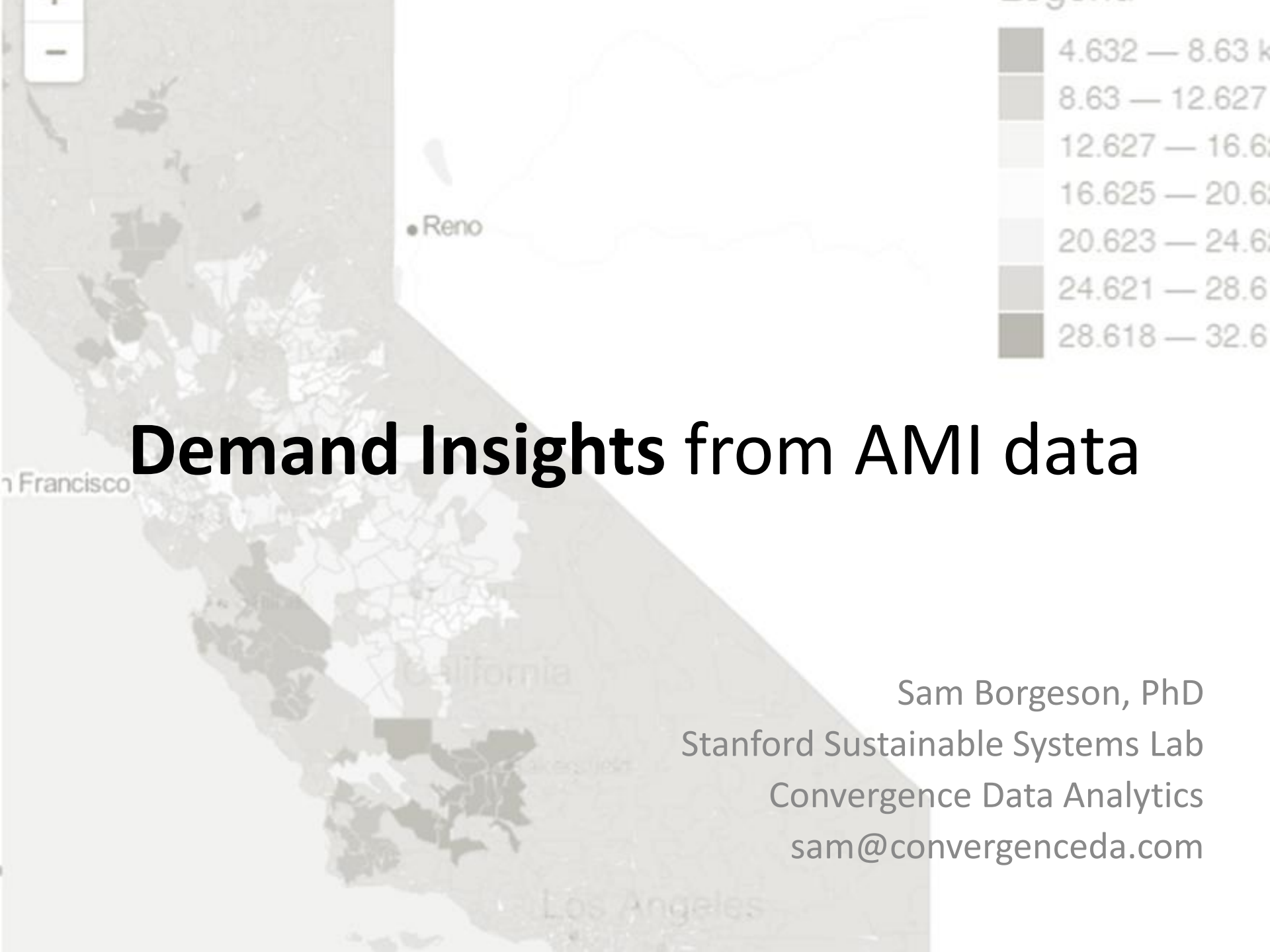

Demand Insights from AMI data

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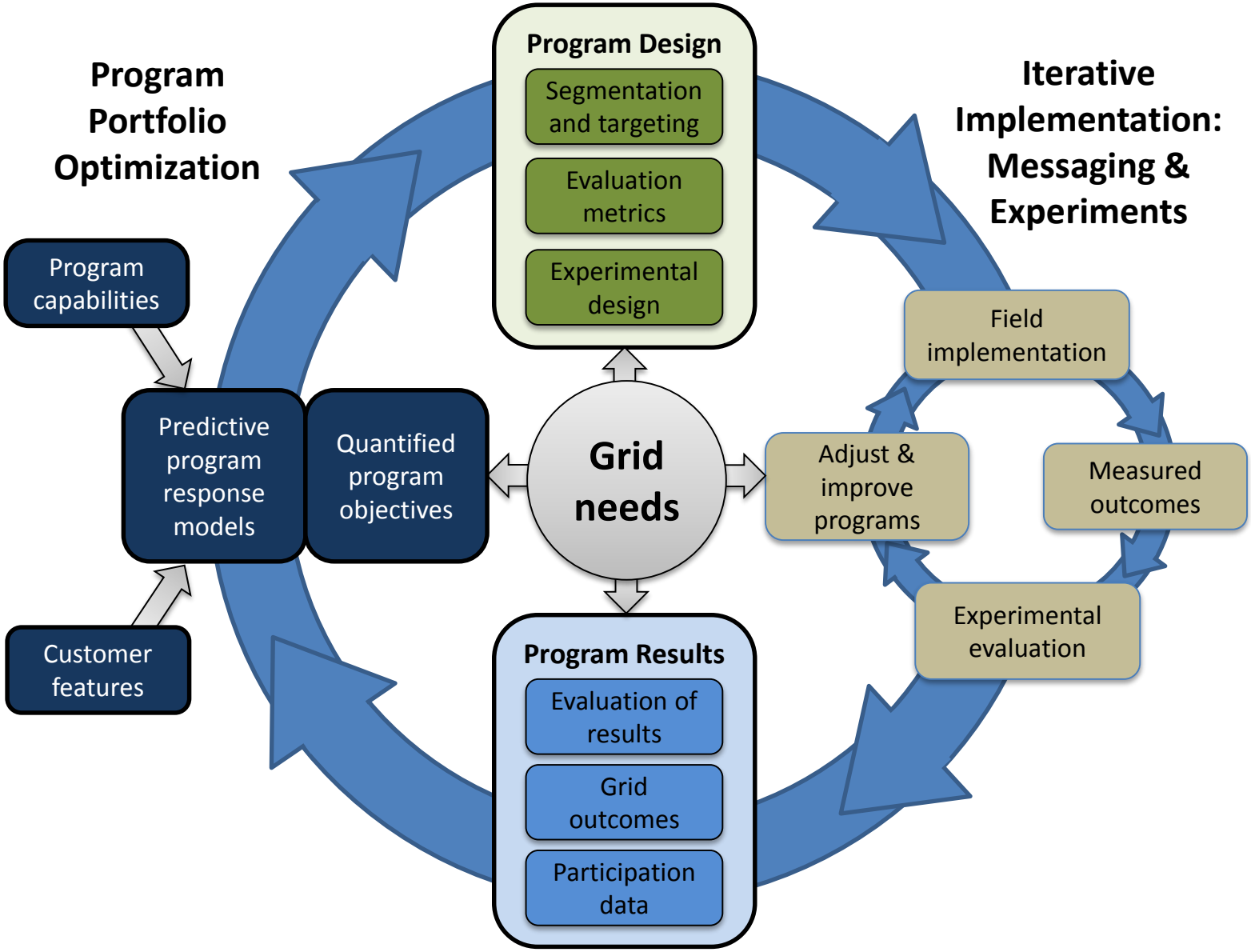
Problem statement

- The grid has evolved without the benefit of a detailed understanding of patterns or determinants of customer consumption
  - Demand is taken as a given and infrastructure is planned and operated accordingly
- In the 21st century, the grid will need to integrate and manage unprecedented levels of renewable and distributed generation
    - This will require fundamental changes to planning and operations supported by flexible demand

Our work

- Convergence Data Analyics builds tools that use machine learning and statistical models to uncover patterns and determinants of demand and realize opportunities for demand flexibility.
  - Flexible Demand: Smart Efficiency and Demand Response
    - Learn customer characteristics from demand data
    - Customer segmentation and targeting based on consumption
    - Data driven evaluation, response modeling, and iterative learning
  - Distribution planning and operations
    - Understanding customer diversity and aggregate behavior
    - Matching intermittent generation with flexible loads and storage
    - Aligning flexible demand with grid needs

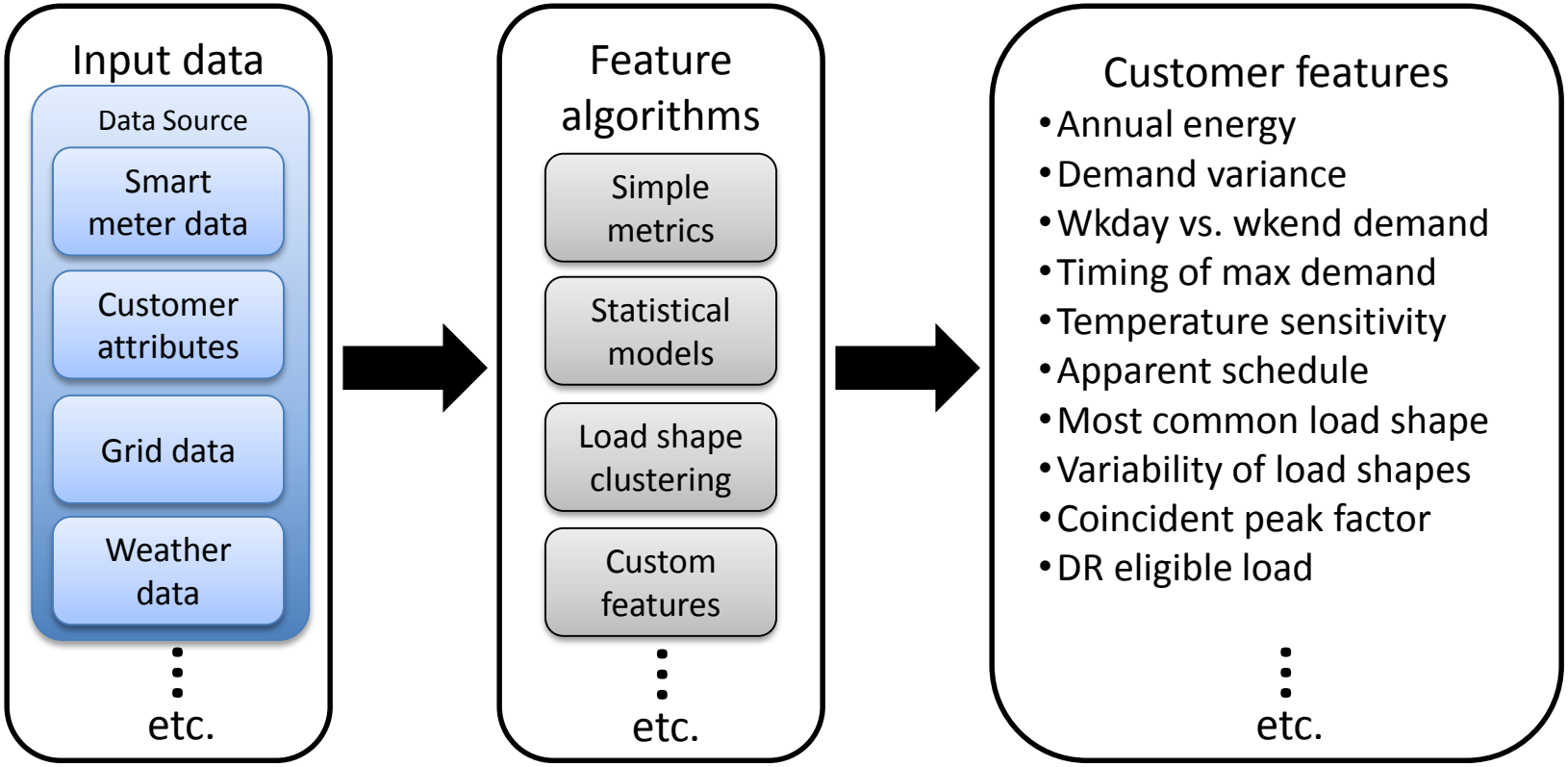
Flexible Demand: Big Picture



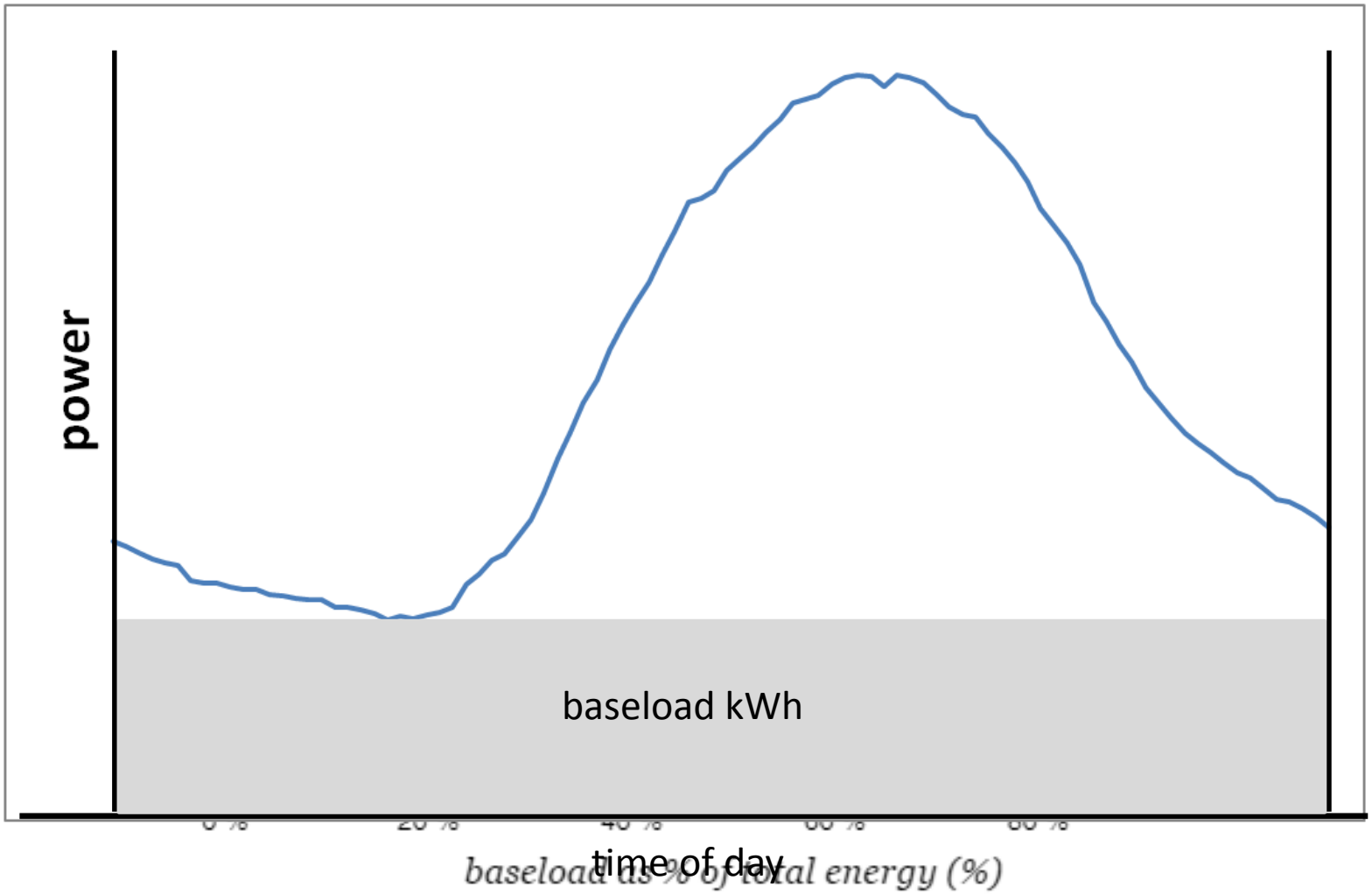
Open platforms

- Algorithmic supremacy is not the right goal
  - All approaches have strengths and weaknesses
  - In practice, there is not much difference in power/fit between well implemented methods
- To thrive, the intelligent efficiency industry needs to earn the trust of regulators and customers
  - We cannot learn or innovate without trying things that do not work
  - Better separate fact & fiction on what can be learned using meter data
- We are open sourcing all of our tools (VISDOM for R and the Python-based Demand Insight Engine) and subjecting our algorithms to peer review
  - Building community & best practices on efficient, scalable, and repeatable analyses
  - We focus on adoption: enabling utilities and EE/DR pros to learn from data; lifting the veil of mystery from the analysis

Demand feature engine



Ex: Baseload



Customer demand feature matrix

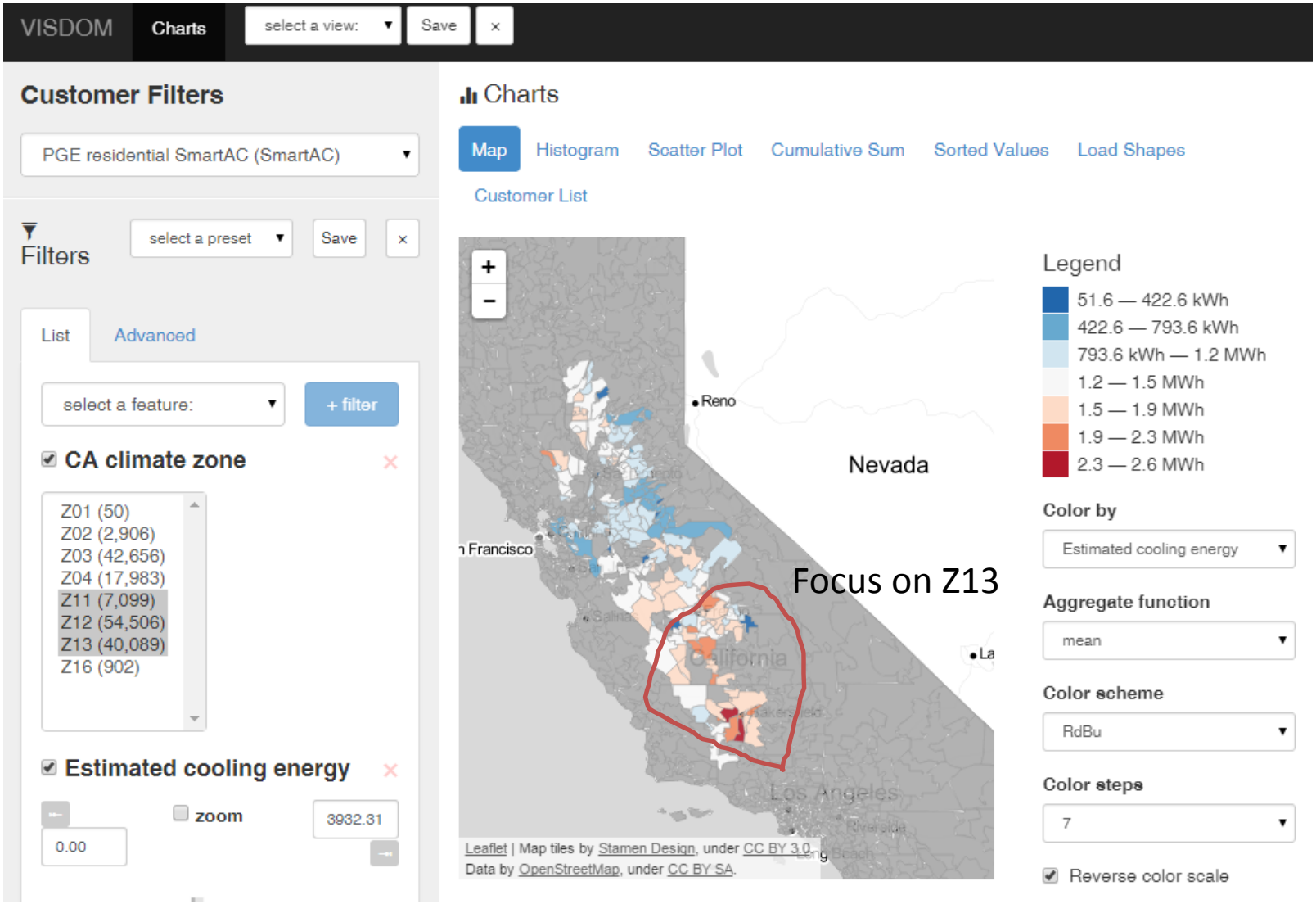
Cust id	Location code	Coincident peak factor	DR eligible load	Coincident peak load	•••	Temp sensitivity	Load shape variability
1	J-02-03	1.2	100 kW	400 kW	…	1.1 kW/°F	2.1
2	J-02-03	1.1	5 kW	200 kW	…	0.01kW/°F	5.6
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
250000	S-01-04	1.3	10 kW	50 kW	…	0.5 kW/°F	3.2

- Uses data features to provide search engine for customer behaviors.
  - Filter
  - Visualize
  - Interact
  - Export

Ex: Segmentation and targeting

- Define desired program participant profiles in terms of feature values
- Example: HVAC DR Control Program
  - Target geography
  - High cooling consumption
  - Load shape peak during grid stress
  - Low load shape variability

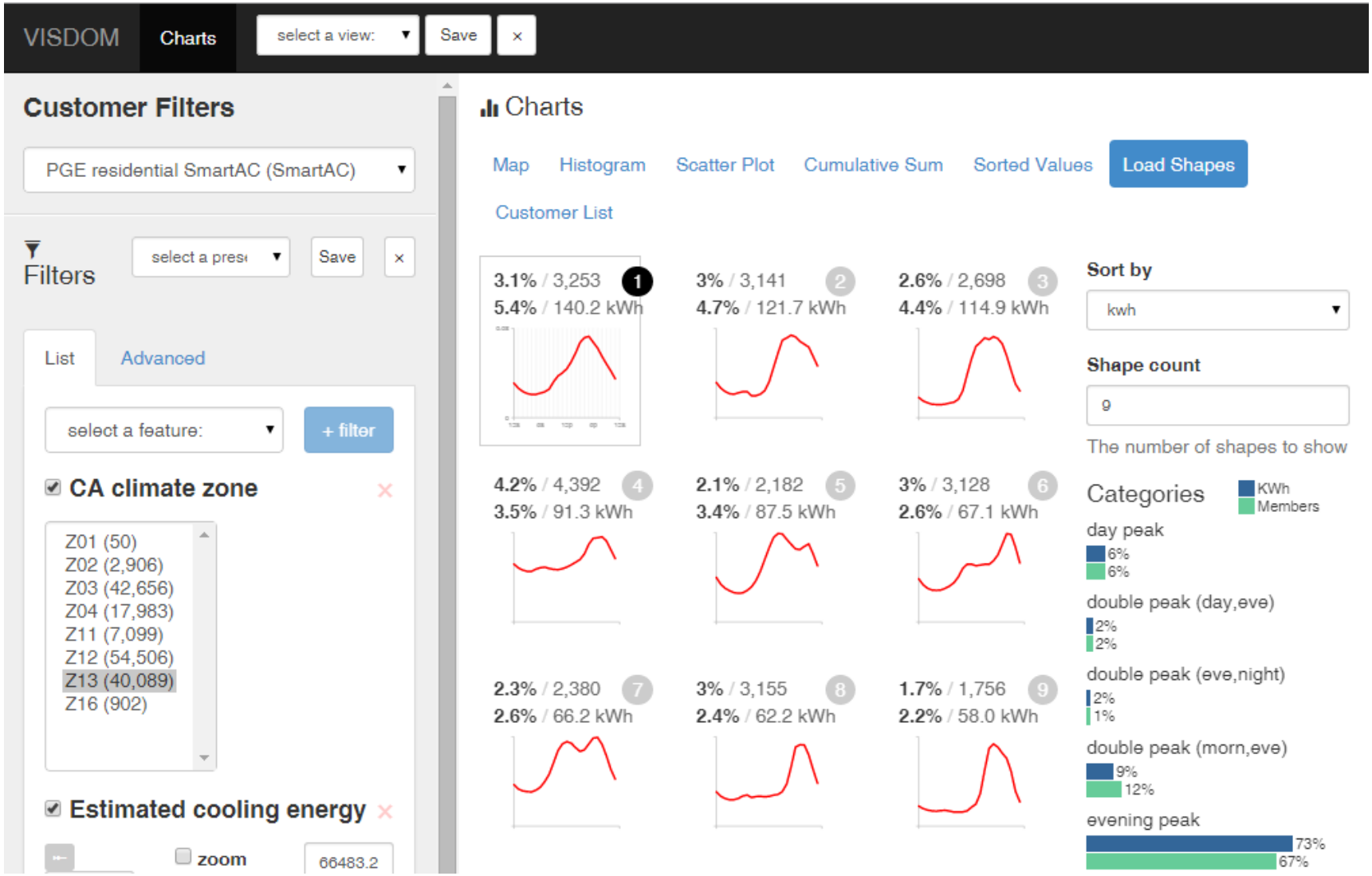
HVAC: Find cooling loads



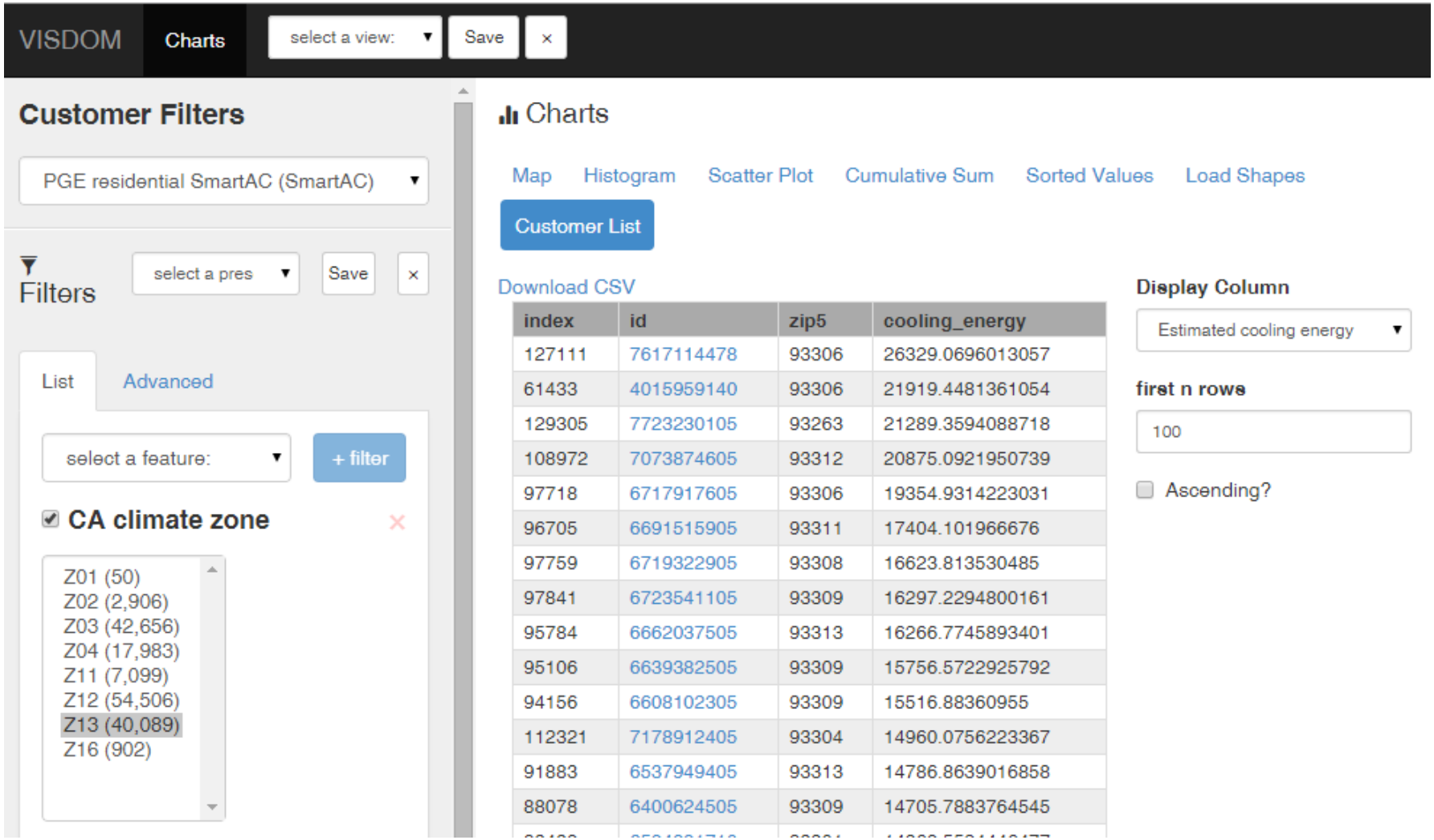
Z13: cooling

- Quite a bit of diversity across households

Z13: evening peaking customers



Z13: Export targeted customer data



Thank You

Convergence Data Analytics, LLC

Actionable insights from customer meter data.

www.convergenceda.com

How can we help put your data to work?

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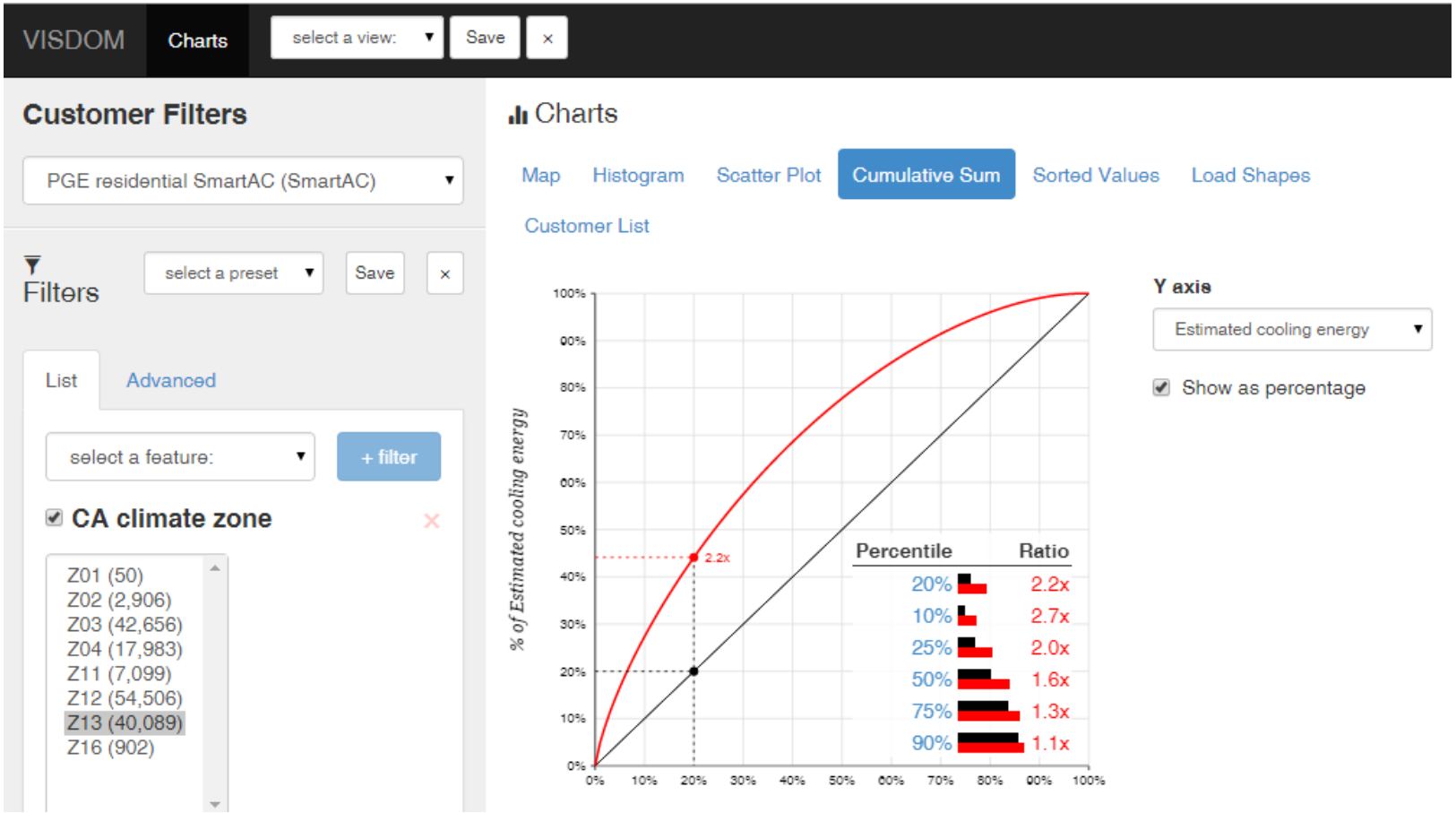
Z13: top users

- Top 20% of customers use >45% of cooling



The payoff

Final output is a ranked list of customers ordered by priority based on customized targeting criteria:

1. Geography (hot climate zone)
2. Timing of peak demand (early evening peaks)
3. Household cooling loads (biggest AC users)
4. Other program-relevant customer attributes
   - Income and equity impacts of program
   - Past program participation and outcomes
   - Special inclusion or exclusion categories
   - etc.

Program benefits

Energy programs should be designed and implemented using energy data!

- Identify and eliminate free riders from the beginning
- Improved program cost effectiveness
  - 4x expected program response compared to untargeted customers (2x compared to best practice geographic targeting) for the same total customer acquisition costs
- More focused messaging to recruit each customer
  - Personalized information based on energy usage attributes
  - Greater likelihood of enrollment
- Use customer metrics to evaluate program outcomes

VISDOM Structure