

# Integrated Grid Planning Symposium

“State of IGP Technology”

November 16, 2017



# Integrated Grid Planning: The “Must-Haves”

Capability	Conventional Wisdom	Status	Where?
<b>Nodal, 8760 Load Forecasting with Powerflow</b>	Data transfer and quality prohibitive	Commercially delivered	PG&E, CPS Energy, SDG&E, Seattle City Light, others
<b>Batch-Driven ICA</b>	Too computationally-intensive	Refining process at scale	PG&E
<b>Embedded DER Penetration Impact</b>	Hard to reconcile corporate fcst to feeder level	Commercially delivered	PG&E, SCE, CPS, Hawaiian Electric (2018)
<b>DER Avoided Cost Project Value/Optimization</b>	Locational value measurement	2018 Delivery	Hawaiian Electric, PG&E, Seattle, CPS
<b>Dynamic Data and Network Topology Refresh</b>	System Integration and Data Management Challenge	Commercially scaling	Nashville Electric, PG&E, FortisBC, Hawaiian Electric (2018)

# Attributes of Future-Proof Grid Planning

1. Scale Architecture: Expect “Billions of Rows”
2. It’s an 8760, Meter-Level World
3. Scenario Engine at the Core
4. Must Support Many Stakeholders:
  - Transmission/Distribution/Ops/Fuels
  - Corporate Forecasting
  - Regulators
  - Market Participants
5. Bottom-Up = Top-Down
6. Economic Meets Engineering Meets Social

# First, A Foundation: Geospatial Load and DER Growth



# Scenario Engine: Adjustment Portfolios

The screenshot displays the LoadSEER-GIS application window. The main map shows an aerial view of a residential area with several orange solar panel icons. A central yellow hexagon is labeled "Conn:5 Load:50".

**Configuration Panel (Left):**

- CUSTOMER CLASS:** PV (User Confidence: 70)
- HORIZON TIME:** Short Term: 3 - 5 years (User Confidence: 70)
- LOAD ESTIMATE:** LOW, MEDIUM, HIGH (User Confidence: 70). Load Per Connection (kW): 10
- CONNECTIONS:** LOW, MEDIUM, HIGH (User Confidence: 60). Number of New Connections: 5. Parcel Size Per Connection (Acres): 0.3288206208326740
- FEEDERS:** Each point its nearest feeder (radio button), All points the same feeder (radio button, selected). Feeder: GL01 (User Confidence: 50)
- COMMENTS:** Validated (checkbox), Known Adjustment (checkbox)
- Buttons:** SAVE, CANCEL

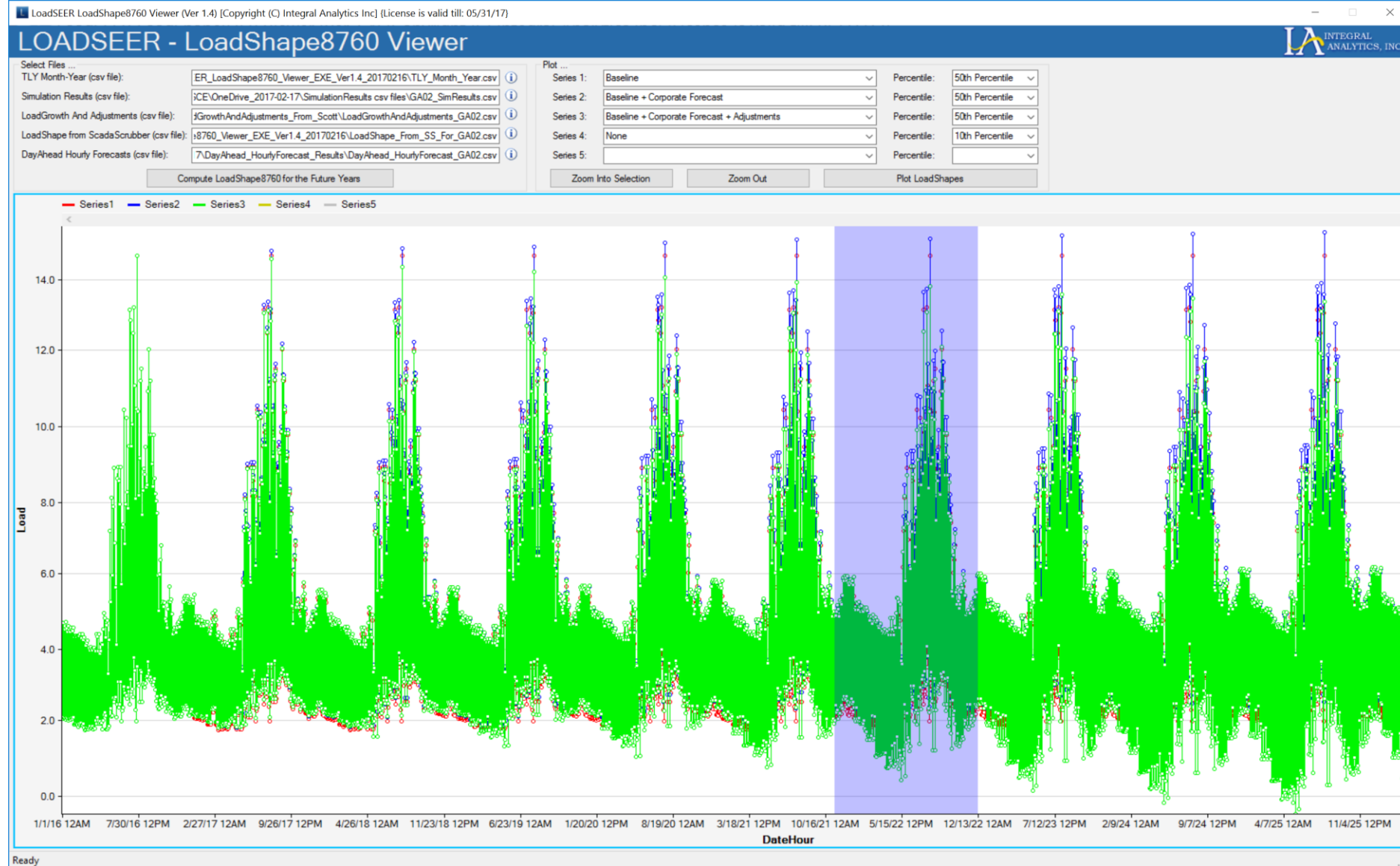
**LoadSEER Scenario Probability Gauge (Right):**

The gauge shows a probability range of 41 - 51%. The needle is positioned between the 40 and 50 marks on the scale. The gauge is color-coded: green (0-30), yellow (30-60), and red (60-100).

**Map Coordinates:** Lat: -94.805018, Long: 29.291634. **Map Scale:** 1 : 1,328.74

**Powered by:** esri

# 8760 Frequency and Duration of Load: Circuit Granularity



# Nodal Value of DER...Integrated to Planning

**LOADSEER** English (US) [Settings] [Refresh]

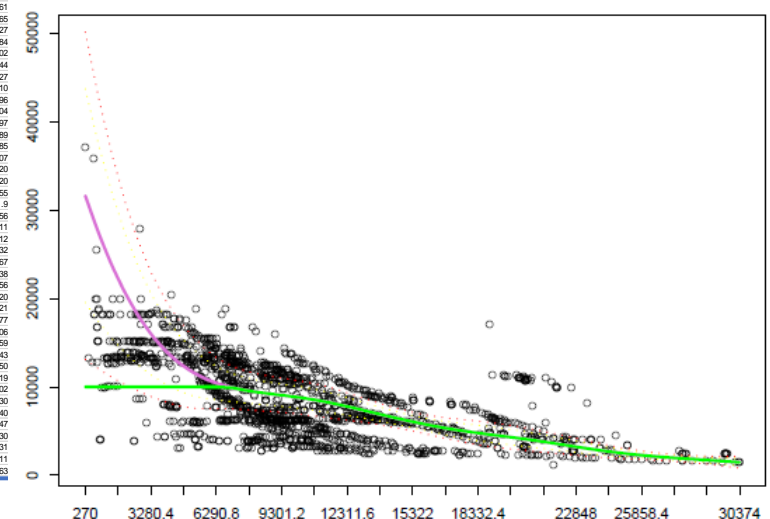
Node Viewer

Node Financials Zoomlevel: 14 active Layer:

	Solar	HVAC	Lighting	Total
<b>Avoided Capacity Cost (\$Kw):</b>	2,094,950	2,254,595	2,512	4,352,057
<b>Avoided Energy Cost (\$Kwh):</b>	937,762	857,790	26,830	1,822,382
<b>Avoided Kwh (x yrs):</b>	1,578,374	1,411,724	41,235	3,031,333
<b>Avoided T&amp;D (\$):</b>	411,843	666,980	1,224	1,080,047
<b>Bill Savings (\$):</b>	7,133,133	7,232,972	157,677	14,523,782
<b>Participant Test (Avg):</b>	0.42	1.24	24.60	8.75
<b>Trc Test (Avg):</b>	0.53	1.70	29.07	10.43
<b>Adoption Probability (Avg):</b>	0.63	0.64	0.39	0.56

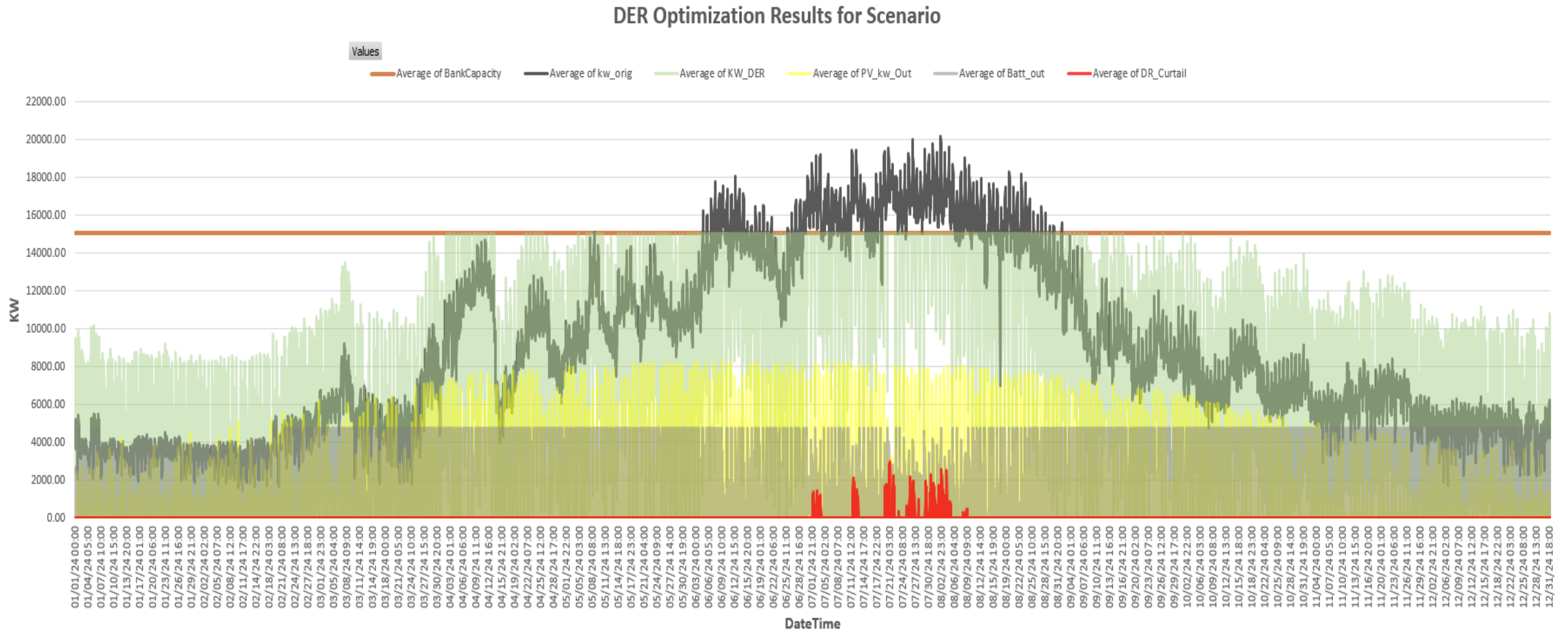
# Batch Integration Capacity Analysis (grid-constrained)

				2016 2016		2017 2017		2018 2018	
Object Type	Object Name	ID	Shape Name	MW	Limiting Hour	MW	Limiting Hour	MW	Limiting Hour
Dpa	Dpa_1	1	PV - Non-Tracking	67.477	Apr, Weekend/Holiday, 1 PM	61.265	Apr, Weekend/Holiday, 1 PM	58.022	Apr, Weekend/Holiday, 1 PM
Bank	Bank_2	2	PV - Non-Tracking	3.972	May, Weekend/Holiday, 12 PM	2.136	May, Weekend/Holiday, 12 PM	1.164	May, Weekend/Holiday, 12 PM
Feeder	Feeder_3	3	PV - Non-Tracking	1.252	Sep, Weekday, 1 PM	1.136	Sep, Weekday, 1 PM	1.063	Sep, Weekday, 1 PM
Feeder	Feeder_4	4	PV - Non-Tracking	1.134	May, Weekday, 12 PM	1.07	May, Weekday, 12 PM	1.058	May, Weekday, 12 PM
Feeder	Feeder_5	5	PV - Non-Tracking	0.616	Sep, Weekend/Holiday, 1 PM	0.504	Sep, Weekend/Holiday, 1 PM	0.41	Apr, Weekend/Holiday, 1 PM
Feeder	Feeder_6	6	PV - Non-Tracking	0.365	Sep, Weekend/Holiday, 1 PM	-0.155	Sep, Weekend/Holiday, 1 PM	-0.576	Sep, Weekend/Holiday, 1 PM
Feeder	Feeder_7	7	PV - Non-Tracking	-0.324	Apr, Weekend/Holiday, 1 PM	-0.681	Apr, Weekend/Holiday, 1 PM	-0.831	Apr, Weekend/Holiday, 1 PM
Feeder	Feeder_8	8	PV - Non-Tracking	0.613	May, Weekend/Holiday, 12 PM	-0.054	May, Weekend/Holiday, 12 PM	-0.261	May, Weekend/Holiday, 12 PM
Bank	Bank_9	9	PV - Non-Tracking	6.778	Apr, Weekday, 1 PM	5.735	Apr, Weekday, 1 PM	5.171	May, Weekday, 12 PM
Feeder	Feeder_10	10	PV - Non-Tracking	-0.594	Jun, Weekday, 1 PM	-0.819	Jun, Weekday, 1 PM	-0.966	Jun, Weekday, 1 PM
Feeder	Feeder_11	11	PV - Non-Tracking	1.699	Apr, Weekday, 1 PM	1.48	Apr, Weekday, 1 PM	1.403	Apr, Weekday, 1 PM
Feeder	Feeder_12	12	PV - Non-Tracking	1.316	Apr, Weekend/Holiday, 1 PM	1.299	Apr, Weekend/Holiday, 1 PM	1.333	May, Weekend/Holiday, 1 PM
Feeder	Feeder_13	13	PV - Non-Tracking	1.626	May, Weekday, 12 PM	1.453	May, Weekday, 12 PM	1.397	May, Weekday, 12 PM
Feeder	Feeder_14	14	PV - Non-Tracking	1.102	May, Weekday, 12 PM	1.003	May, Weekday, 12 PM	0.918	May, Weekday, 12 PM
Feeder	Feeder_15	15	PV - Non-Tracking	0.12	Sep, Weekend/Holiday, 2 PM	-0.127	Sep, Weekend/Holiday, 2 PM	-0.244	Sep, Weekend/Holiday, 2 PM
Feeder	Feeder_16	16	PV - Non-Tracking	1.079	May, Weekday, 1 PM	1.008	May, Weekday, 1 PM	0.899	May, Weekday, 1 PM
Bank	Bank_17	17	PV - Non-Tracking	7.44	May, Weekend/Holiday, 12 PM	6.866	May, Weekend/Holiday, 12 PM	6.428	May, Weekend/Holiday, 12 PM
Feeder	Feeder_18	18	PV - Non-Tracking	1.414	Apr, Weekend/Holiday, 1 PM	1.364	Apr, Weekend/Holiday, 1 PM	1.289	Apr, Weekend/Holiday, 1 PM
Feeder	Feeder_19	19	PV - Non-Tracking	1.716	Apr, Weekend/Holiday, 1 PM	1.657	Apr, Weekend/Holiday, 1 PM	1.609	Apr, Weekend/Holiday, 1 PM
Feeder	Feeder_20	20	PV - Non-Tracking	1.948	May, Weekend/Holiday, 12 PM	1.968	May, Weekend/Holiday, 12 PM	1.997	May, Weekend/Holiday, 12 PM
Feeder	Feeder_21	21	PV - Non-Tracking	1.382	Sep, Weekday, 12 PM	1.274	Sep, Weekday, 12 PM	1.181	Sep, Weekday, 12 PM
Feeder	Feeder_22	22	PV - Non-Tracking	0.669	Apr, Weekend/Holiday, 1 PM	0.497	Apr, Weekend/Holiday, 1 PM	0.405	Apr, Weekend/Holiday, 1 PM
Feeder	Feeder_23	23	PV - Non-Tracking	0.055	Apr, Weekend/Holiday, 1 PM	-0.171	Apr, Weekend/Holiday, 1 PM	-0.319	Apr, Weekend/Holiday, 1 PM
Bank	Bank_24	24	PV - Non-Tracking	7.19	May, Weekend/Holiday, 12 PM	7.058	May, Weekend/Holiday, 12 PM	7.666	May, Weekend/Holiday, 12 PM



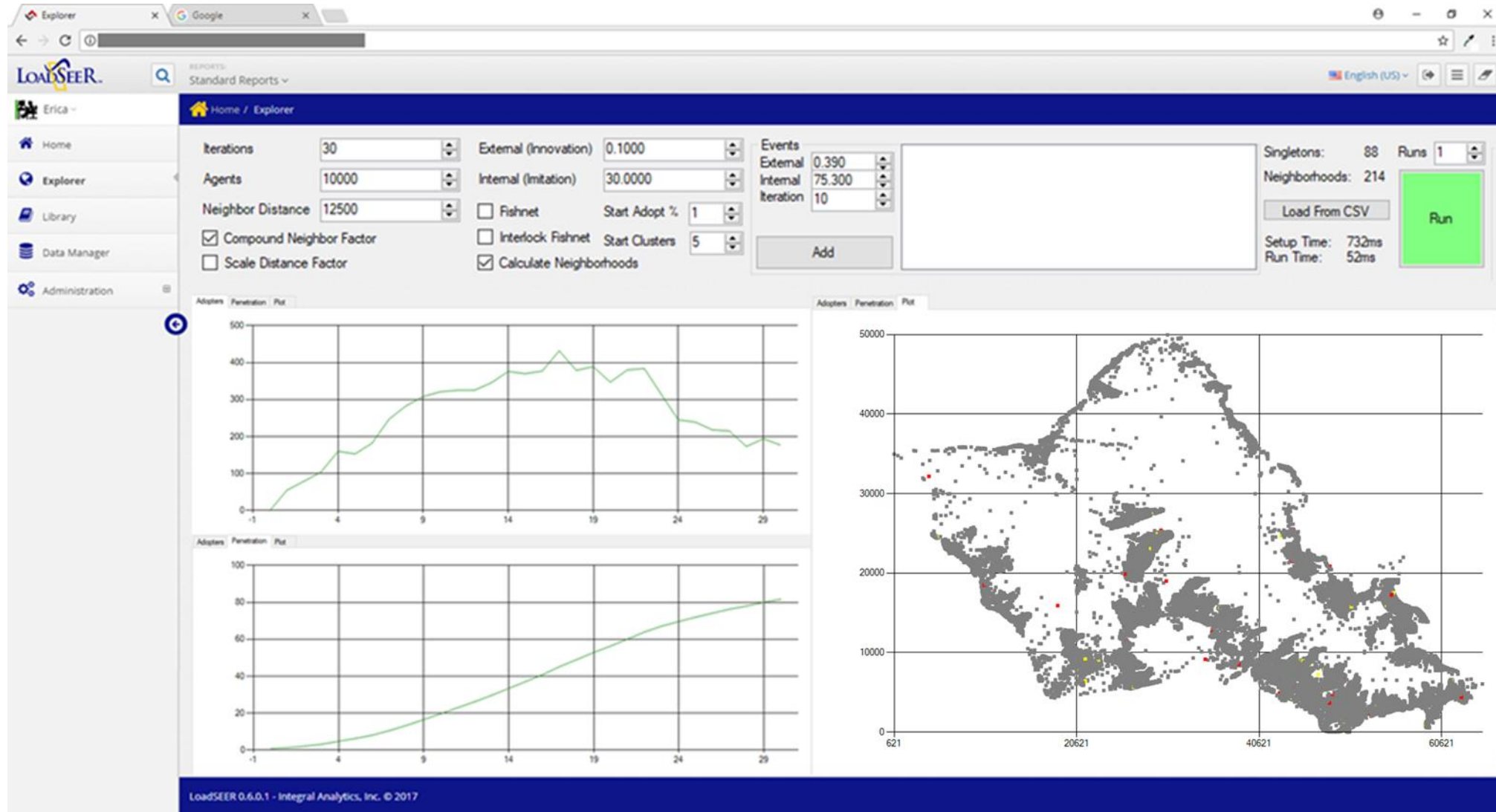


# Circuit DER Optimization: Least Cost Meets Grid Needs



- Solving for grid integrity constraints **and** least-cost/economic optimization, simultaneously

# Electric Vehicles on Oahu: Agent-Based Modeling



# Electric Vehicles on Oahu: Agent-Based Modeling (Year 5)

The screenshot displays the LoadSEER software interface. The top navigation bar includes 'Home / Explorer'. The left sidebar contains 'Home', 'Explorer', 'Library', 'Data Manager', and 'Administration'. The main control panel includes the following settings:

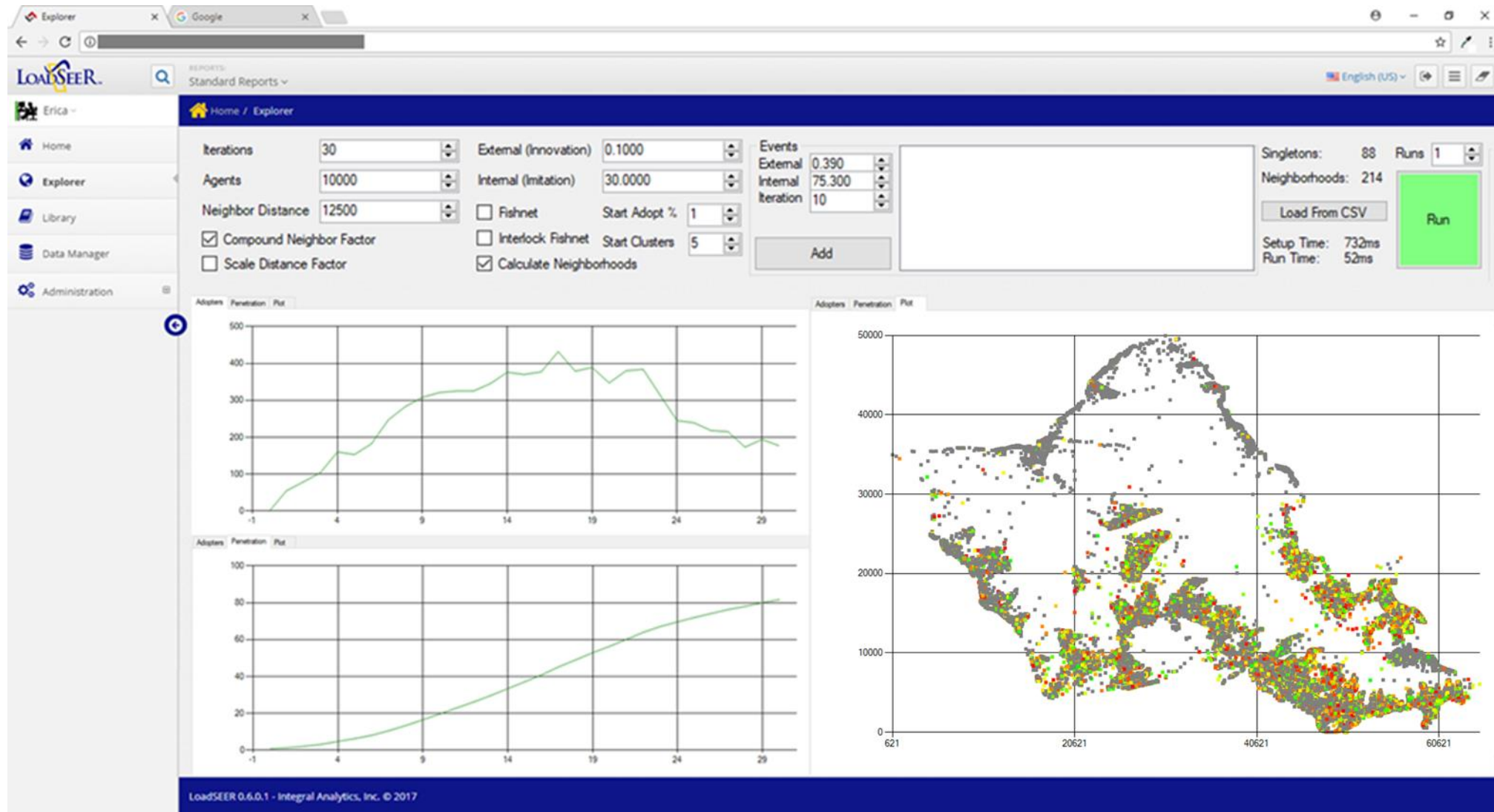
- Iterations: 30
- Agents: 10000
- Neighbor Distance: 12500
- External (Innovation): 0.1000
- Internal (Imitation): 30.0000
- Events: External (0.390), Internal (75.300), Iteration (10)
- Start Adopt %: 1
- Start Clusters: 5
- Options:  Compound Neighbor Factor,  Scale Distance Factor,  Fishnet,  Interlock Fishnet,  Calculate Neighborhoods
- Singletons: 88
- Runs: 1
- Neighborhoods: 214
- Buttons: 'Load From CSV', 'Run' (green)
- Performance: Setup Time: 732ms, Run Time: 52ms

Three plots are visible:

- Adapters Penetration / Plot:** A line graph showing penetration over 30 iterations. The y-axis ranges from 0 to 500. The curve rises from 0 at iteration 1 to approximately 400 by iteration 15, then fluctuates between 350 and 450 until iteration 25, before slightly declining.
- Adapters Penetration / Plot:** A line graph showing a different penetration metric over 30 iterations. The y-axis ranges from 0 to 100. The curve shows a steady, nearly linear increase from 0 at iteration 1 to approximately 80 at iteration 30.
- Adapters Penetration / Plot:** A spatial scatter plot of the island of Oahu. The x-axis ranges from 621 to 60621, and the y-axis from 0 to 50000. The plot shows a dense distribution of grey points representing agents, with several clusters of colored points (red, yellow, green) indicating specific agent types or states.

At the bottom of the interface, the text reads: 'LoadSEER 0.6.0.1 - Integral Analytics, Inc. © 2017'.

# Electric Vehicles on Oahu: Agent-Based Modeling (Year 8)



# Agent-Based Modeling: DER Propensity to Feeder Integrity



- PV/EV Agent Forecast
- Linked to Feeder via Synergi
- Load/Production Shape Impact
- Avoided Cost/CAPEX substitute
- Incentive/TOU Program Mgt

# Takeaways

- “State of the Art” is underestimated
- Scale computing is removing barriers
- Vendors are collaborating
- The days of static studies and Excel are limited
- Stakeholders: Seek, embrace and de-risk innovation