Accuracy of Clustering as a Method to Group Distribution Feeders by PV Hosting Capacity

Robert J. Broderick, Matthew J. Reno, Karina Munoz-Ramos

Sandia National Laboratories, Albuquerque, NM, USA

Motivation

As PV penetration continues to increase, utilities are concerned about the impact that these systems will have on the distribution system.

Gathering the data and creating feeder models that accurately predict the impact of PV systems on the distribution feeder is a difficult and tedious process.

Recently, data clustering techniques for grouping distribution feeders with similar characteristics have been proposed for simplifying the PV interconnection process by creating hosting capacity maps for entire service areas.
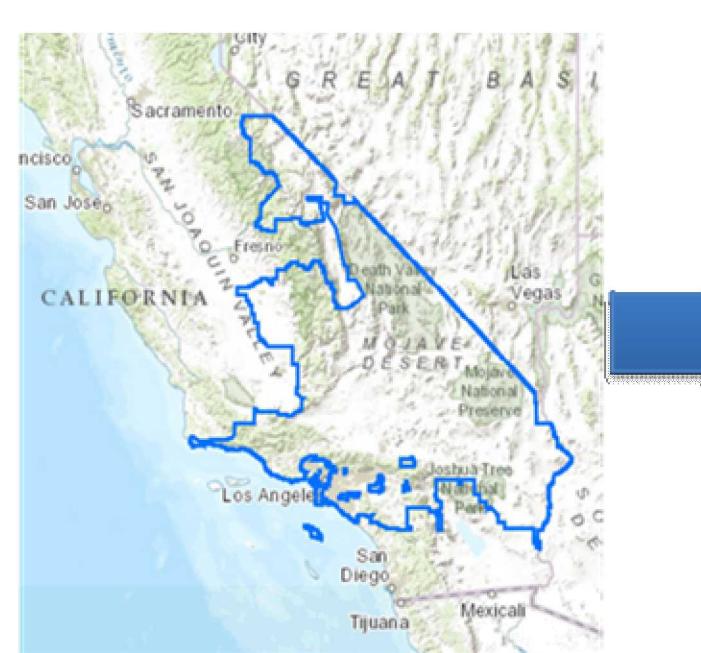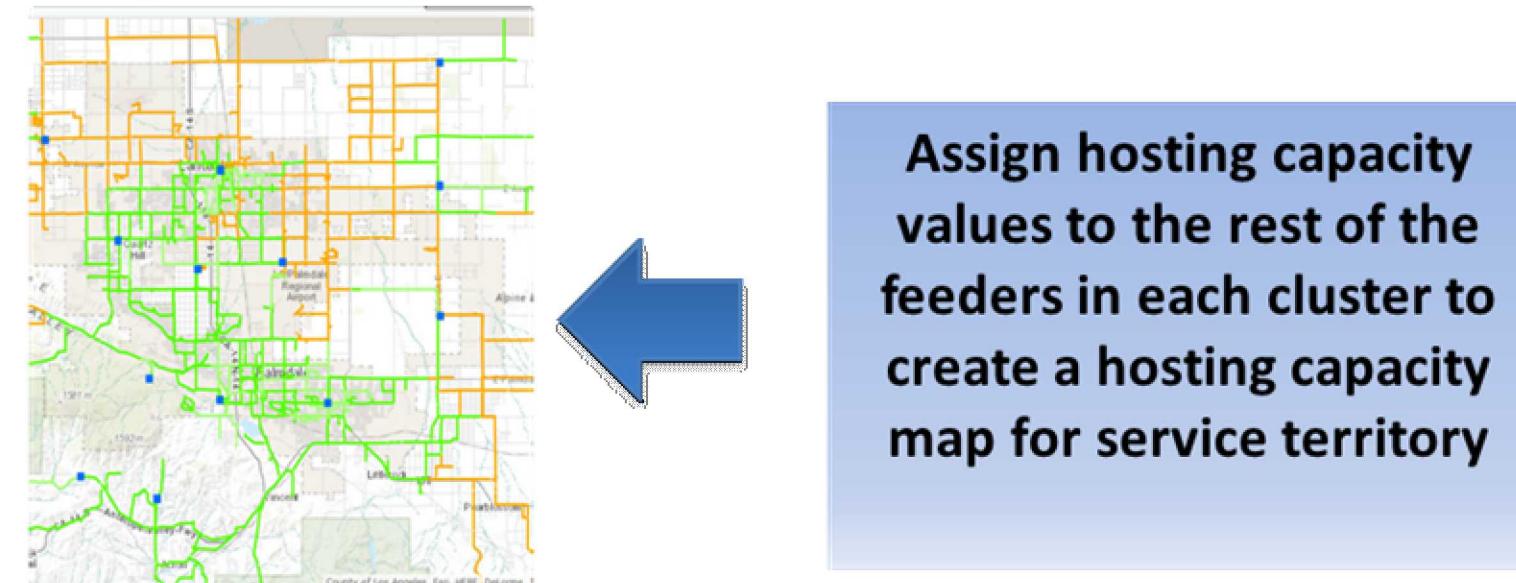

Study Data

Example Utility feeder data and Feeder characteristics for full set of 8143 feeders (Blue) and 214 study feeders (Red)
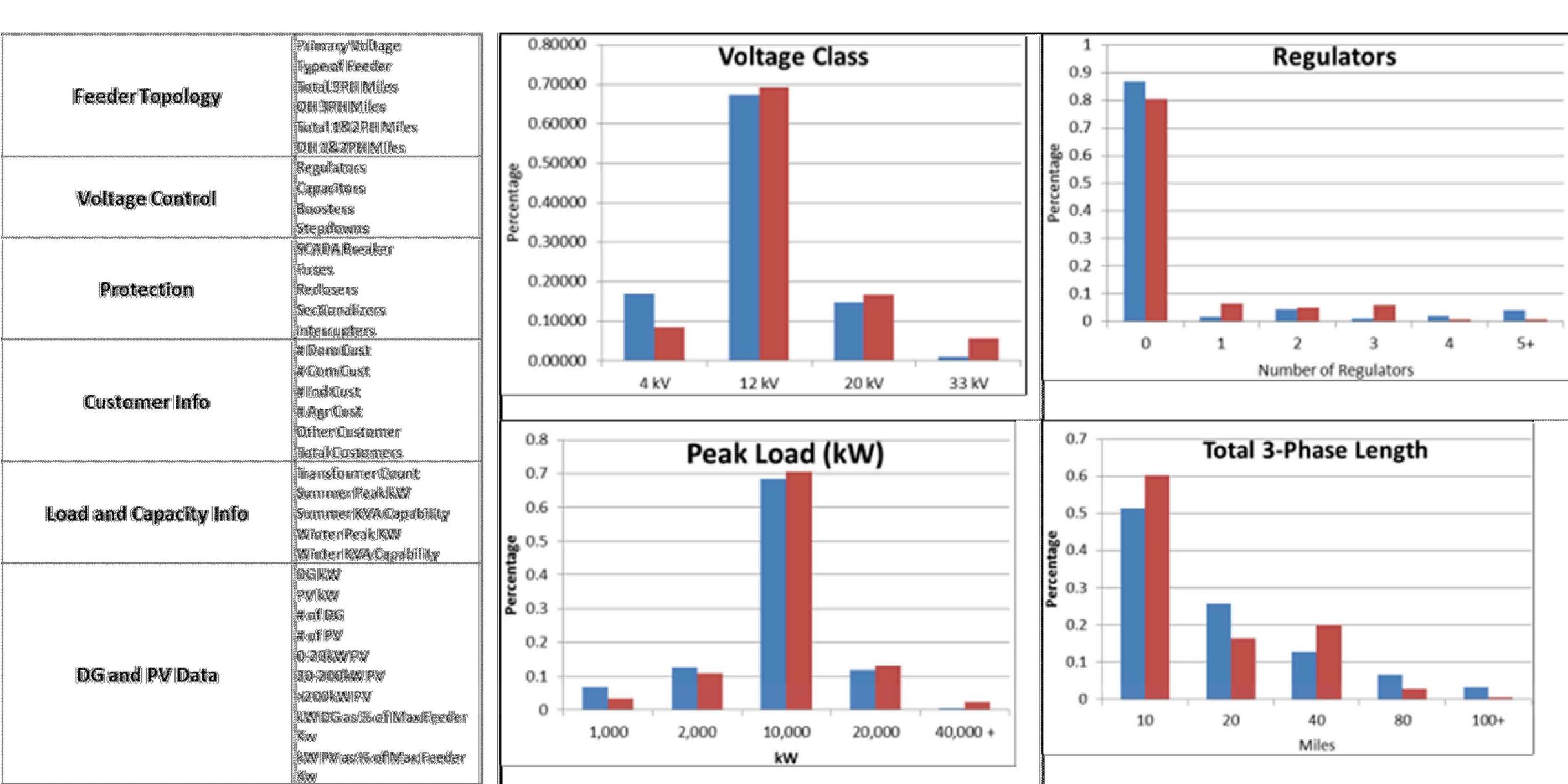

Statistical Clustering Methods

We want to place feeders into specific groups, driven by feeder properties, so that feeders in one cluster are similar to each other, and dissimilar from feeders in other clusters.

Common methods for clustering include hierarchical and k-means. The k-means method was chosen due to its advantage in clustering with larger data sets.


Bi-plot of the 8 cluster solution for 8,143 feeders with 214 study feeders shown by markers
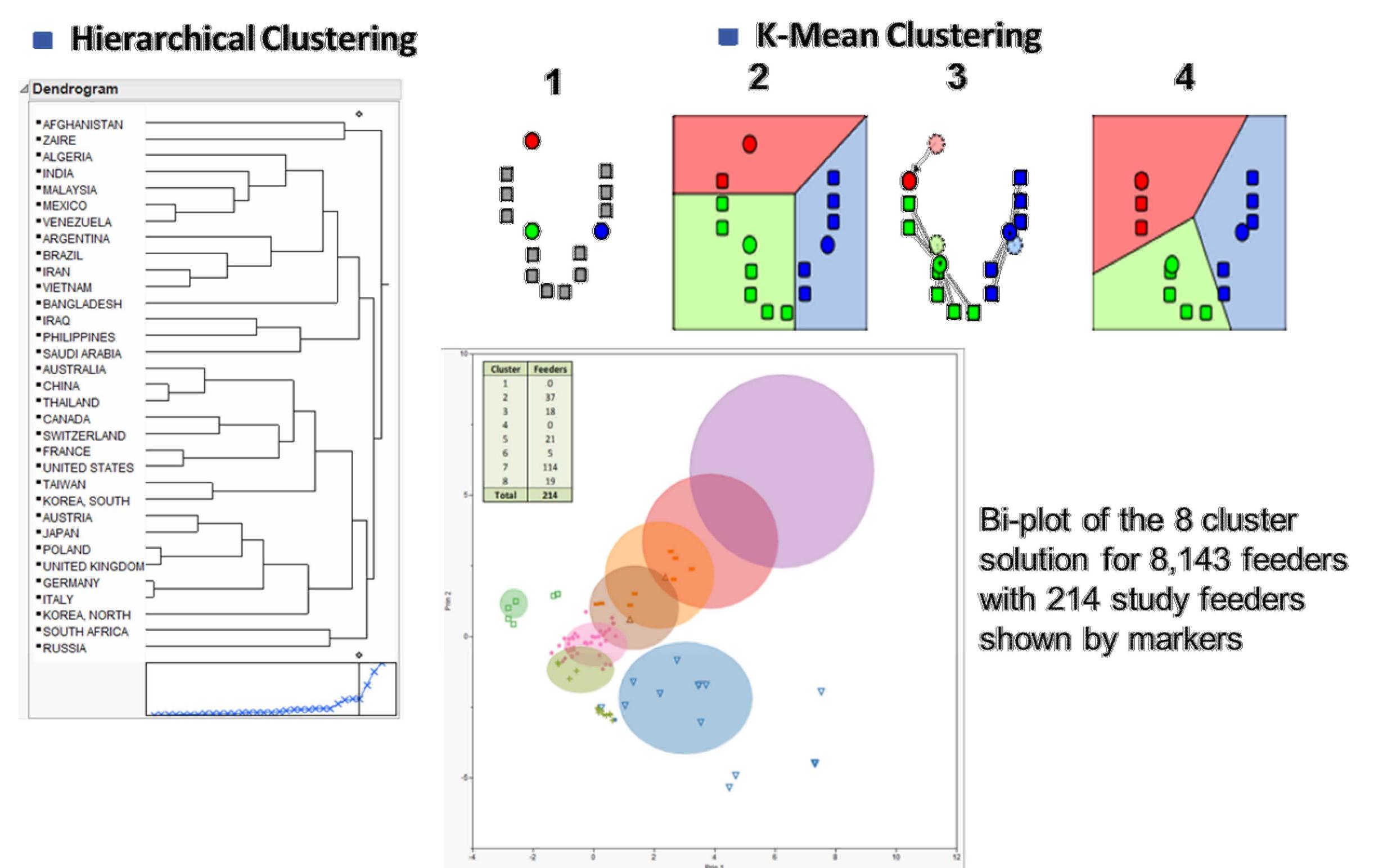
Clustering Results
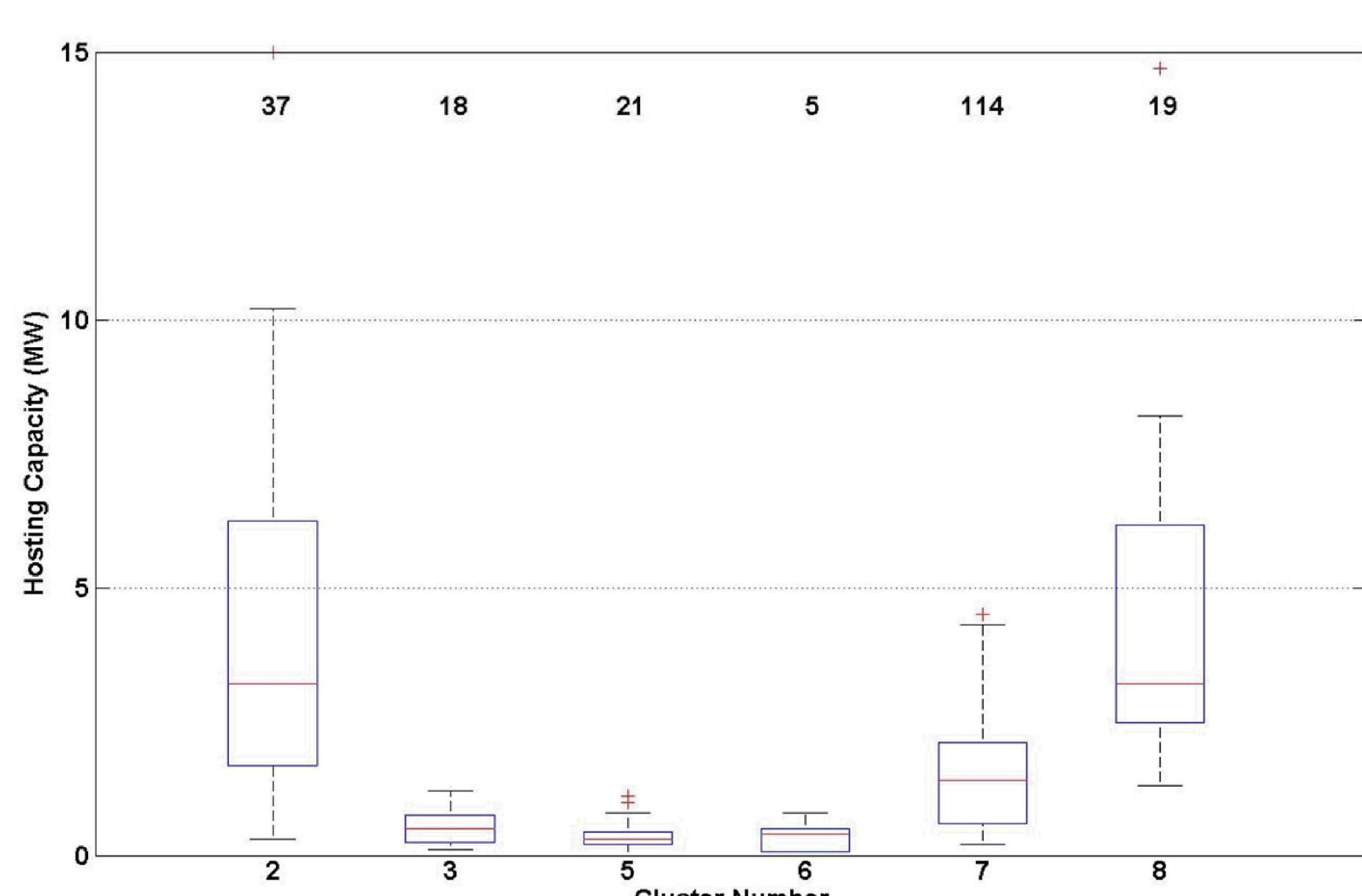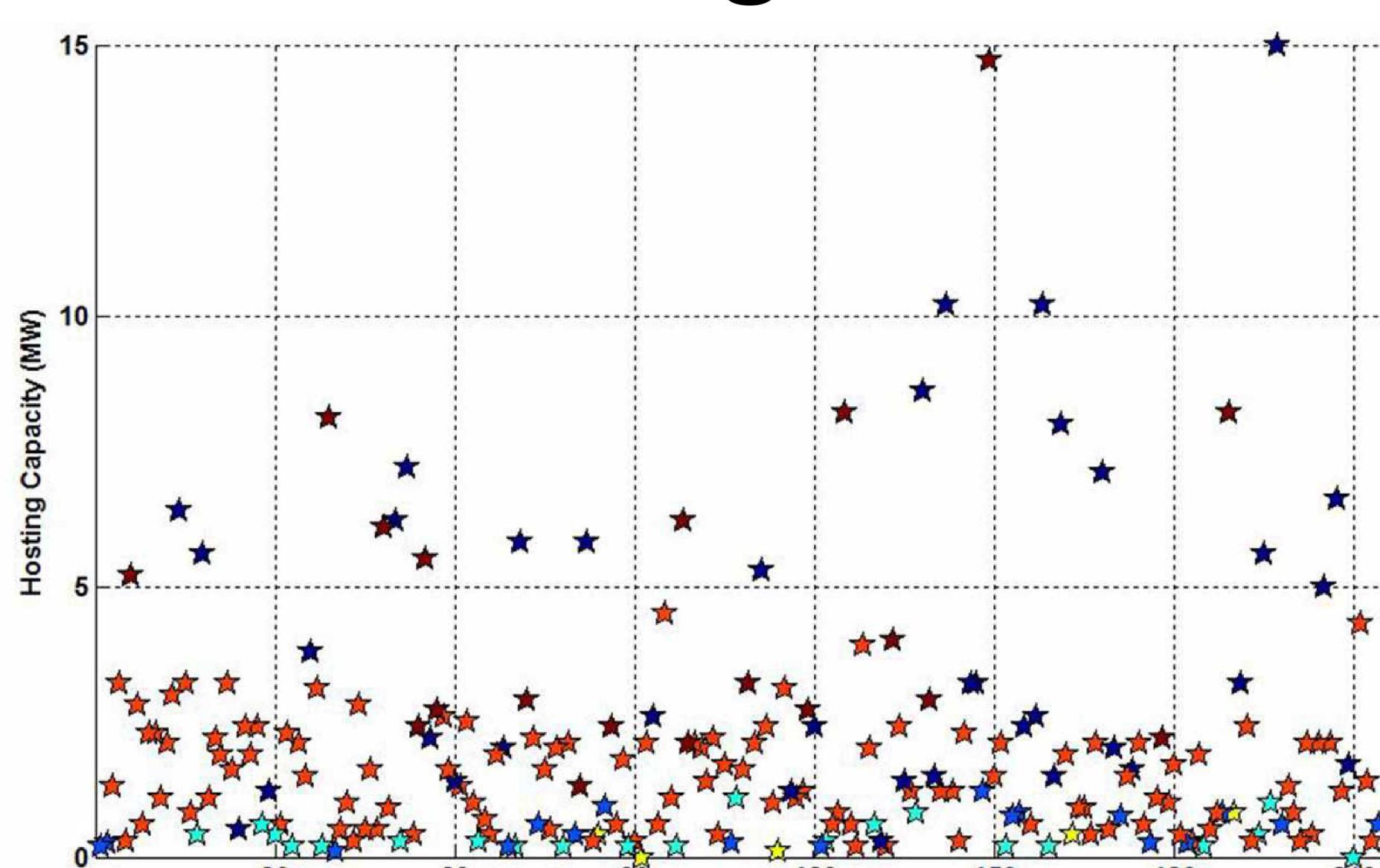
Detailed Clustering Results

Hosting capacity violation type shown by marker shape for each feeder in the same 6 clusters.
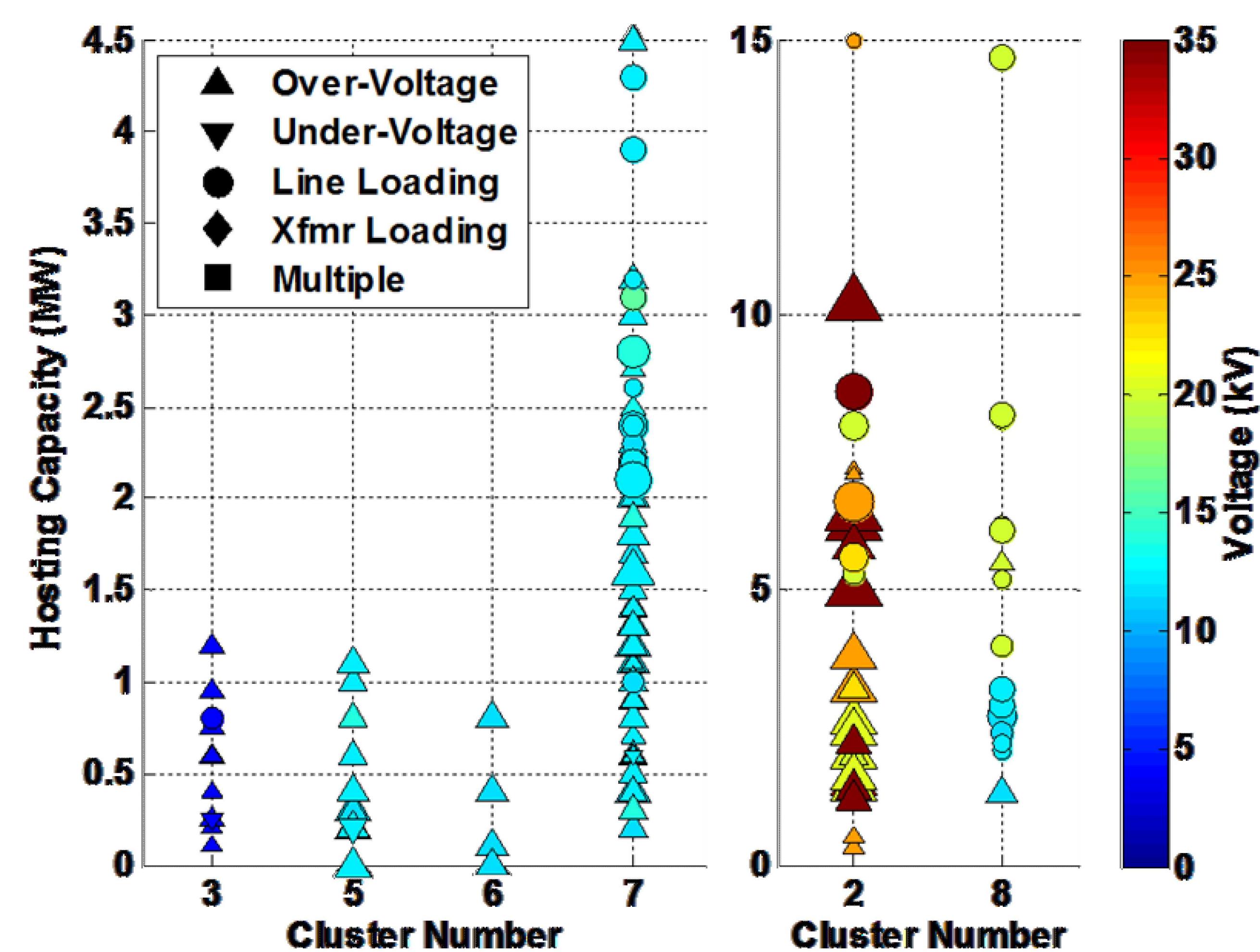
Conclusions

Methods Explored in this paper:
- Dependence of hosting capacity accuracy on the number of clusters.
- Dependence of hosting capacity accuracy on weighting of key cluster variables.

The accuracy of K-Means clustering as a method to group distribution feeders was relatively inaccurate with the best solution showing an average hosting capacity variation of 77%.

K-Means clustering is still useful as it provides good separation between clusters in many cases, but it has its limitations.

Clustering will never perfectly group feeders such that all unique characteristics match with a single PV hosting capacity for the feeder, but it can provide a rough estimate of the hosting capacity for similar types of feeders.