Maximizing the Utility Value of Distributed Energy Resources

INTEGRAL ANALYTICS
COMPANY PROFILE

Software Users:

200+

Software Tools:

18

- Market leader in Grid & Supply Analytics for Planning, Operations, Demand-Side Management, Storage and DER Valuation, Integration and Optimization
- Products deliver **granular, actionable intelligence** to utility distribution management, energy, resources and financial value
- Software users span utilities, integrators, consultants & regulators
- Bench depth of PhDs and programmers with deep energy expertise
- Patented architecture and methodology, based on least cost principles
- Scalable platform integrates requirements of emerging system regulations in California, New York, Massachusetts, and others

Customers Include:

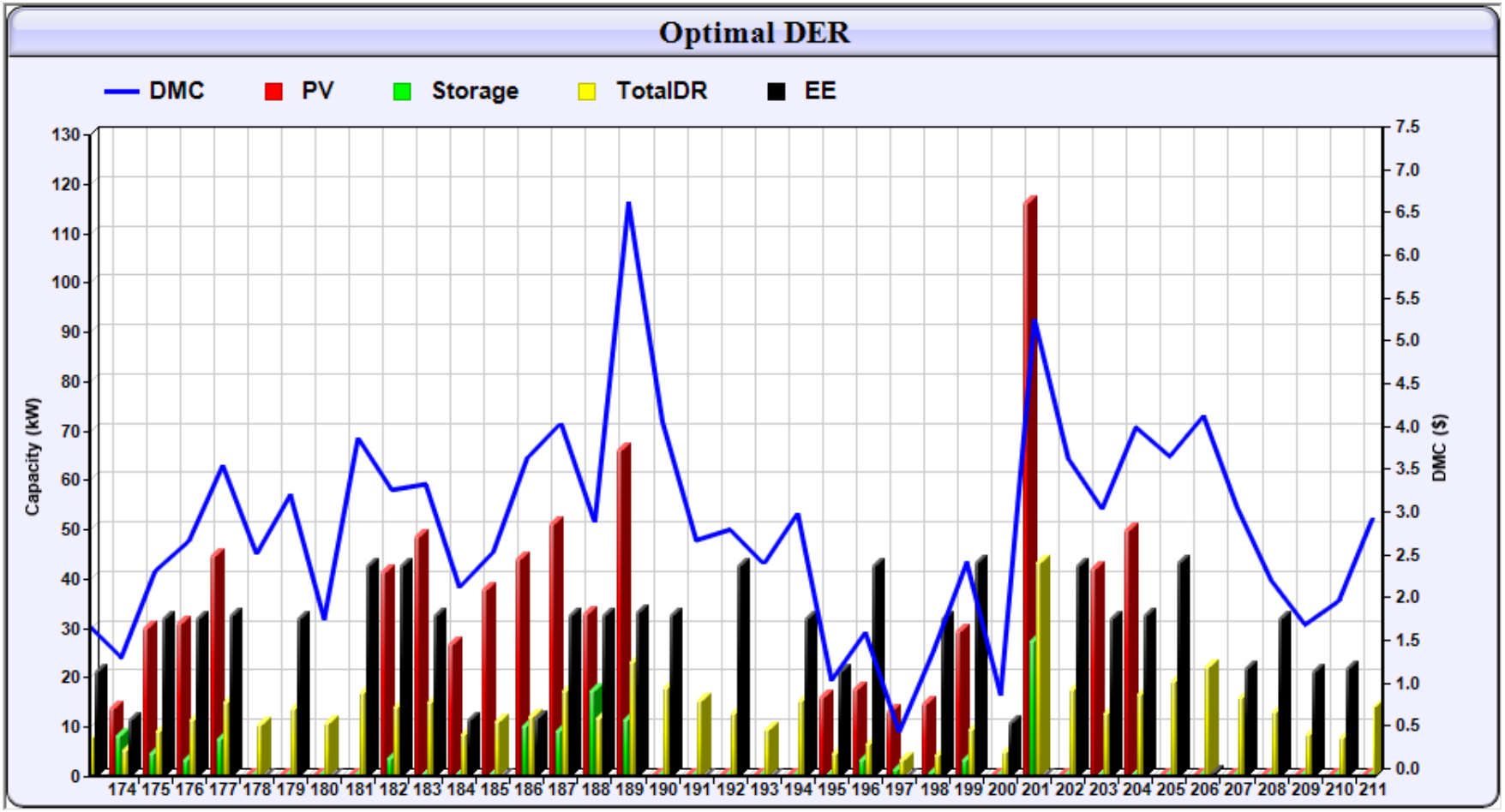
DUKE ENERGY, KCP&L, SOUTHERN CALIFORNIA EDISON, NES, PG&E, DTE Energy, FORTIS BC, Seattle City Light, AVISTA, AEP, Xcel Energy

Smart Grid Data Analytics Global Market: $760 million in 2012 to $4.3 billion in 2020*

*Navigant Consulting Q4 2013

INTEGRAL ANALYTICS

LOCATION MATTERS



GRANULARITY INCREASES BENEFITS

Granular Analysis	**$**	**1,696,177**
Traditional Analysis	**$**	**298,355**
% Difference		**469%**

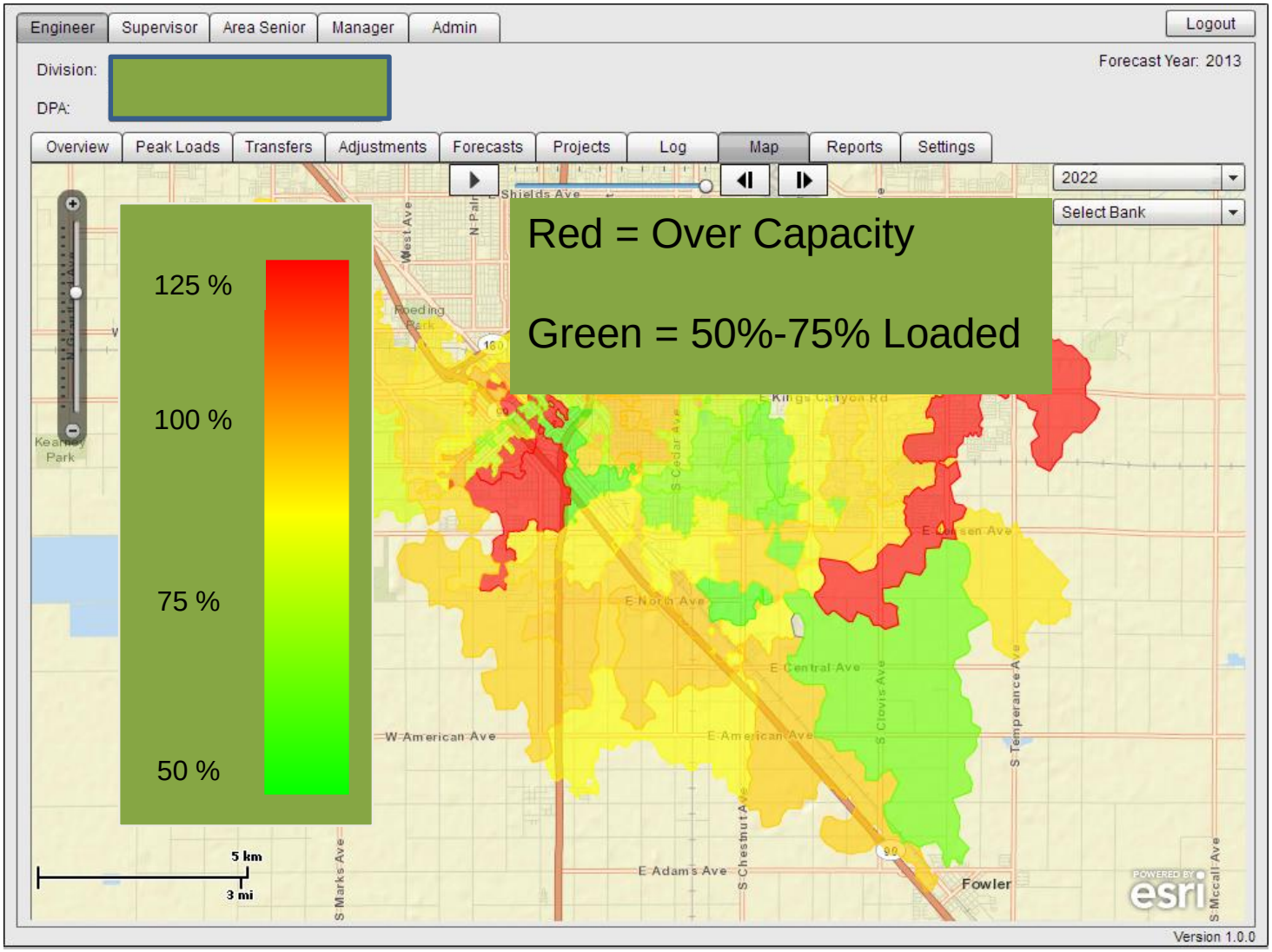
Traditional Analysis undervalues due to:

- Ignoring multiple year weather/ micro climates
- Not addressing changing peak coincidence over time
- Under-valuing the covariance between price and load
- Ignoring forward price uncertainty
- Not forecasting circuit peak loads
- Over-averaging avoided T&D
- Ignoring the customer specific capacity cost to serve
- Ignoring avoided costs between the substation and the customer location
- Targeting which ignores free ridership potential

COST TO SERVE AT GRID EDGE

	Grid Side	Supply Side
Variable Costs	Voltage KVAR Power Factor Line Losses Limiting Factors	Ancillary Services Plant Following Wind/ Cloud Firming Current hour LMP
+		
Fixed Costs / Capacity	Asset Protection Circuit Capacity Deferral Bank Capacity Deferral Future Congestion (Trans)	Capacity Premium 10 Year LMP Forecasts Future Covariance

WHERE WILL GRID BE CONSTRAINED?



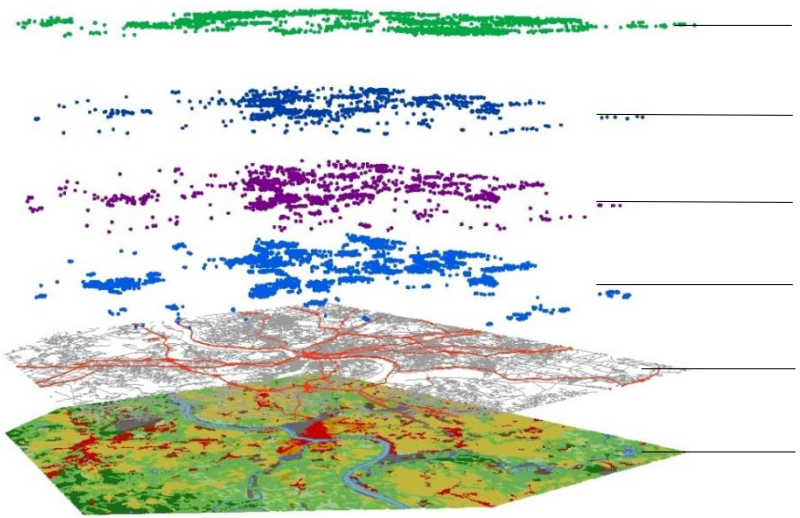
LONG-TERM FORECAST

Triangulate with 3 long-term forecasts approaches

1. Spatial Forecast
   - 30 years of satellite data into GIS
   - historical growth,
   - regression modeling on known patterns of past growth,
   - multiplier effects across industries.
2. Corporate Forecast allocated by MWh
   - Using customer billing data or equivalent
   - Econometric forecast for up to 100 variables, 20 weather variables,
   - Adjusted via circuit load factor, post hoc.
3. Circuit Peak Load Forecast
   - Based on historic peaks
   - Regression analysis using potentially 100 economic variables and 20 weather variables
   - Modelled over 30 weather years

SPATIAL LOAD FORECASTS

INPUTS



Customer Locations / Per Capita Growth

Demand Side Management / Load Control

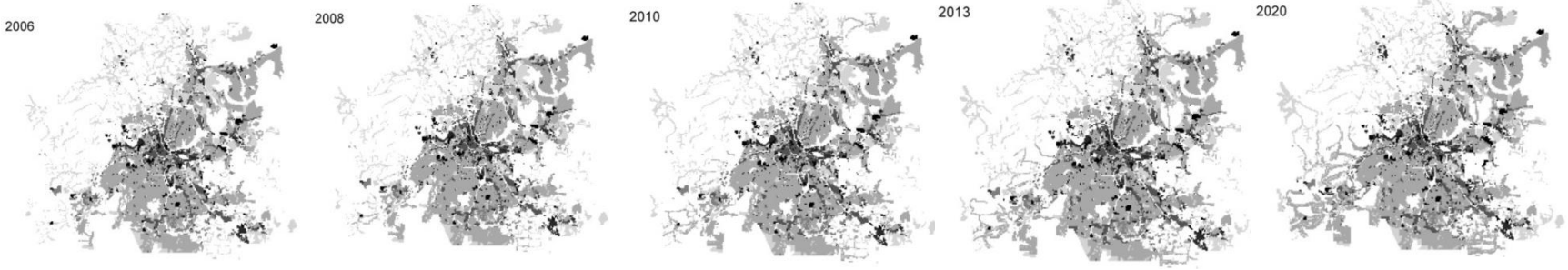
Optimal Solar/Storage Sites

Plug-in Electric Vehicle Penetration

Transportation Infrastructure

Future Land Use/Econometric Growth

OUTPUTS



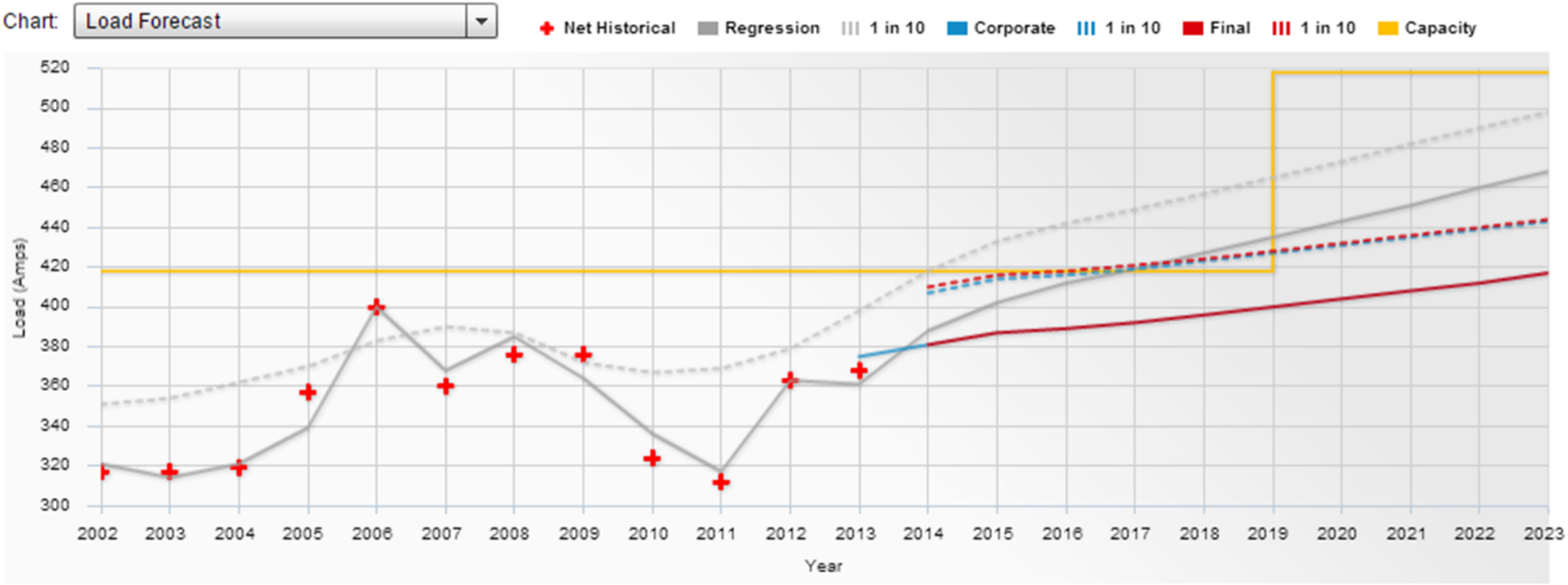
Edit Forecast: Franklin / Canyon Substation A / 8671112

Forecast for: 8671112

Before Projects | After Projects

Model | Results

Chart: Load Forecast



	2014	2015	2016
Projected load (Amps)	410	416	418
Surplus / Deficiency (Amps)	8	2	0
Percent loaded	98%	100%	100%

Regression
Adjusted R Square: 0.88 (High)

Corporate
Spatial Growth: 0.79 (High)
Adjusted R Square: 0.9 (High)

Regression coefficients:

Variable	Coefficient
3-Day Weighted-Avg High Temperature	0.202533
Income: Total Personal, (Mil. $)	0.000229
Employment: Service Sector/Full or Part Ti	0.022601

Blend

Final forecast: 100% Corporate, 0% Regression
Recommended: 49% Corporate, 51% Regression

OK | Cancel

Engineer | Area Senior | Admin | Logout

Edit Forecast: Franklin / Canyon Substation A / 8671112 ×

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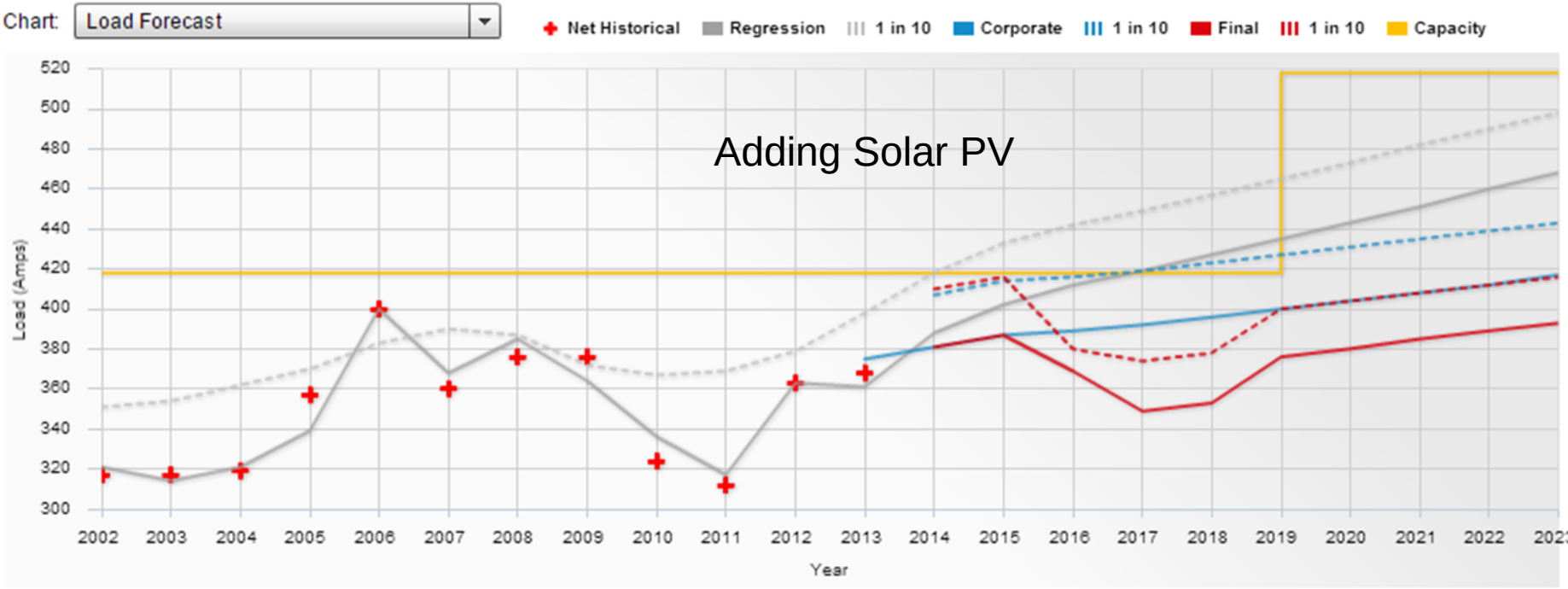

	2014	2015	2016
Projected load (Amps)	410	416	380
Surplus / Deficiency (Amps)	8	2	38
Percent loaded	98%	100%	91%

Regression
Adjusted R Square: 0.88 (High)

Corporate
Spatial Growth: 0.79 (High)
Adjusted R Square: 0.9 (High)

Regression coefficients:

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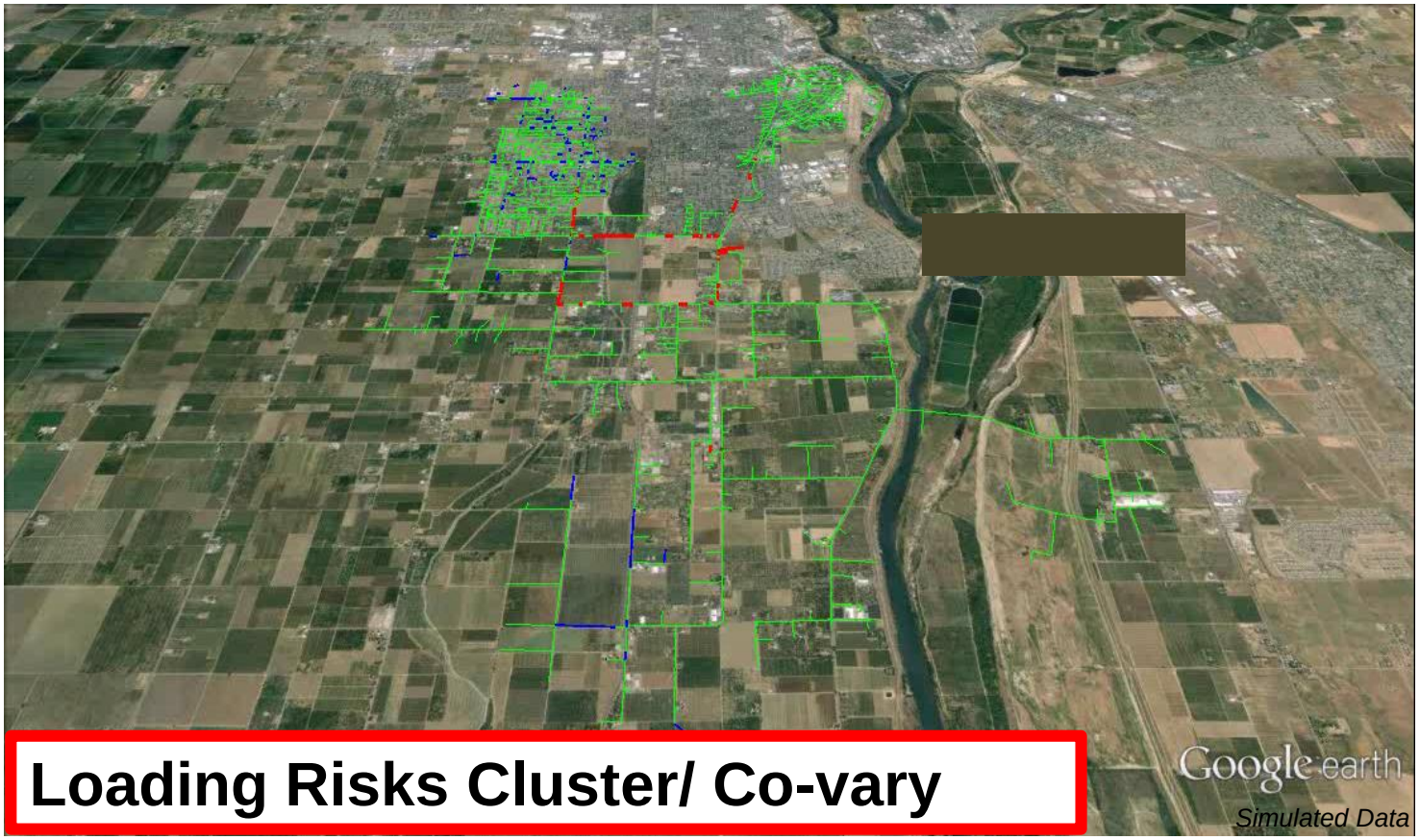
OK | Cancel

LIMITING FACTORS: GRID CONSTRAINTS POWERFLOW LEADS DER OPTIMIZATION



@ Service Transformer

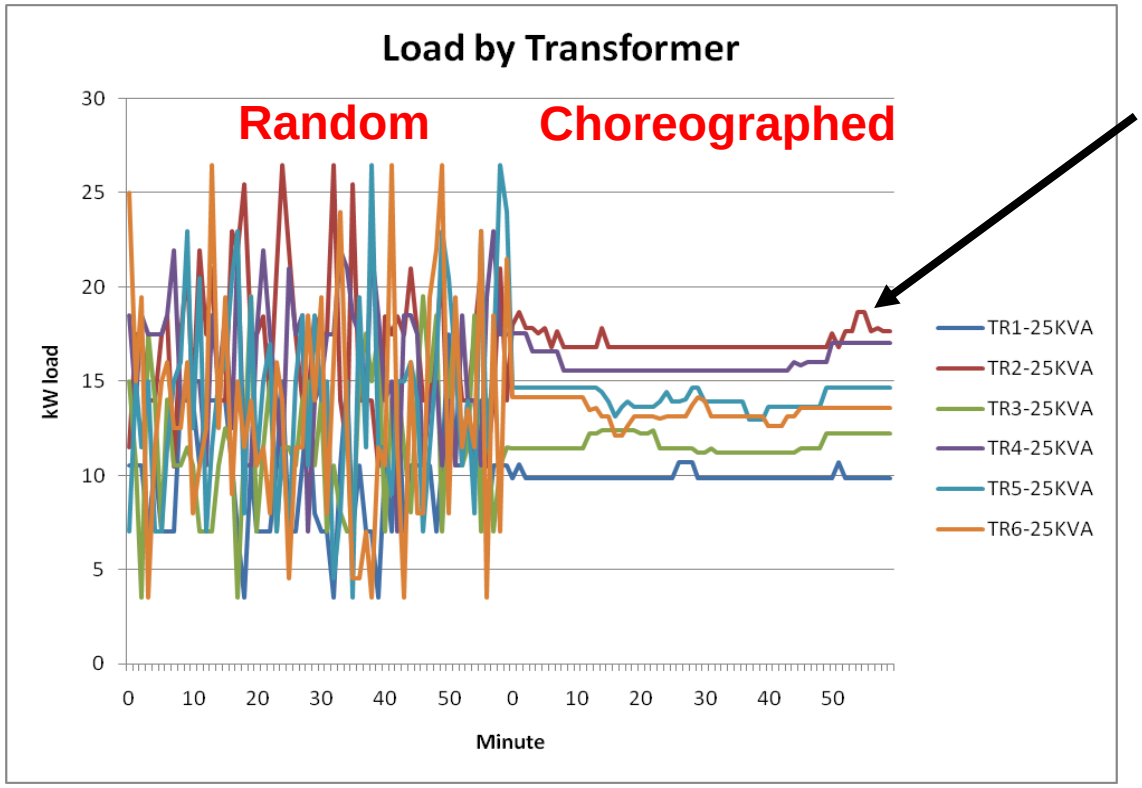
Blue < 116V

Red = Overloaded

CHOREOGRAPHY OF DERS

Voltage Improves, Asset Protected

IA only needs 25%-40% customer participation to levelize load, which saves utility money and does not force customers to participate.

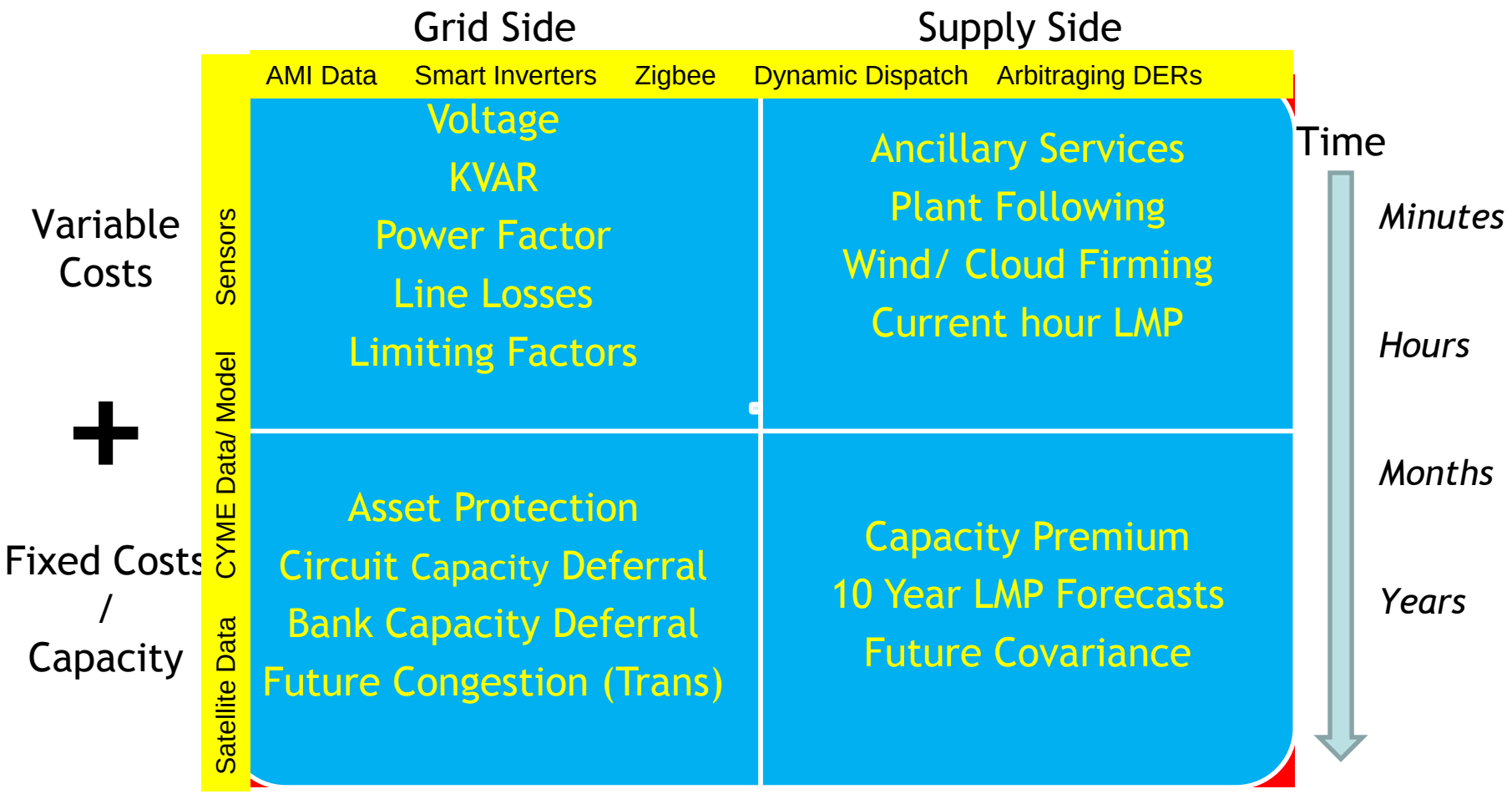


Bumps intentional to limit the extent that AC units are started/stopped, and to optimize on customer marginal costs, not just on load alone.

Loads are flat enough to observe improved voltages and protects the service transformer

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

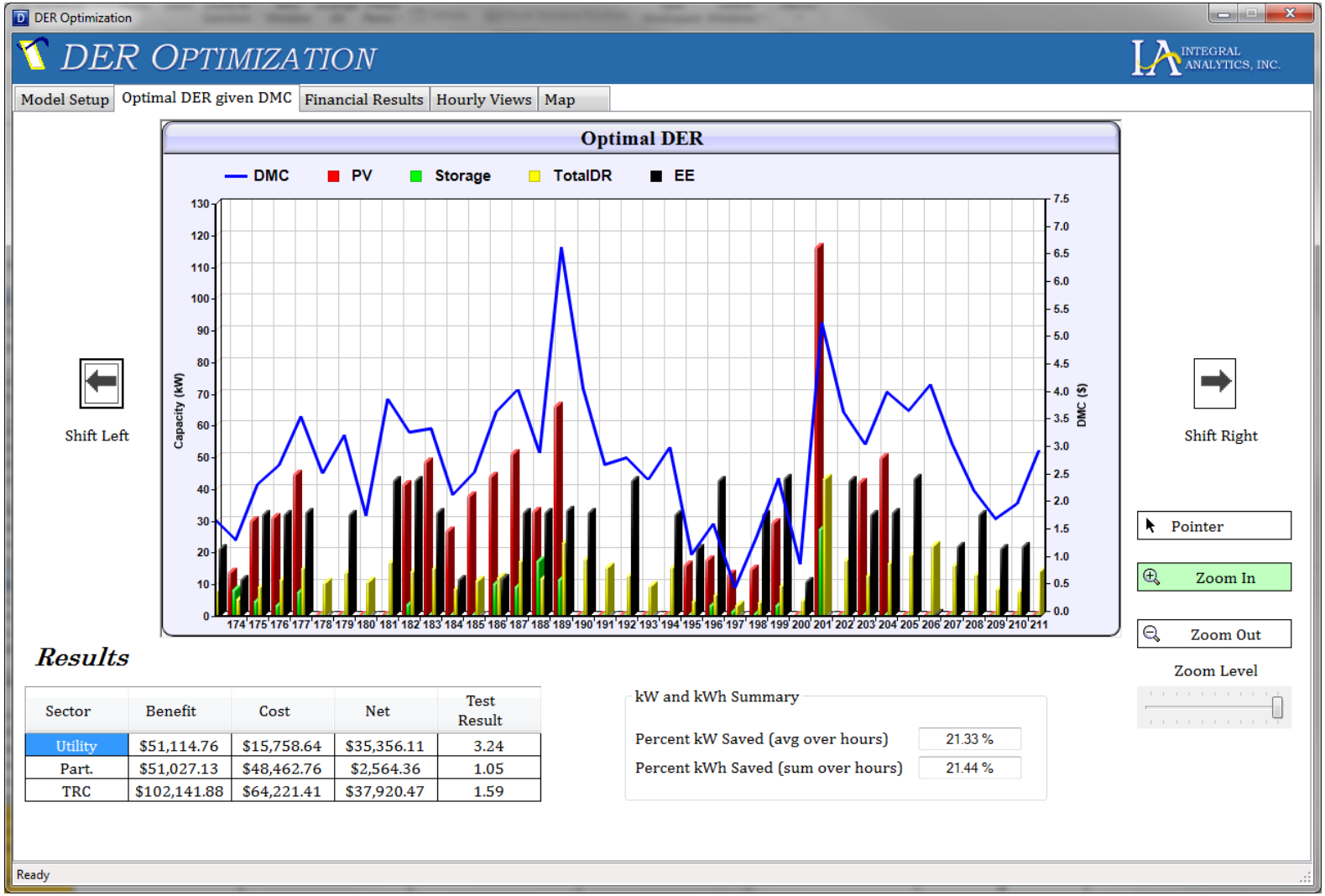
DISTRIBUTED MARGINAL COSTS (DMC)



DMC is the actual Cost to Serve, and can be used in non ISO markets as well.

LOCATIONS CLOSELY CORRELATE TO DISTRIBUTED MARGINAL COST

DAILY DMC ($$ COSTS AVOIDED) DRIVE LOCATION/MAGNITUDE



LESSONS LEARNED IN CA

- Reliability is goal one
- Hosting maps are needed to streamline PV/DER interconnection
  - Requires 10 year nodal forecasts
  - Proportionally spreading load change doesn't work
- Each utility has different operational needs, so policies/methods differ.
- Multiple forecasts required to mitigate risk
  - Minimum day shapes
  - Monthly net shape migration.
- 10 year forecasts and DER hosting technical limits are paramount
  - Need these before discussing market signals.

DER REQUIRE GRANULAR ANALYSIS

1. Determine capacity deferral value by location
2. Quantify power flow benefits/risks of DER
3. Capture variable supply side benefits like supply following
4. Forecast circuit peak loads
5. Avoid over-averaging avoided T&D
6. Calculate the customer specific capacity cost to serve
7. Capture avoided costs between the substation and the customer location

Need Granular analysis to capture FULL benefits of DER at the edge of the grid.

CONTACT INFORMATION

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