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2x to 5x greater benefits; integrate and optimize

The net present value benefits of distributed energy resources are 2x to 5x greater than we have estimated, A series of barriers that are overcome include average load shapes, lack of distribution marginal costs that capture more granular value, lack of distribution load flow analysis, lack of covariance analysis (of weather/loads/prices), and lack of optimization in operations, which are captured in planning and the DER portfolio. The Attached PPT explains. (Please excuse that slide 11 is not interactive in the PDF version attached. PPT version is over 10 MB.)

Additional submitted attachment is included below.

Developing the Plans: Four Steps Net 2x to 5x Greater Benefits

Utility Variable Generation Working Group:

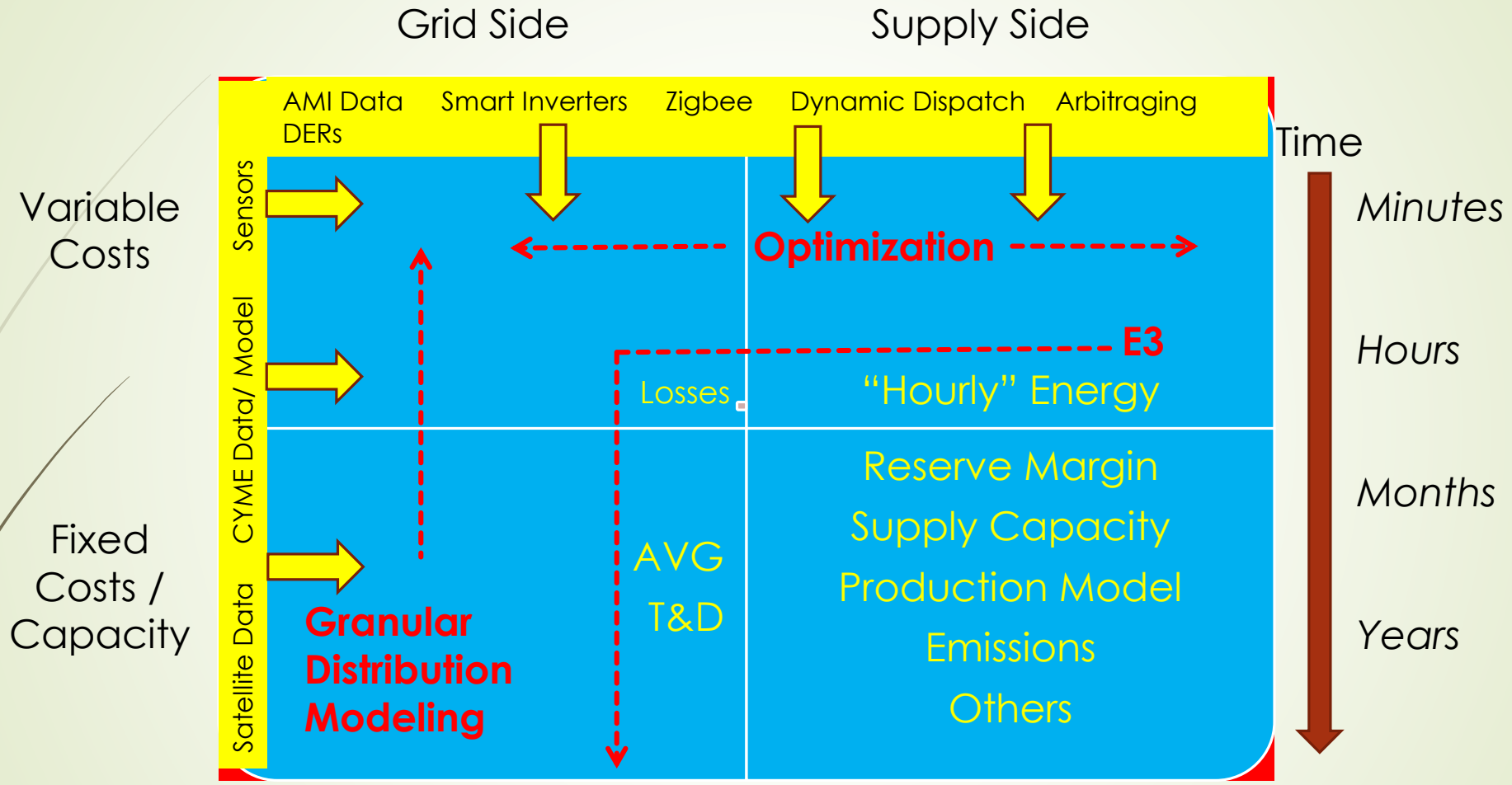
Fall Technical Workshop

San Diego, CA

Dr. Eric Woychik, Strategy Integration, LLC

14 October 2015

Grid Edge Requires A More Granular Focus

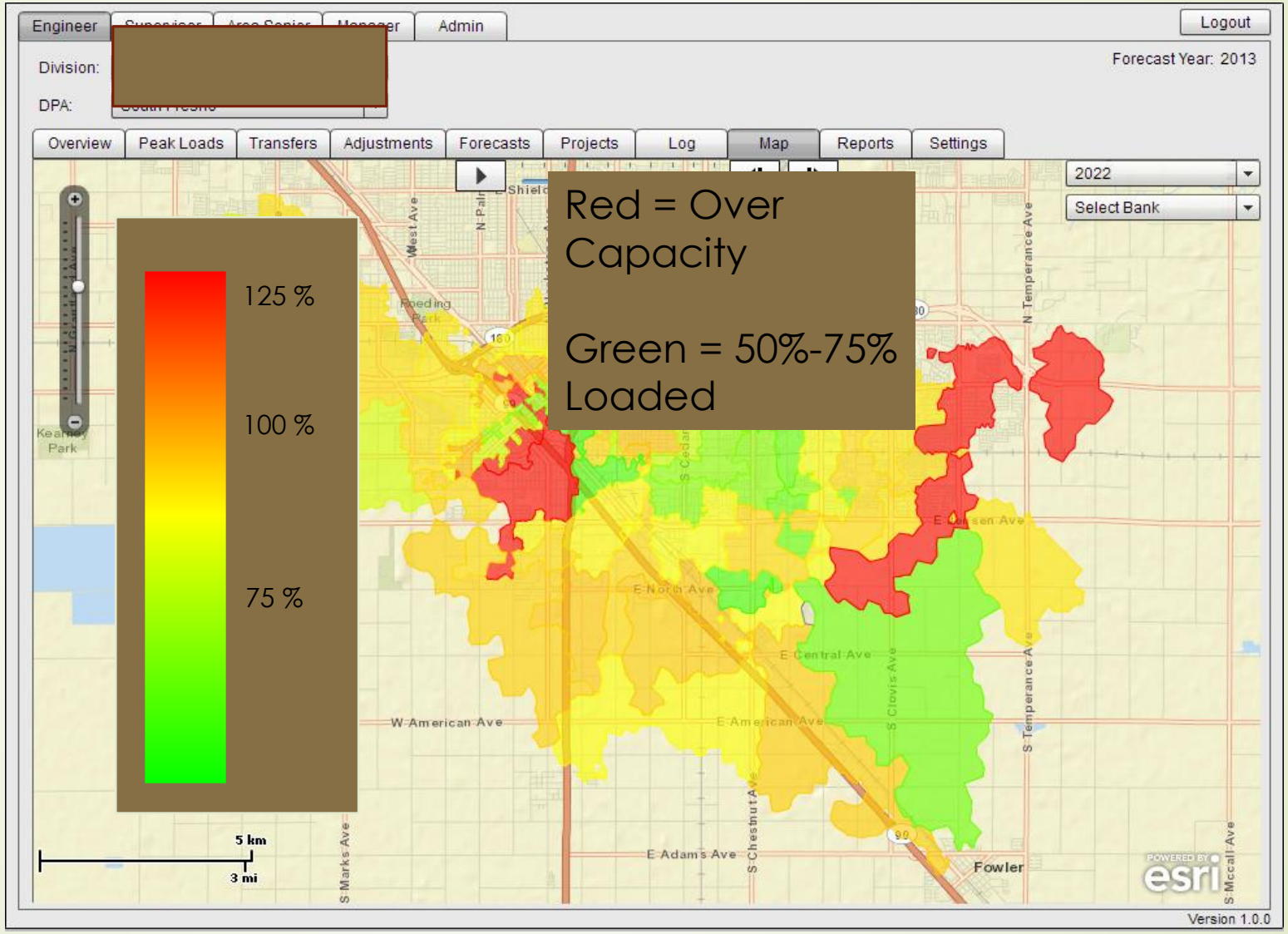


Averaging under-estimates savings opportunities. Current cost-effectiveness does not address sub-hourly avoided costs, nor granular distribution marginal costs. But, approaches can be blended.

Integrated Capacity Analysis (ICA): Load Flows

Red = Target EE/DR/PV

Green = Load Building is Least Cost, for EV Charging or New Economic Development



Distributed Energy Resource (Integration) Plans

- Developed a 4-step method to integrate resources, with Duke Energy, NVE, AVISTA…
  1) Customer targeting
  2) Distribution location
  3) Covariance/option value
  4) Optimization of packages @ locations
- Found Net-present-value benefits from DER to be 2x to 5X greater compared to prior expectations
- Key is to break down the silos to integrate supply+ EE+DR+DG+ST+distribution – most fail to integrate/optimize

Four Steps to Maximize Value (& Hosting)

Plans should achieve integration & optimization

- Customer targeting/engagement with new data – locations – also "Participant Test"
- DER integration @ distribution locations – also utility "Program Administrator Test"
- Capture (weather-loads-prices) covariance – also "Total Resource Cost Test"
- Optimize to choreograph loads and resources to maximum benefit – also "Societal TRC Test"

California's Dist. Resource Plans vs 4 Steps

A. We must do more than Integrated Capacity Analysis (ICA) with Load Flows

i) ICA provides only physical (kW, Kvar) constraints

B. Integrate & optimize DERs at locations = ICA + econ

i) Target customers (high use/demand, grid impacts)

ii) Value DER packages at locations (to customer)

ii) Apply covariance (weather, loads, prices, DER)

iv) Optimize DER packages for grid/customers

=> Provide Locational Net Benefits Analysis (LNBA)

DER/DRP/IDSR Plans Require LNBA

- "More than smart" suggests ICA; "grid constraints are here, there… but we need to move beyond to LNBA
- DERs properly integrated increase DER hosting, which means ICA alone is WRONG without LNBA
- Locational Net Benefits Analysis (LNBA)defines which resources, where, in what quantities, which translates to least-cost DER hosting
- DER "loading order" based on LNBA will "max value"
- Use of "all-in" Distribution Marginal Costs simplify and clarify the tradeoffs across all resources.

Four Dimensions of Distribution Marginal Costs

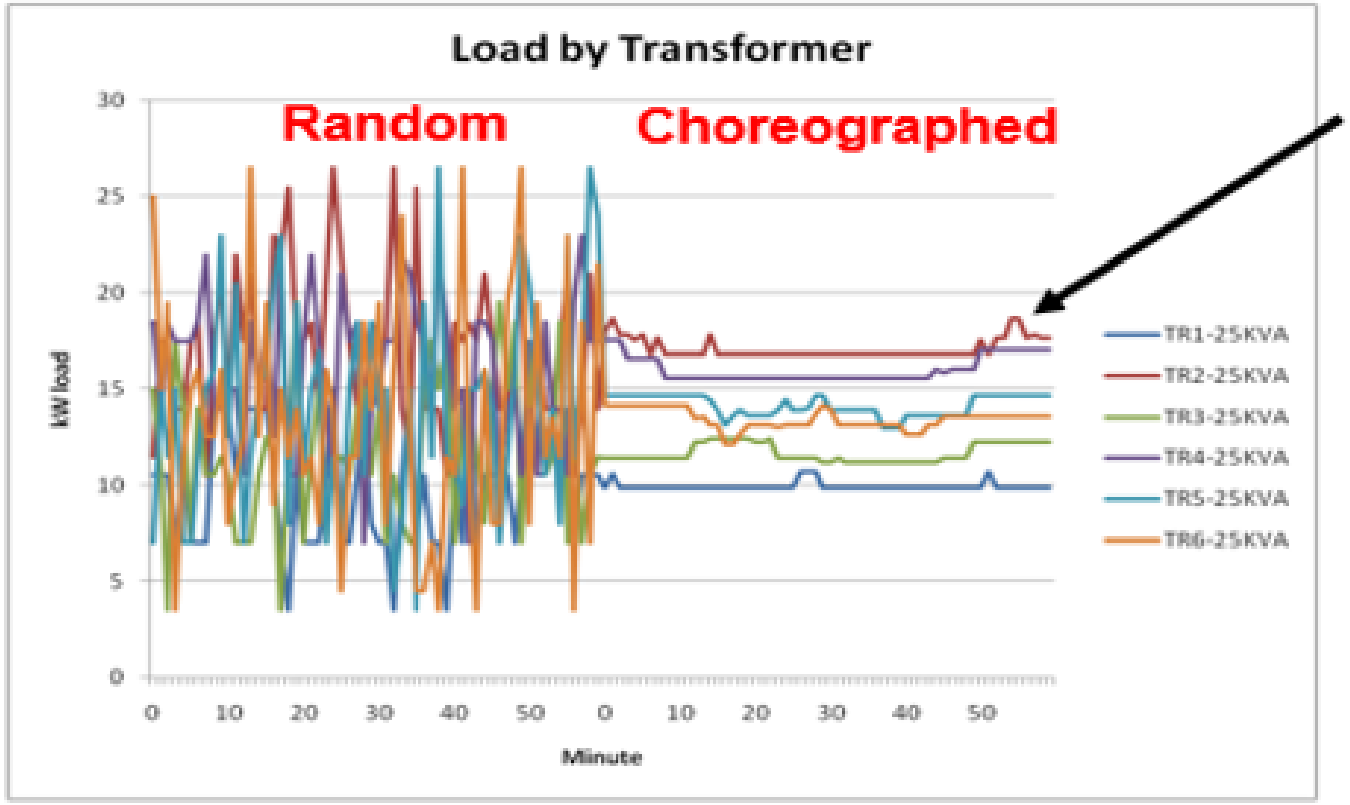
Distributed Optimization based on DMCs

- Distributed optimization captures customer and utility value from all aspects of the grid (wholesale/distribution) and DER resources
  - Utility optimization (minimize costs, improve reliability, integrate renewables)
  - Load and DER optimization (maximize customer comfort and minimize costs)
  - Deploy the flexible virtual power plant – two-way power flows
  - Optimization is based on continuous comparison of DMCs…

- Alter load shapes, choreograph DERs -- maximize portfolio benefits

Optimize Transformers Use

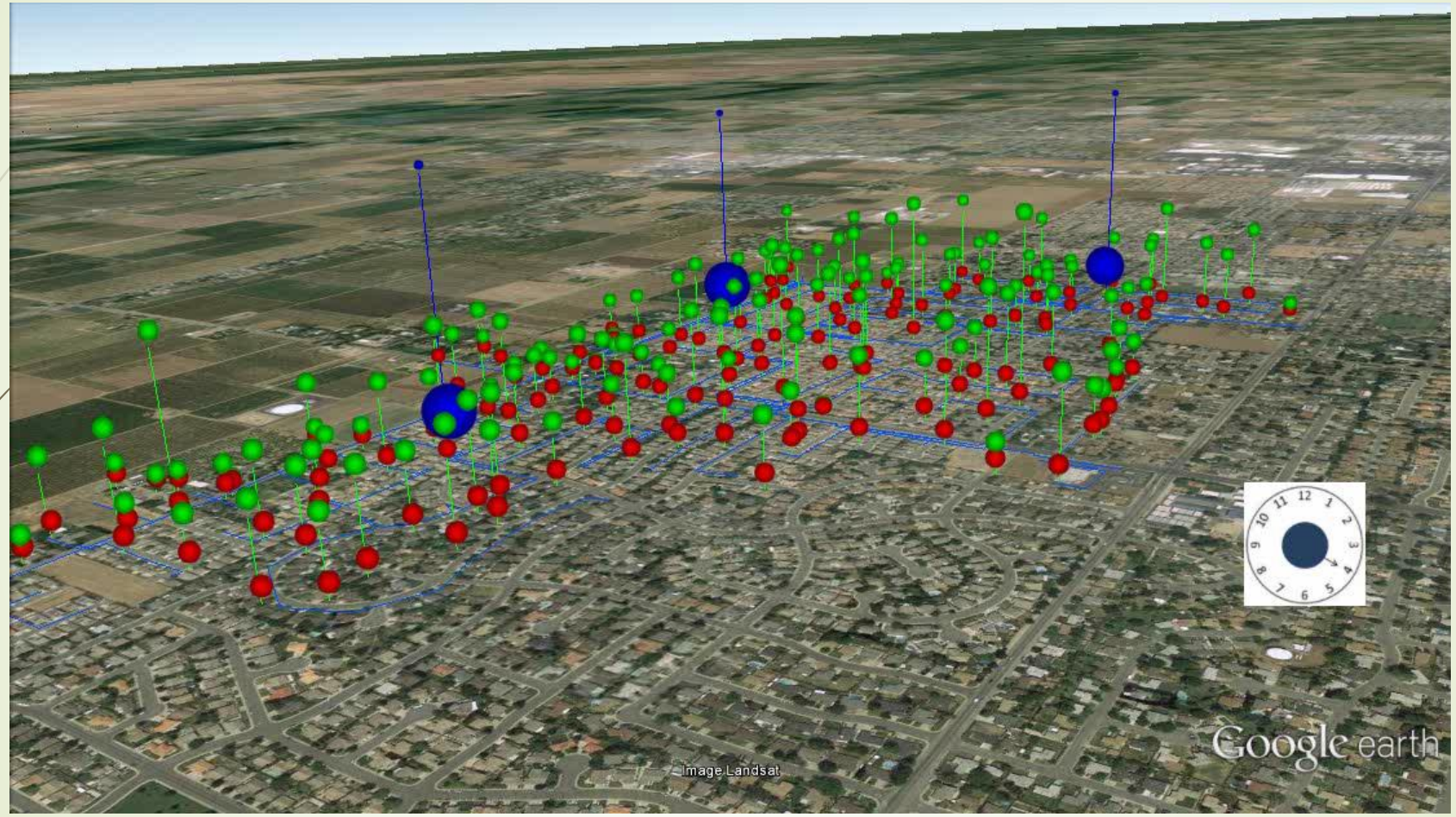
Viewed At The Transformer Level



Bumps intentional to limit the extent that AC units are started/stopped, and to optimize on customer marginal costs, not just on load alone.

Six transformers, 30 homes, displaying normal volatility in load prior to IDROP vs. after optimizations are operational.

Use Loads+Battery Storage @ Customer Level



Blue = Battery Charging
Yellow = Fed to Grid

Rough Breakdown of 2x to 5x Greater Value

- Increased granularity alone can add 1x (100%) – CA's 16 average load shapes (in CE calculator) limit data, compared to 576 custom load shapes plus…
- Customer targeting with grid constraints (load-flow) can add another 1x to 2x (100% - 200%) to benefits
- Covariance of weather and loads, much less prices, nets another .6x (60%) just for DR (see NEV showing)
- Distributed optimization of grid and customer benefits can add another 1x to 2x (100% - 200%) + to benefits

Summary: Execute on LNBA (and ICA)

- Get beyond ICA to execute on LNBA – maximize value and hosting with LNBA
- Four steps – customer targeting, DER packages at locations, covariance (weather loads-prices), and distributed optimization
- Use DMCs to enable tradeoffs, transparency, and achieve 2x to 5x greater value
- Engage at the platform level across all resources (the previous silos)

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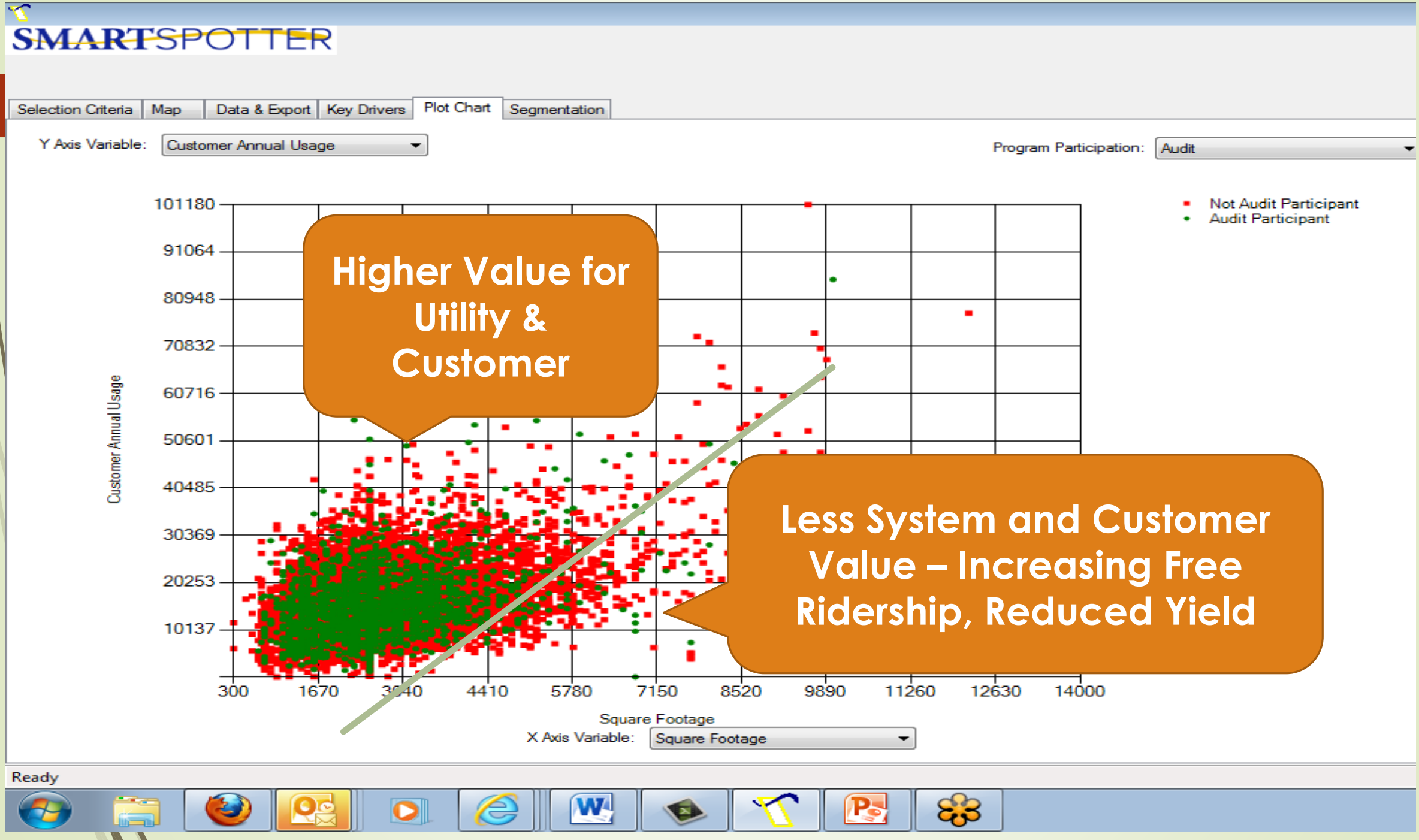
Appendix

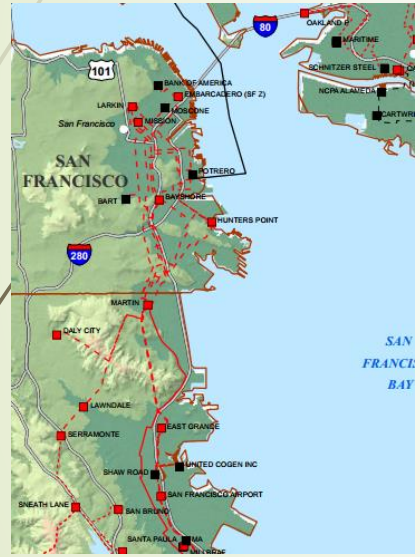
1) Customer targeting & Consumer Engagement

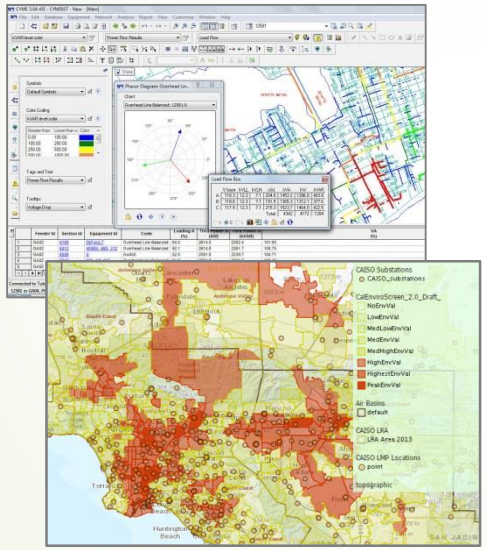
- To maximize consumer uptake requires:
  - Smarter targeting: value, not volume, use of interval and "big data"
    - If customers are given the right messages in the right sequence at the right time, they will engage more
  - Higher-quality engagement: coordination of marketing, technologies & programs; proper sequencing of touch points; and use of incentives/financing
  - Building relationships: consistent performance and customer value with technology & programs

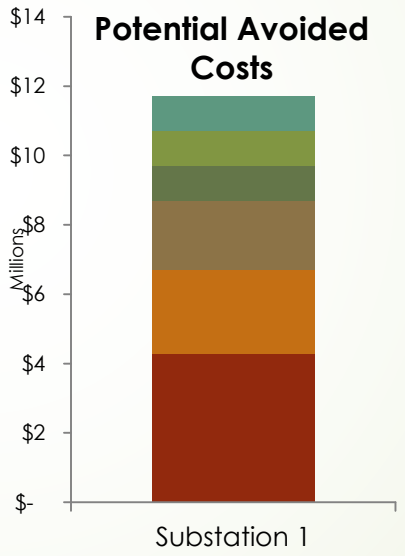

SMARTSPOTTER
Selection Criteria
Map
Data & Export
Key Drivers
Plot Chart
Segmentation
Y Axis Variable:
Customer Annual Usage
Program Participation:
Audit
Not Audit Participant
Audit Participant
101180
91064
80948
70832
60716
50601
40485
30369
20253
10137
Customer Annual Usage
300
1670
3040
4410
5780
7150
8520
9890
11260
12630
14000
Square Footage
X Axis Variable:
Square Footage
Higher Value for Utility & Customer
Less System and Customer Value – Increasing Free Ridership, Reduced Yield
Ready

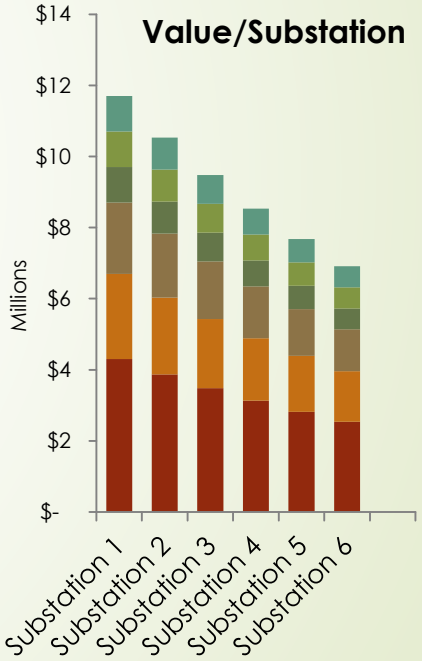
2nd Step – Distribution Resource Plan Analysis*

Identify DPA & Substations → **Perform Planning Analyses** → **Calculate Value (Benefits & Avoided Costs)** → **Rank Substations & Feeders by Value**







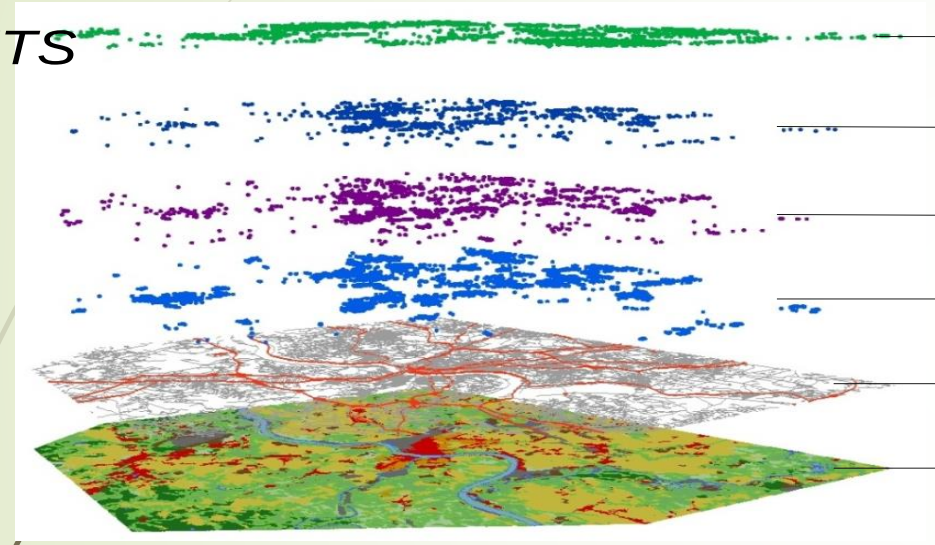


* From *More Than Smart Working Group* discussion, 7 January 2015, San Francisco, CA

Map Layer Hierarchy

LOADSEER
Spatial Electric Expansion & Risk

INPUTS



Customer Locations / Per Capita Growth

Demand Side Management / Load Control

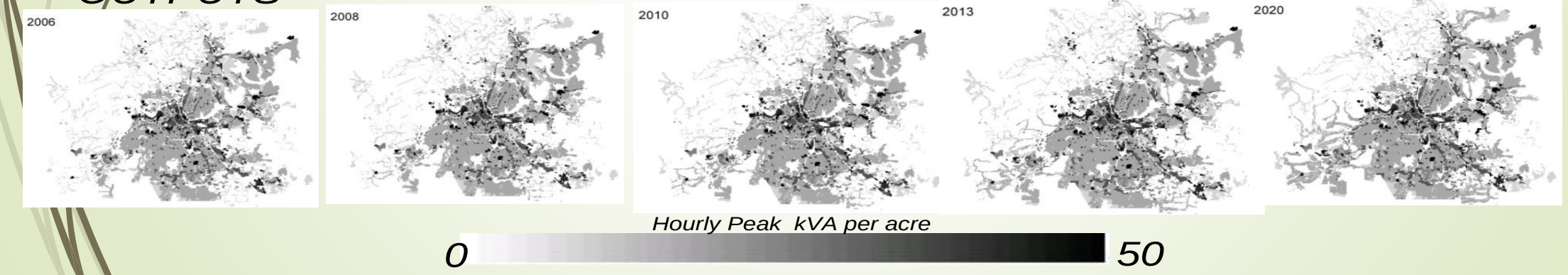
Optimal Solar Power Sites

Plug-in Electric Vehicle Penetration

Transportation

Future Land Use

OUTPUTS

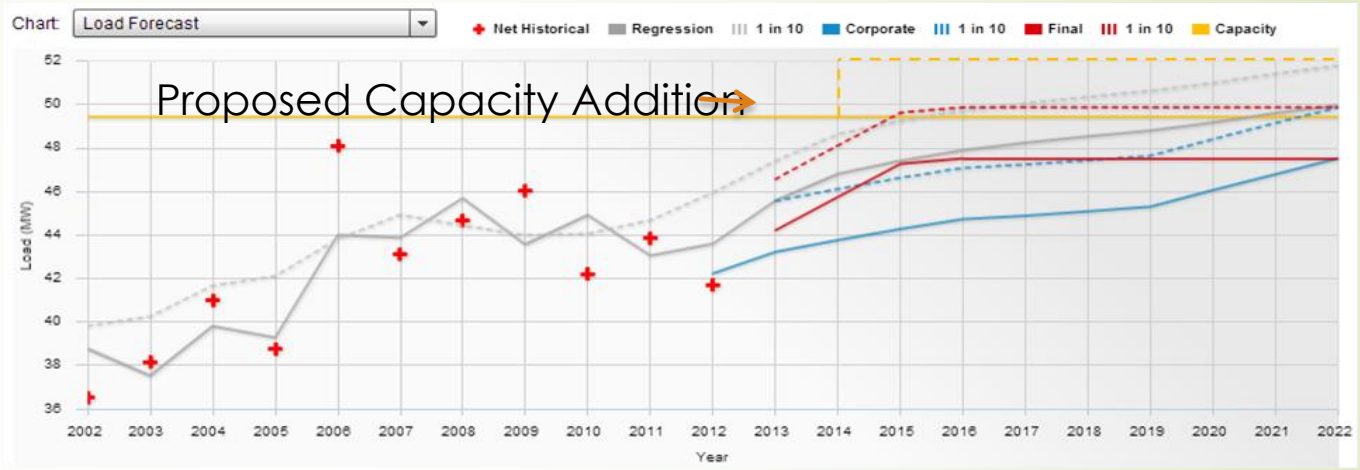


Candidate Deferral w/ Plan

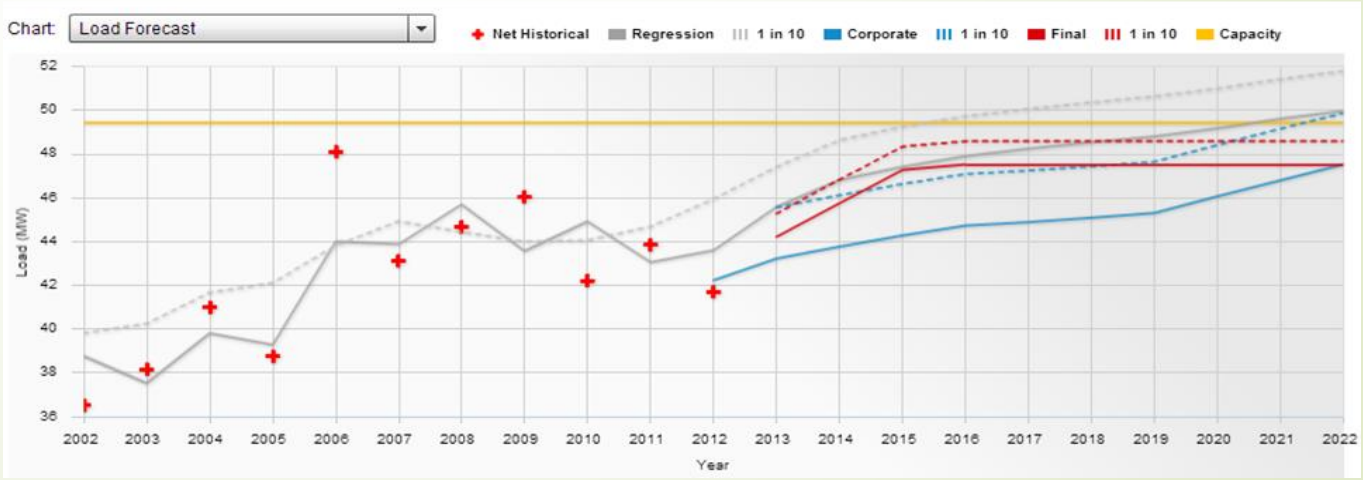
Investment	Annual Cost
$4,700,000.00	$ 427,375.27
DSM Savings Requirement	**Avoided Cost**
1952 kW	$ 218.94

- This example of an actual proposed capacity addition (dotted yellow line), due to the projected 1-in-10 peak demand (dotted red line).
- In order to defer this substation capacity addition, there must be a demand reduction of 1,952 kW on summer peak (lower dotted red line)

Planned Capacity Addition



Demand Reduction & Project Deferral



3) Covariance & Option Value

- An optimal portfolio is dependent on accurately pricing of avoided capacity and avoided energy benefits.

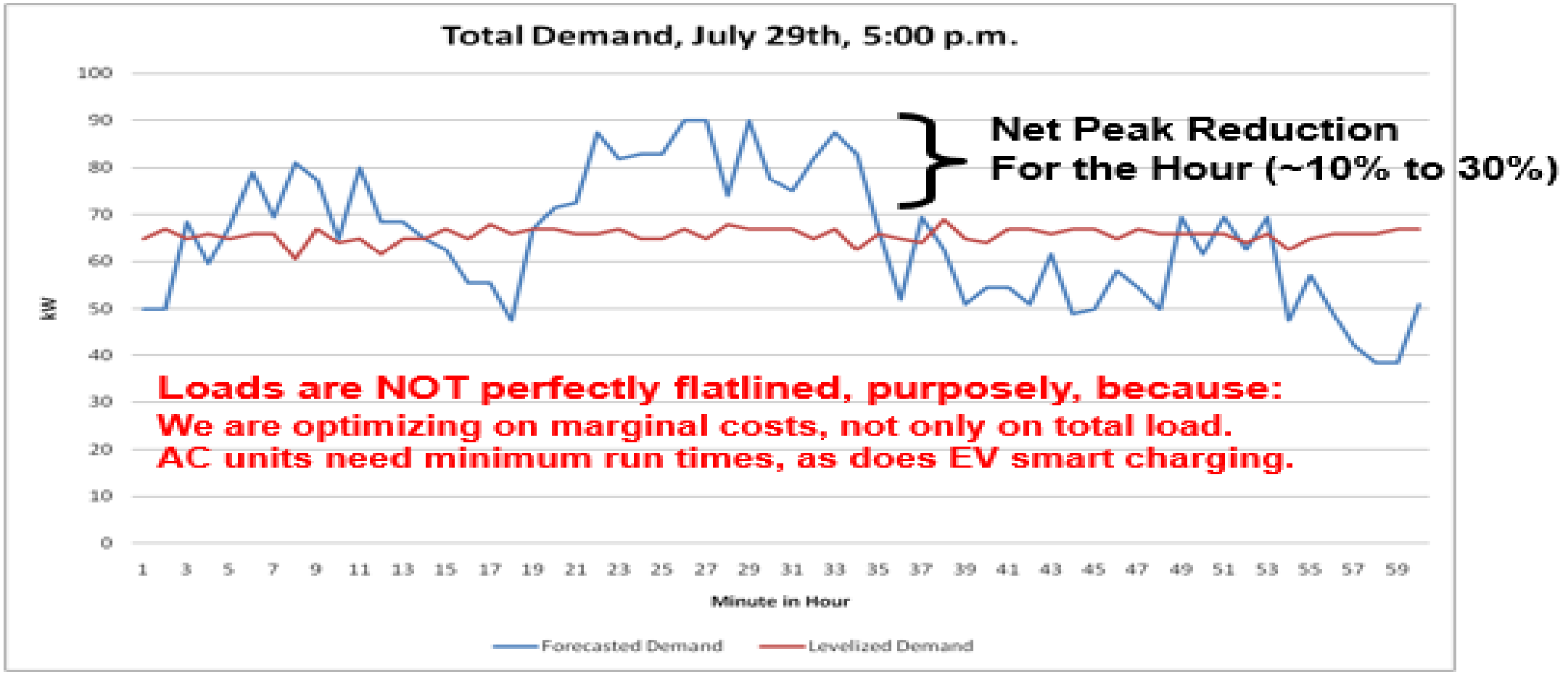
- Traditional linear models use approximations (e.g. average savings, energy price, capacity price, etc.,.).
  - Assume impact of uncertainty (weather, asset performance, etc.,.) is normally distributed.
  - But individually, variables such as prices, loads, weather, and contingencies have stochastic (non-deterministic) characteristics.
  - When considering the impact of multiple non-deterministic variables, even more stochastic attributes arise.

Capture interactive effects

- GridWise Architecture Council introduced its first "Transactive Energy Framework“:
  - Transactive energy (TE) is the use of economic signals to coordinate devices throughout the power grid
- Auto DR - For Example, IA IDROP, Instead of reacting to energy constraints, IDROP proactively predicts load, choreographs demands and shapes loads, all in real time
- Although fundamental models tell part of the story, valuing transactive interactive effects requires sophisticated Financial Engineering Models

Optimize Energy AND demand

Typical Results: From Pilot Testing



New Methodology Consistent with Old SPM Tests for Cost-effectiveness

- Standard Practice Manual (SPM) Tests
  - "Since 1983" – principally the Total Resource Cost (TRC)

1. "Participant Test" – customer targeting
2. "Utility Test" -- grid (revenue) impacts @ locations
3. "All Ratepayers" (TRC) – define the covariance, hedge/insurance/option value
4. "Societal Test" to optimize for the utility and all ratepayers

All four of these steps harness greater granularity

Summary of Four-Step Modeling

Using Best Practices Tools (and SPM) for DSM integration and Optimization

- *Step 1 – Customer targeting and consumer engagement*
- *Step 2 – T&D assessment and targeting of IDSM resources*
- *Step 3 – Option valuation & portfolio covariance assessment*
- *Step 4 – Optimization of measures and portfolio energy/capacity*

Fully achieve DSM integration and portfolio optimization

- Use consumer engagement gateway with “big data” to achieve targeting
- Overlay on distribution and transmission load-flows the DSM impacts
- Capture multivariate benefits and option value
- Alter load shapes, chronograph virtual power plant -- maximize portfolio benefits