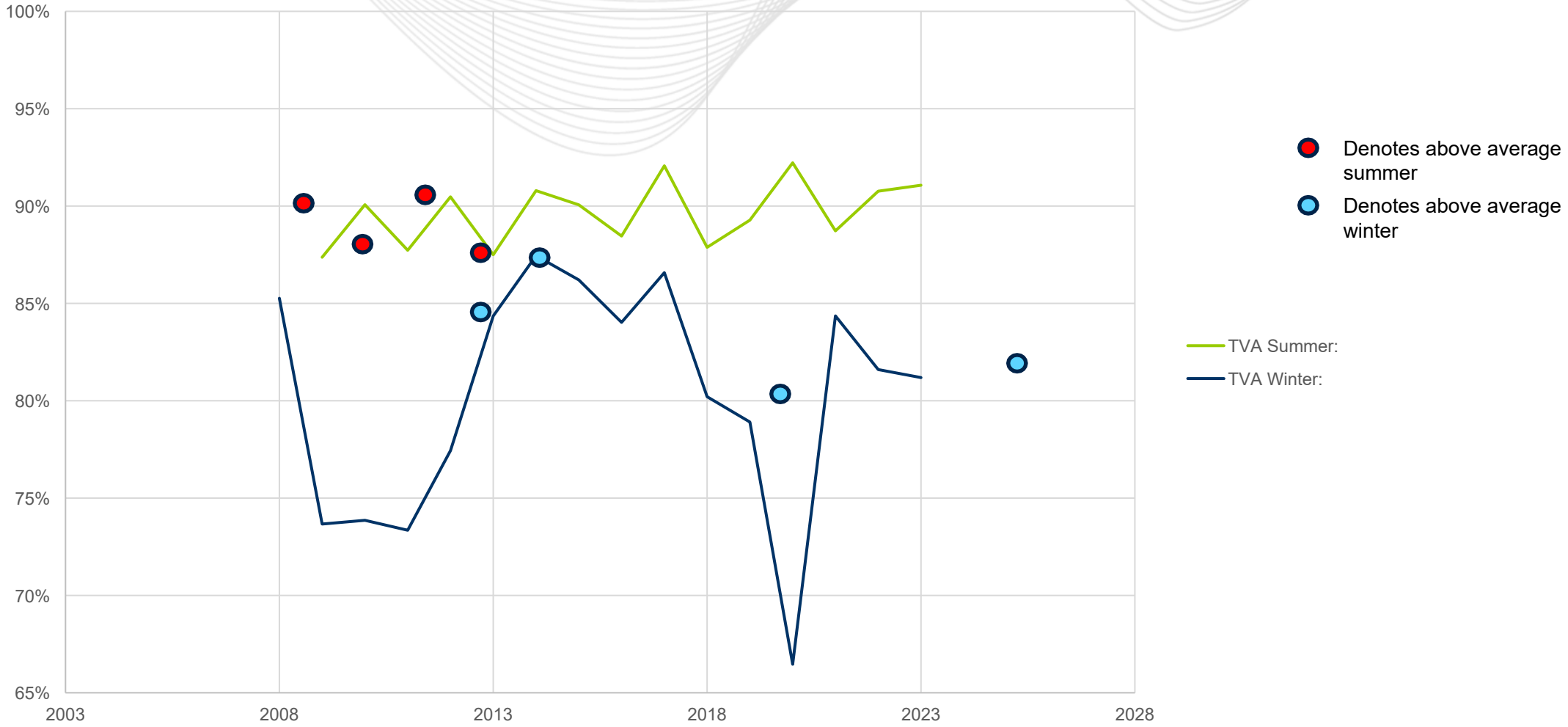
# NYISO / PJM Historical Load Correlation



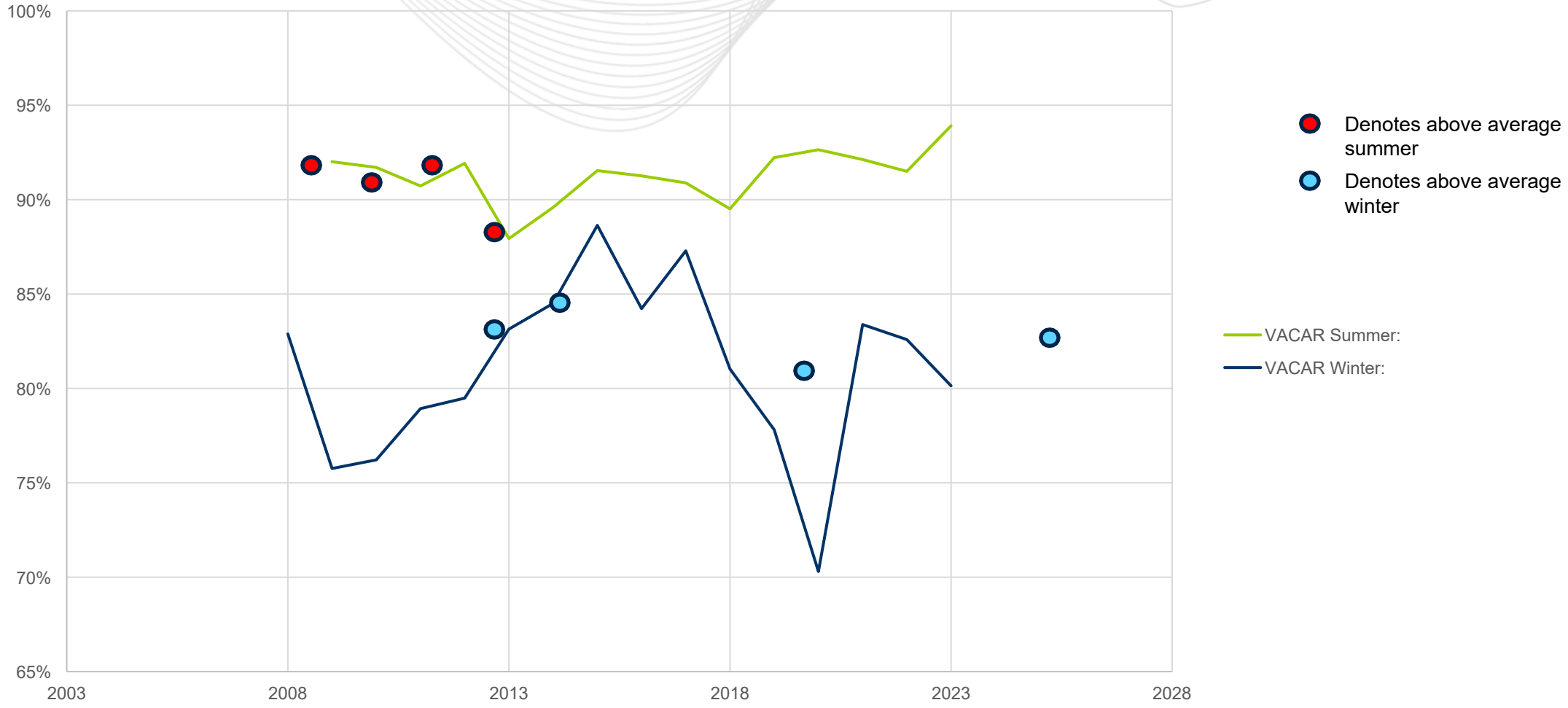
# MISO / PJM Historical Load Correlation



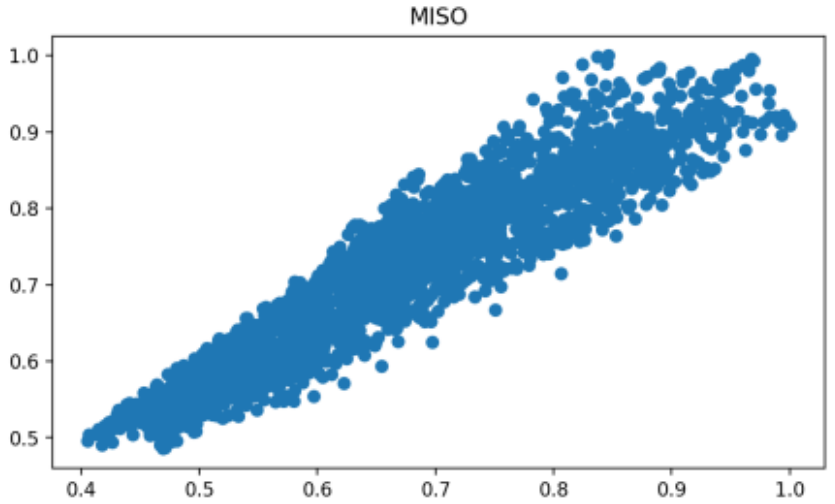
# TVA / PJM Historical Load Correlation

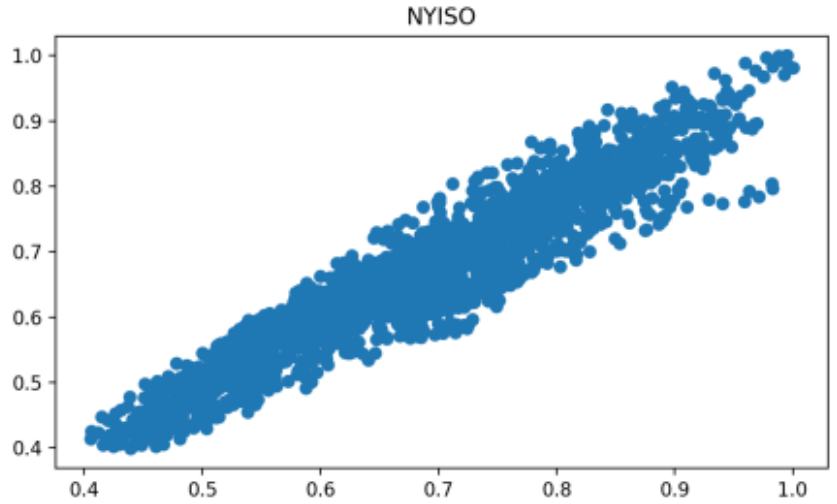


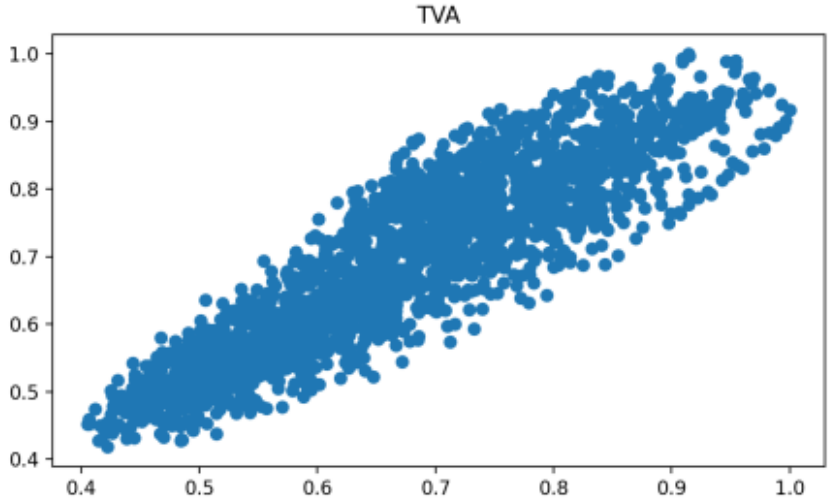
# VACAR / PJM Historical Load Correlation

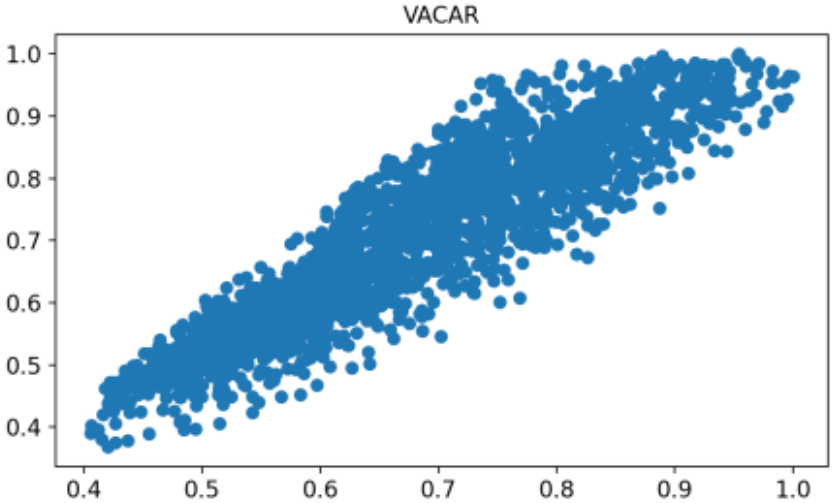


# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Summer 2010



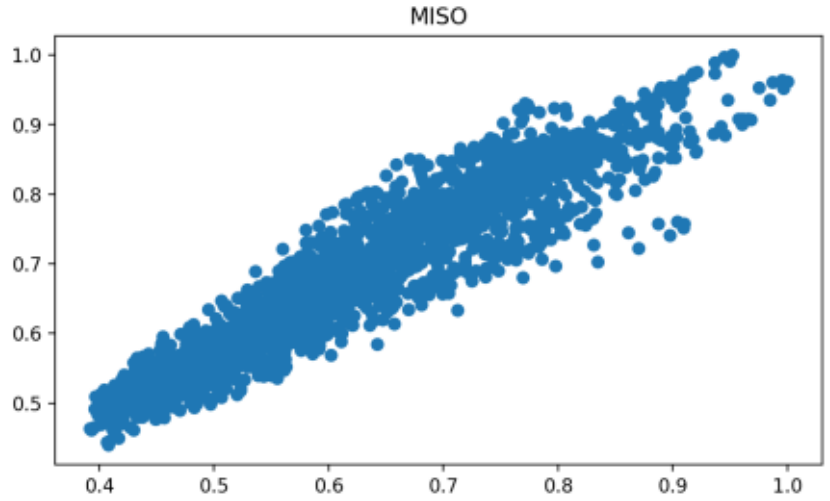



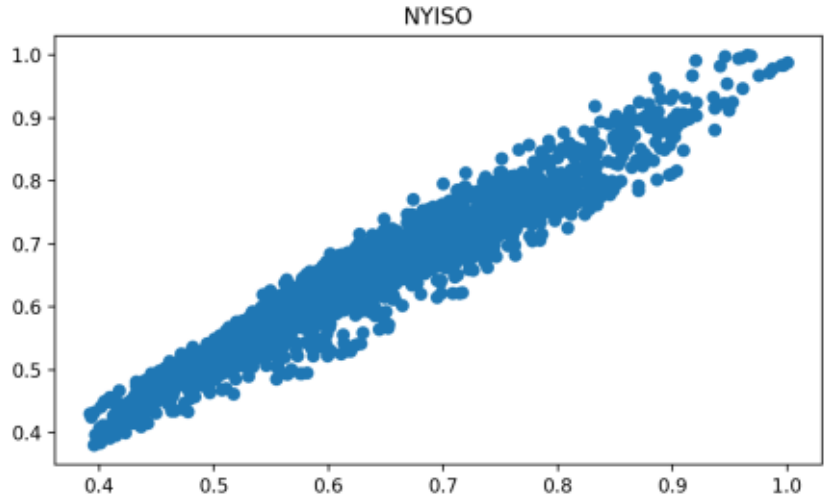



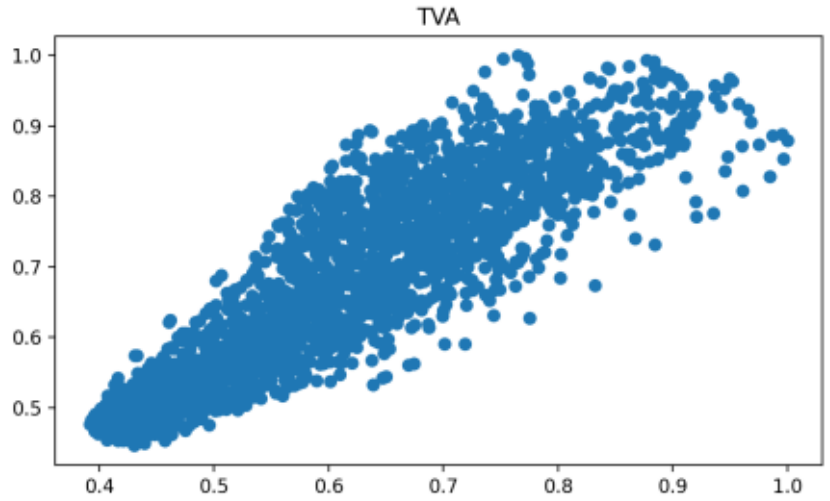



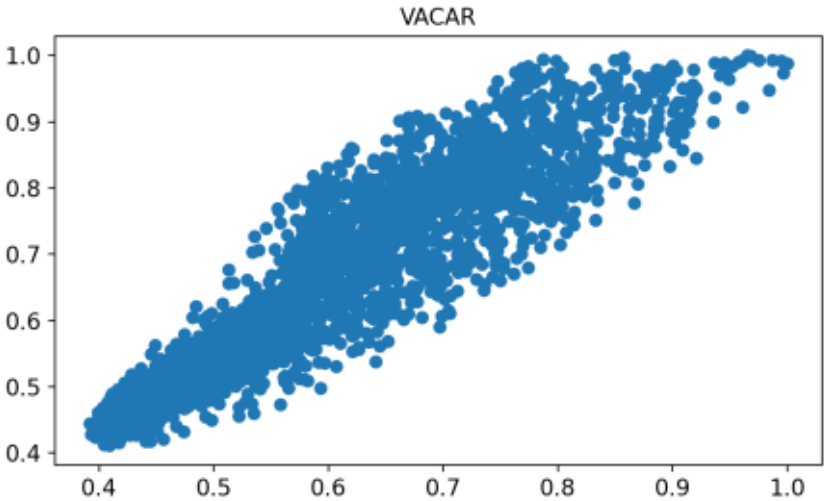

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Summer 2011



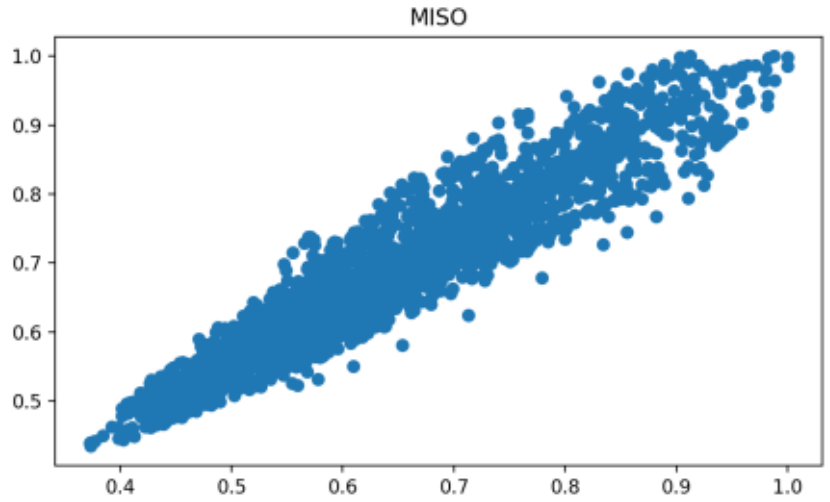



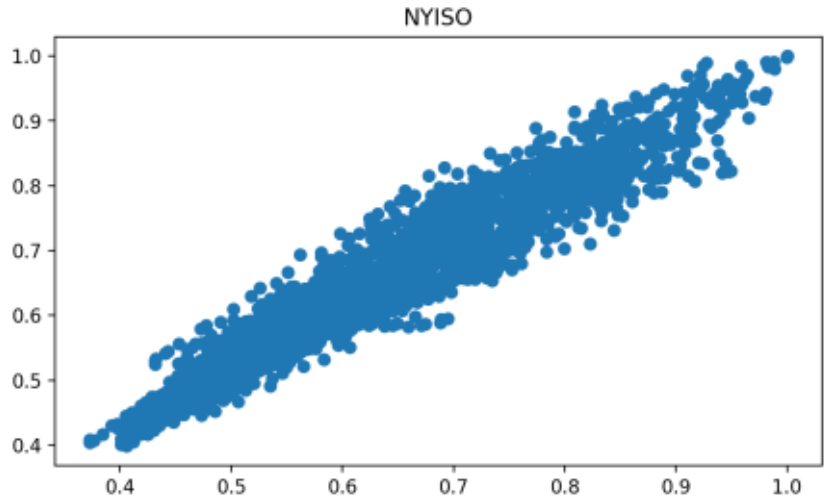



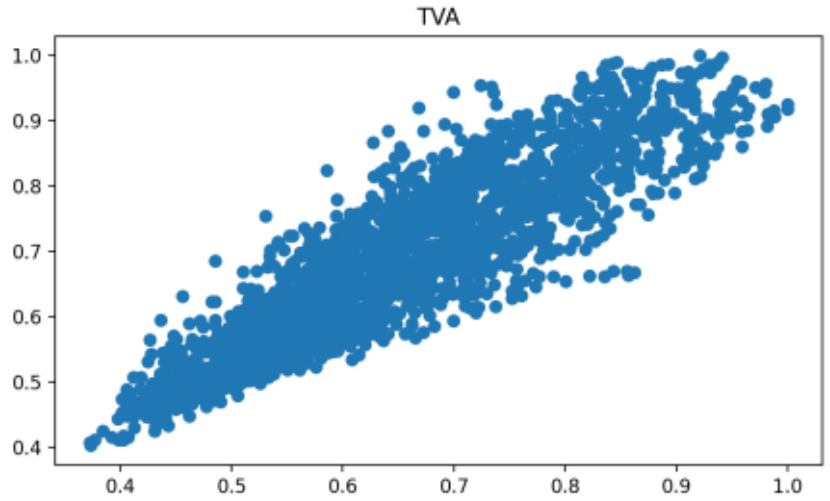



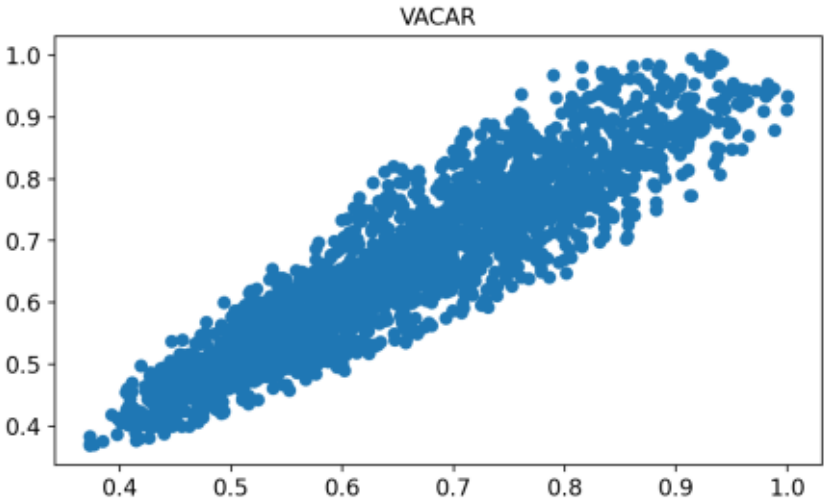

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Summer 2012



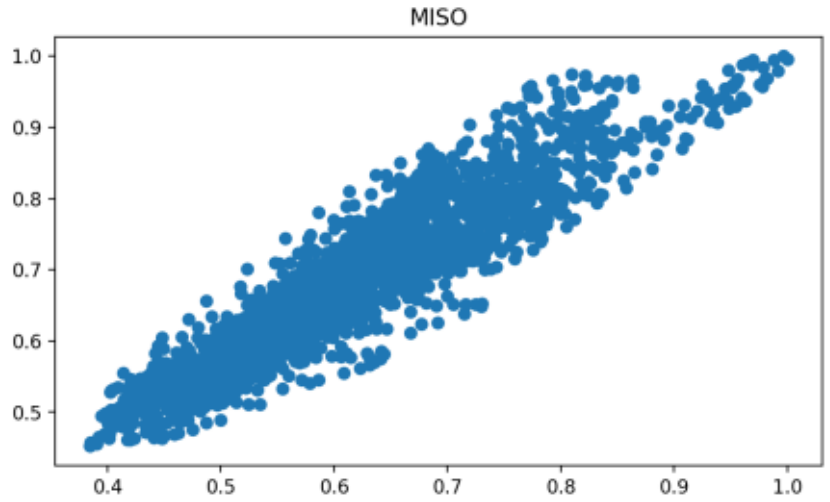



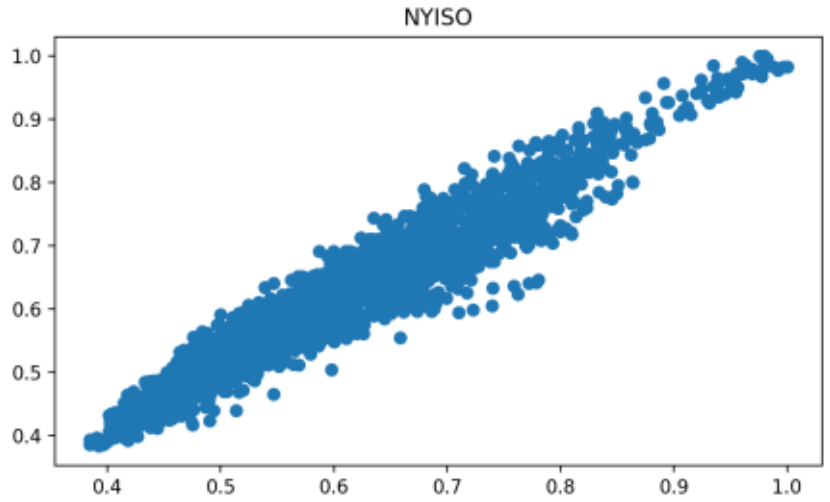



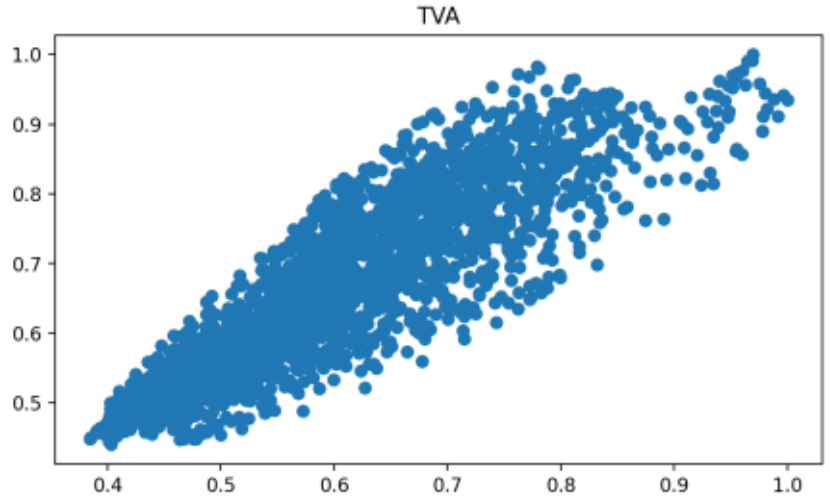



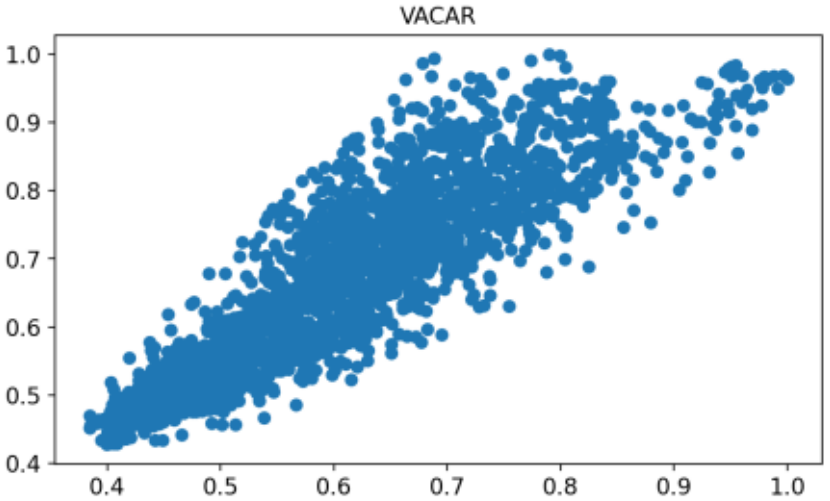

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Summer 2013



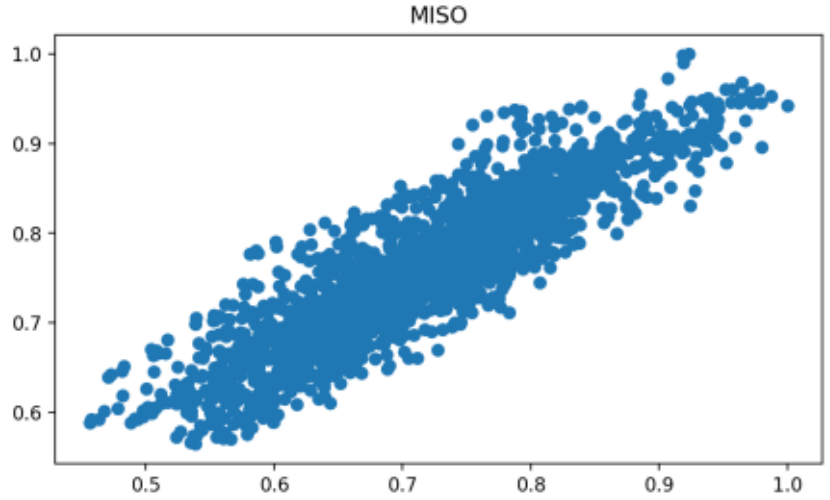



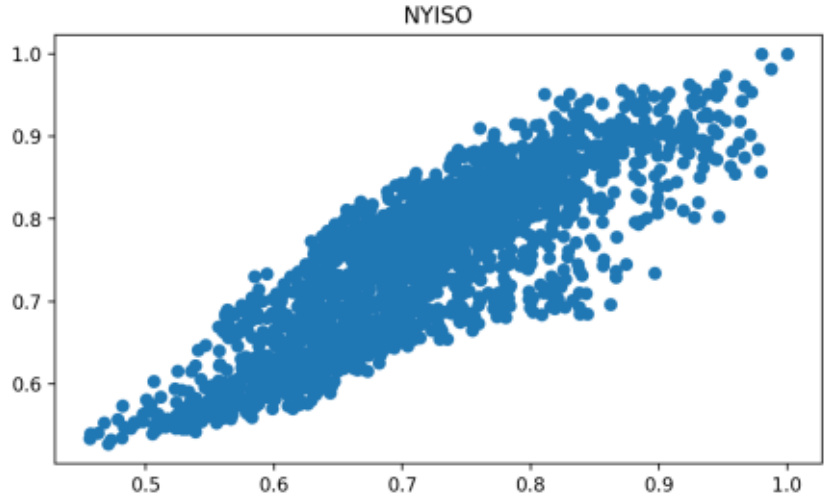



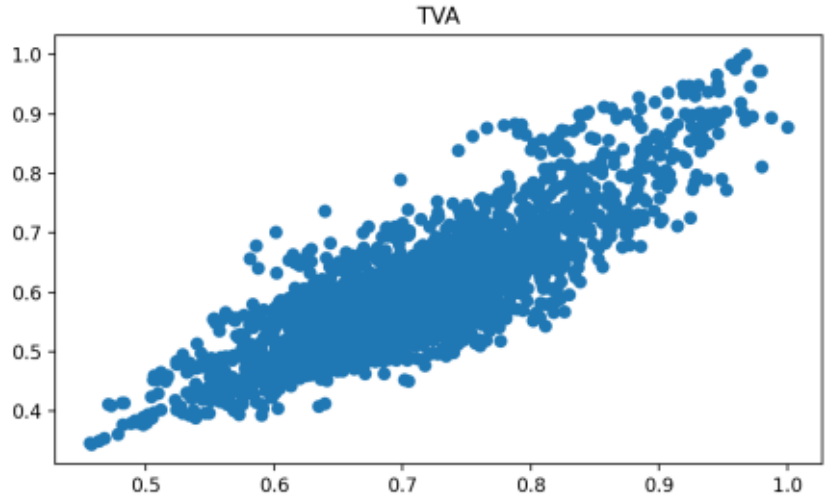



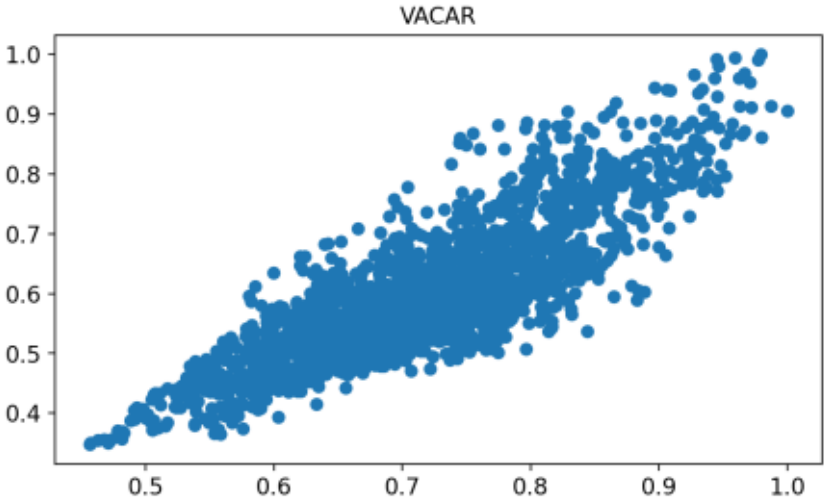

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Winter 2013



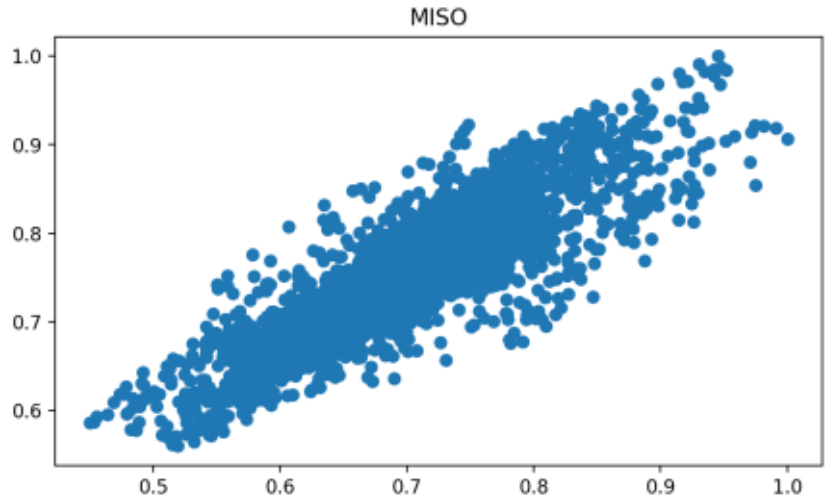



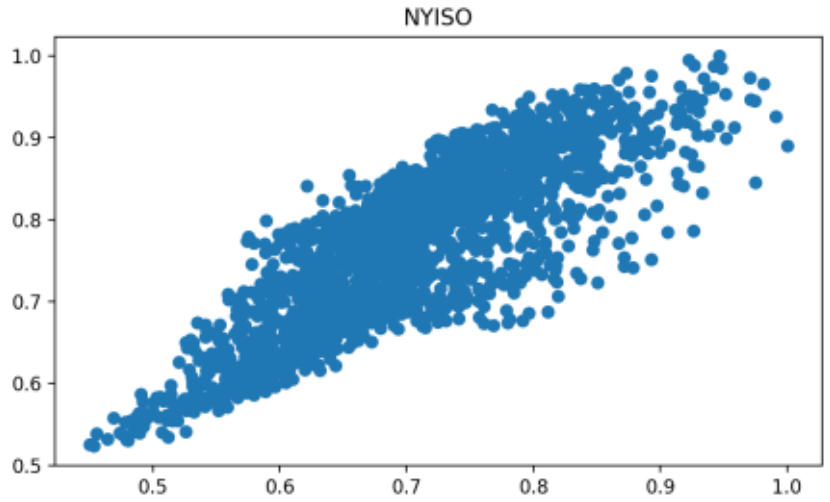



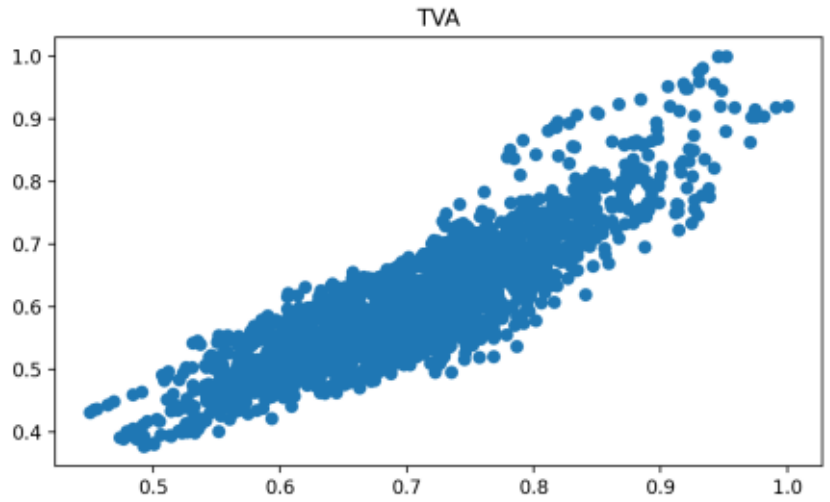



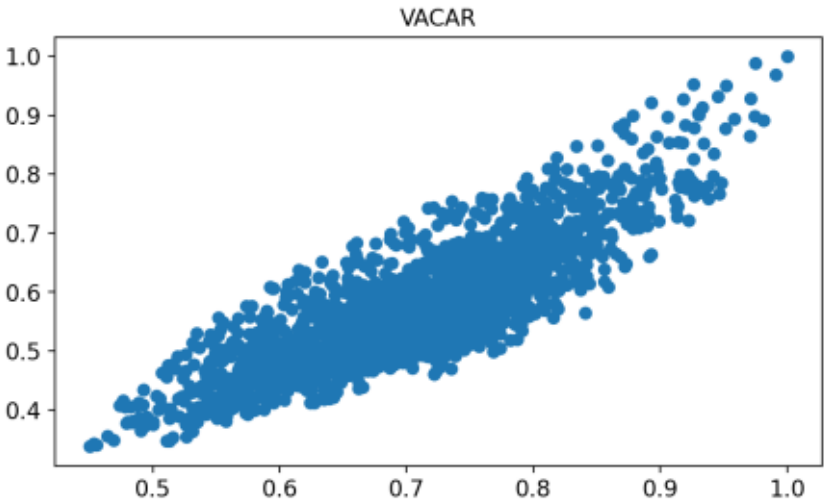

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Winter 2014



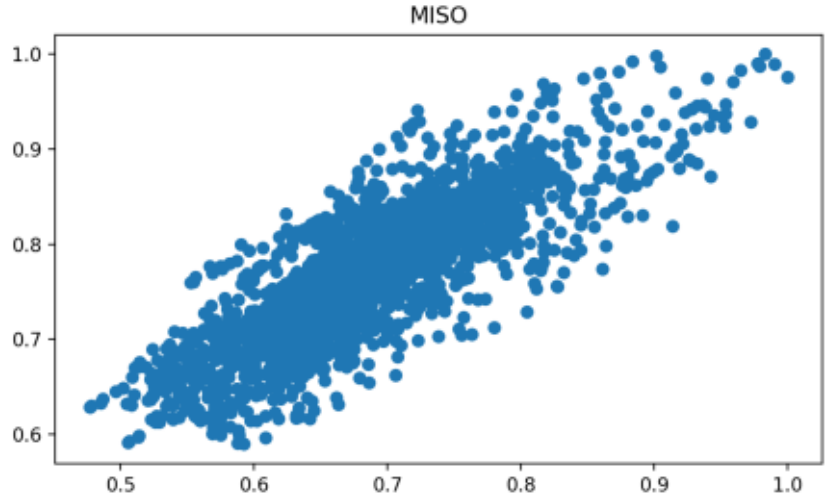



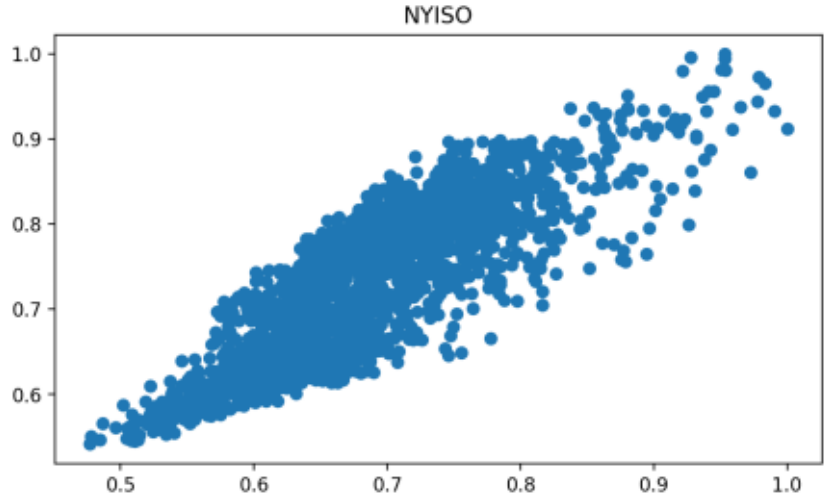



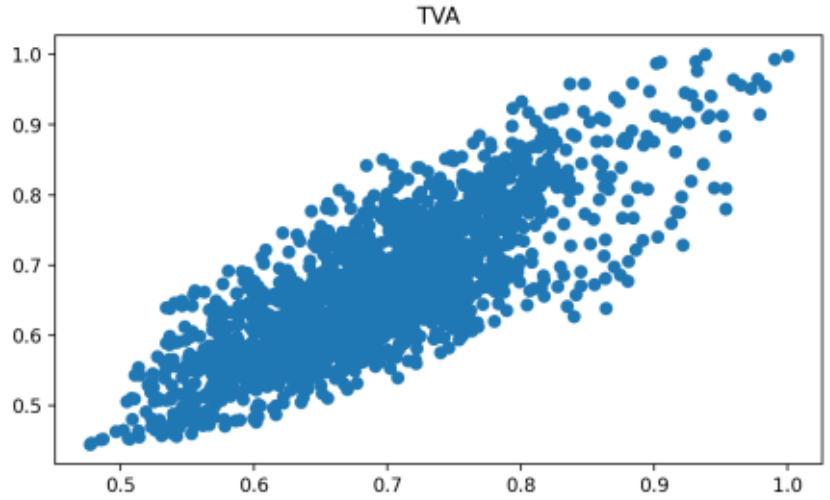



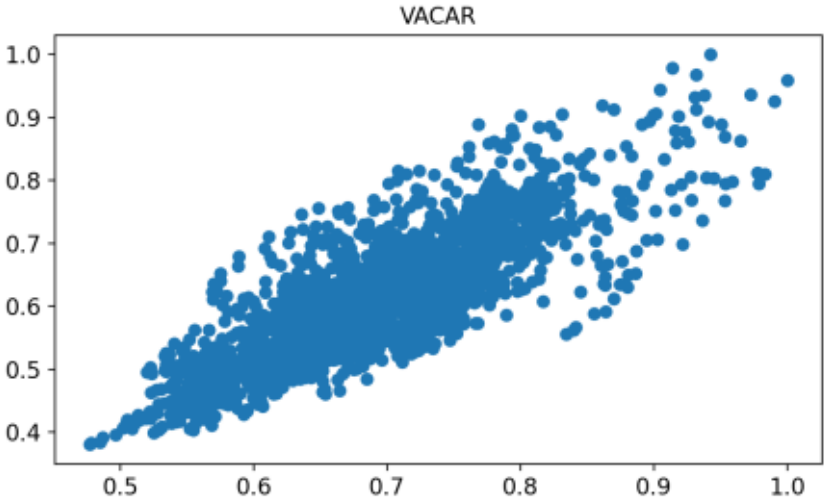

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Winter 2018



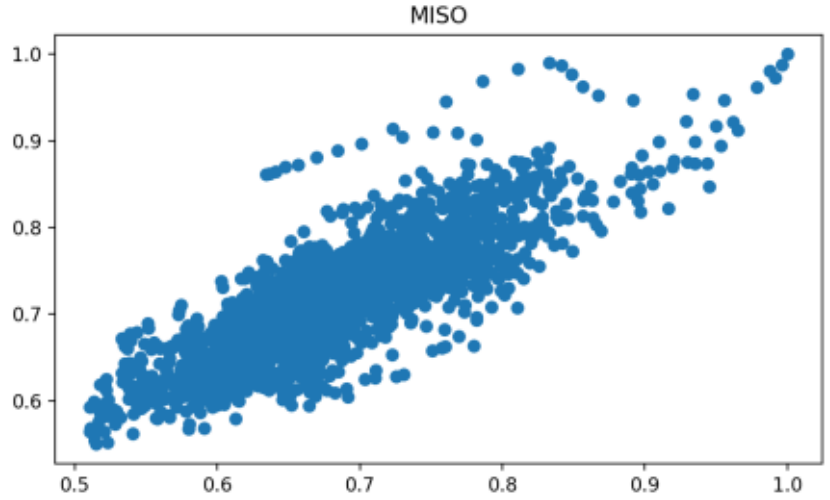



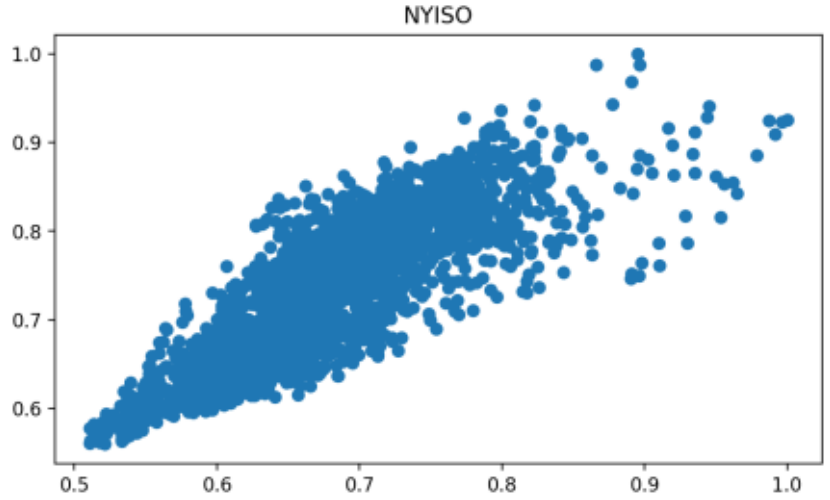



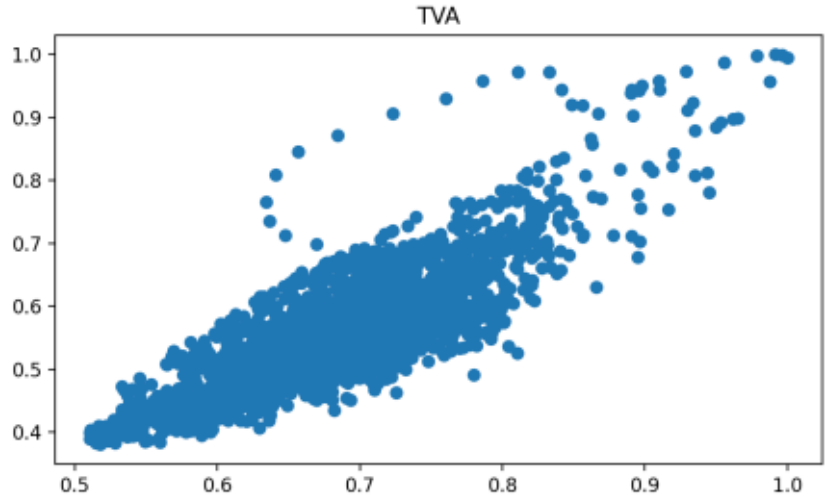



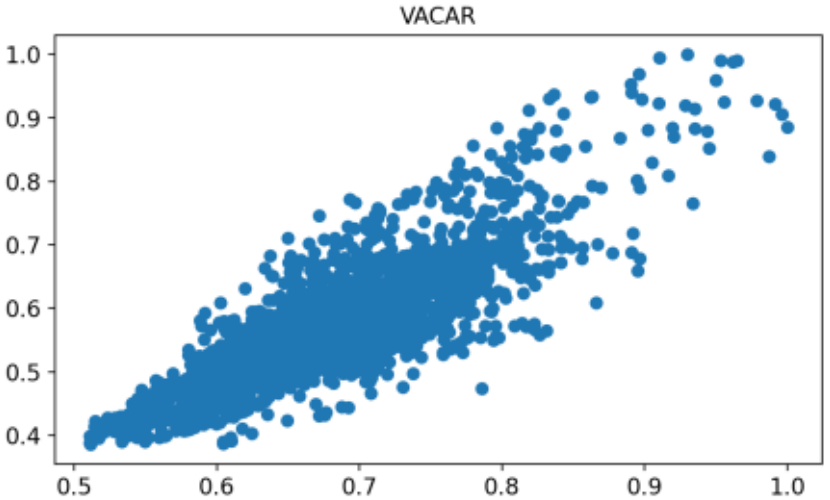

PJM values are on x-axes

# Seasonal Per-Unitized Loads
# PJM vs Neighbors - Winter 2022




PJM values are on x-axes

# Future Reserve Margins of PJM Neighbors

- Information reported in the 2023 NERC Long-Term Reliability Assessment shows the following for year 2027

| Zone | Anticipated Reserve Margin | Reference Reserve Margin | Most Recent IRM |
|---|---|---|---|
| MISO | 19.9% | 18.2% | 17.7% |
| NYISO | 20.6% | 15.0% | 21.5% |
| TVA | 13.8% | 15.0% | NA |
| VACAR | 22.9% | 15.0% | NA |

# How can we use all this info?

- If we can identify from the PJM ELCC run the season and load levels that drive the loss of load events at 1 in 10 in a case without emergency assistance, then we could
  - Identify the corresponding load levels at each neighboring zone, as well as an associated estimated probability of those load levels occurring in the neighboring zone
  - Then, given the expected reserve margin in each zone and one of the load levels identified in the previous step, we could identify the outage levels of the resource fleet in the zones, as well as an associated probability for those outage levels
    - Say, if PJM experiences loss of load events at 95/5 winter load levels, and
    - There is an X% chance that MISO has a 93/7 winter load level at the same time, and
    - There is a Y% chance that MISO has a Z% forced outage level
    - In theory, we could estimate the expected amount of available MWs in MISO potentially available to assist PJM if there is sufficient transfer capability when PJM experiences loss of load events at 95/5 winter load levels

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**Capacity Benefit of Ties (CBOT) Update**

# PROTECT THE POWER GRID

# THINK BEFORE YOU CLICK!

Be alert to malicious phishing emails.

**Report suspicious email activity to PJM.**

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