Integrated Grid Planning Symposium

"State of IGP Technology"

November 16, 2017

Integrated Grid Planning: The "Must-Haves"

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

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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

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First, A Foundation: Geospatial Load and DER Growth

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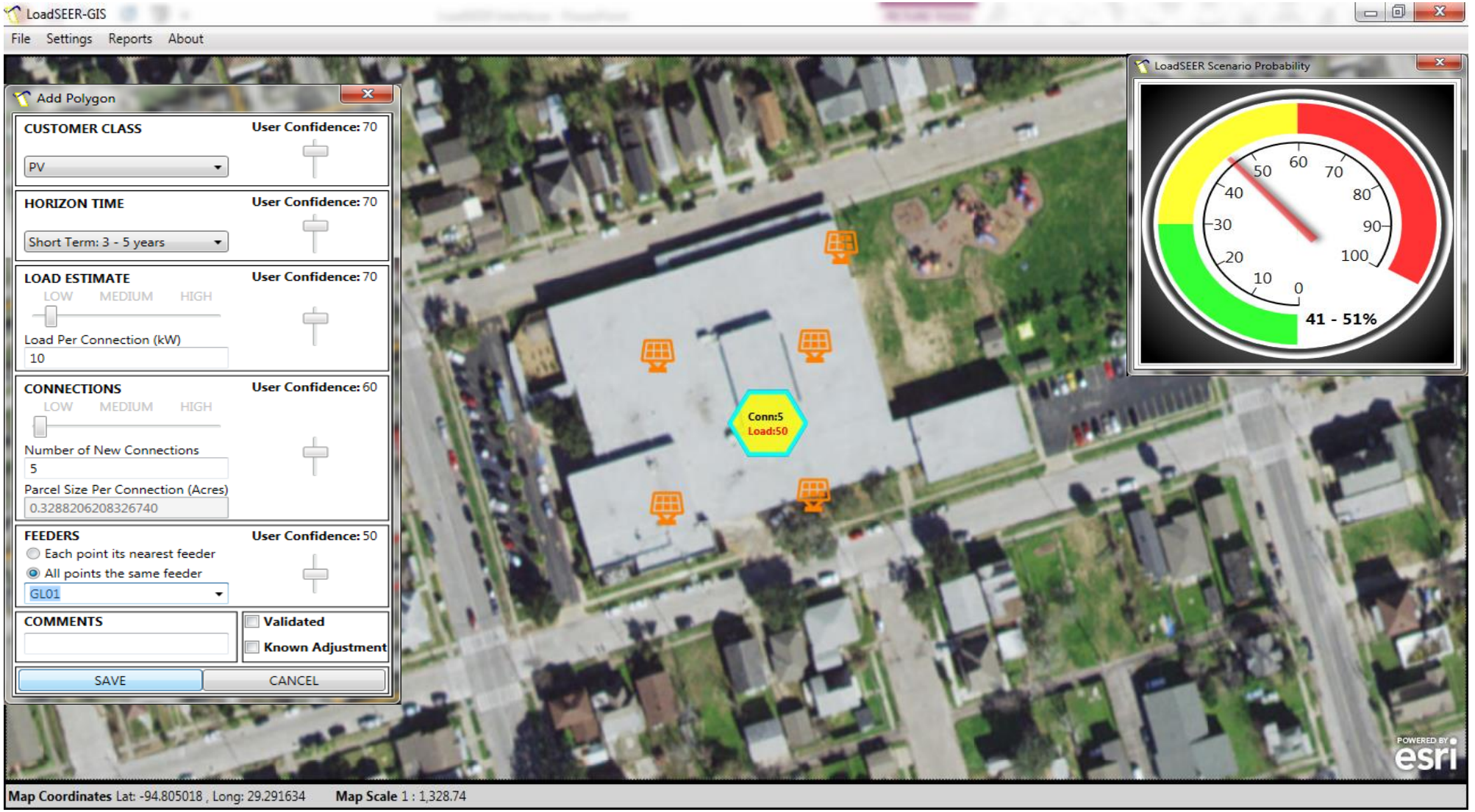
Scenario Engine: Adjustment Portfolios



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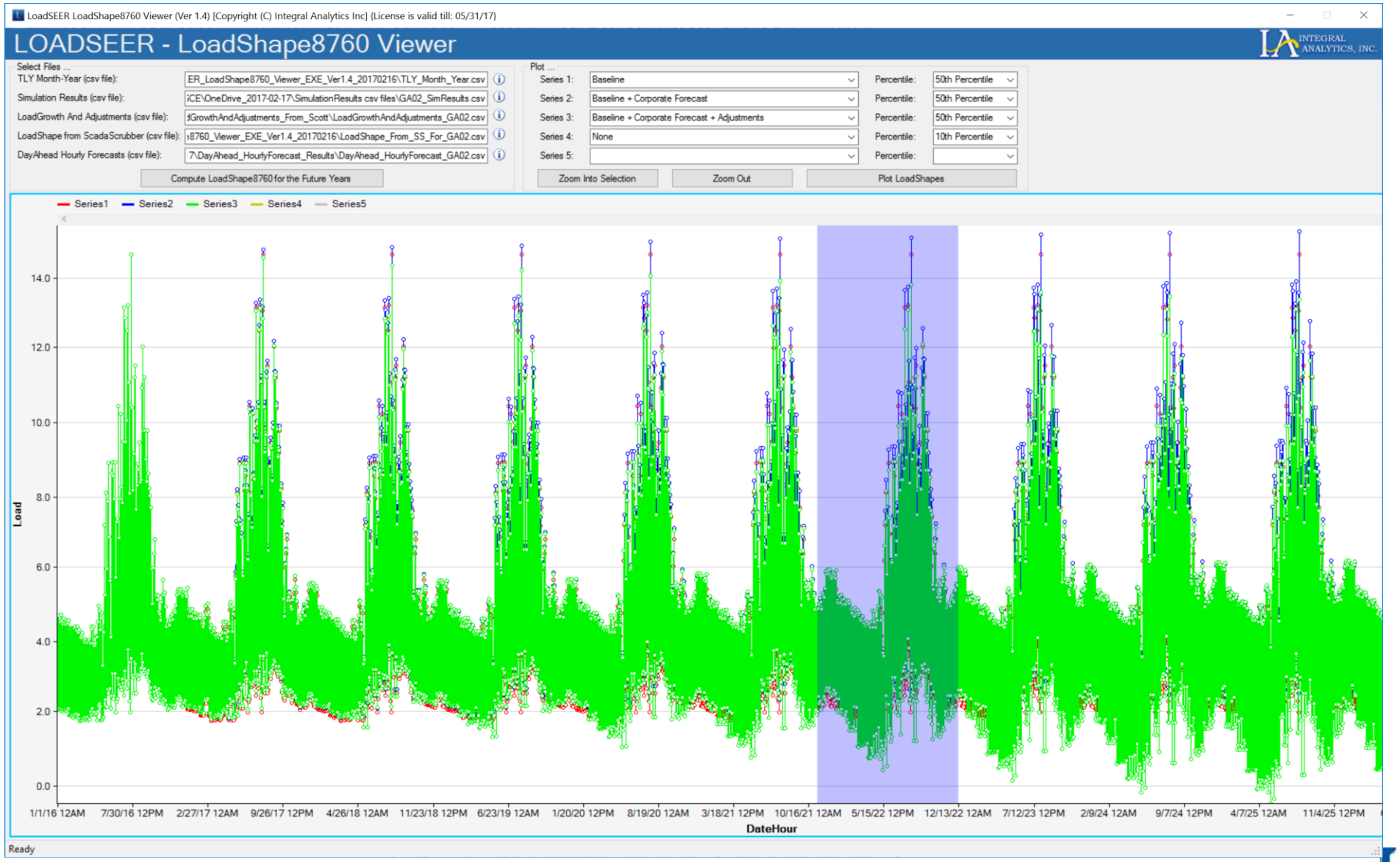
8760 Frequency and Duration of Load: Circuit Granularity



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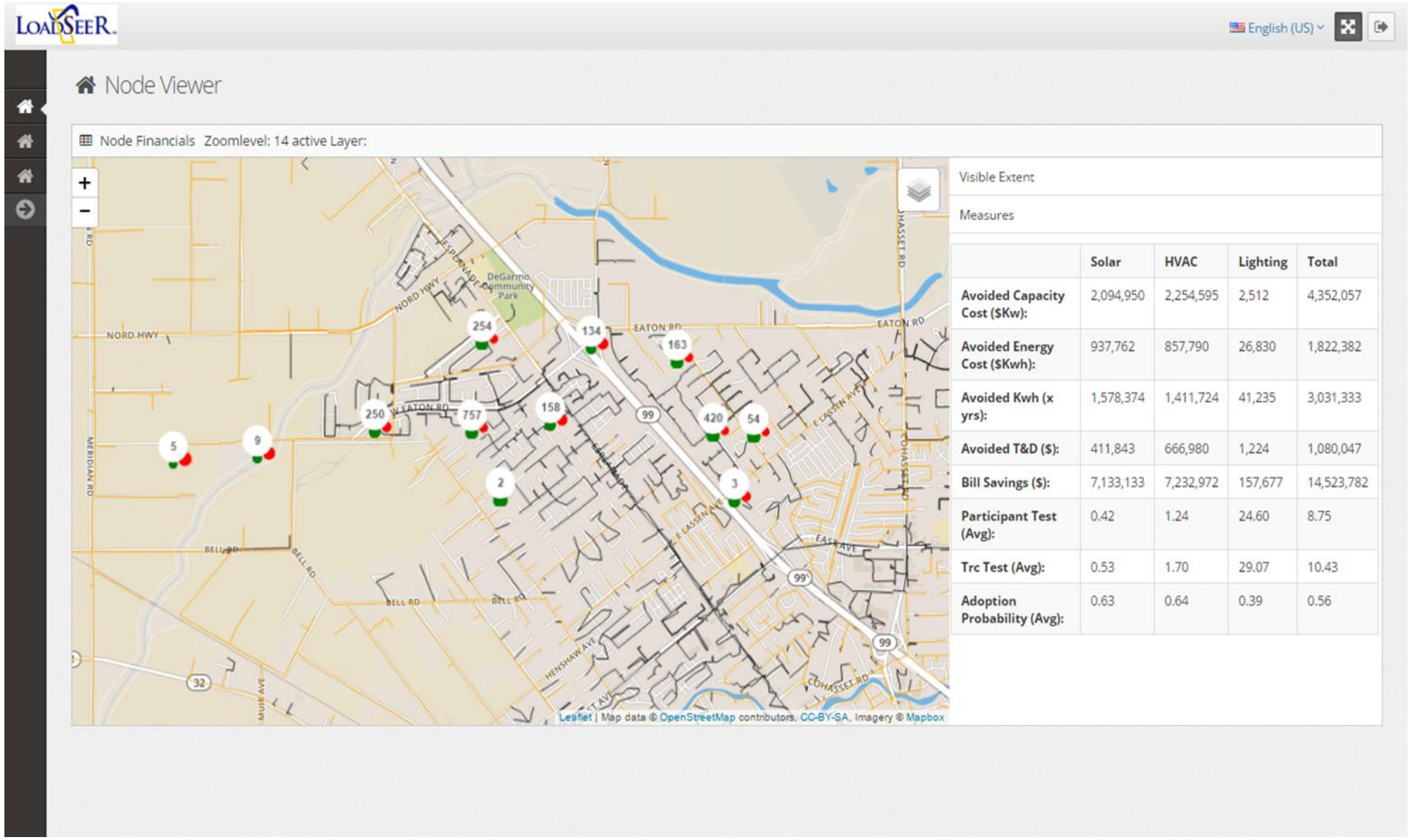
Nodal Value of DER…Integrated to Planning



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

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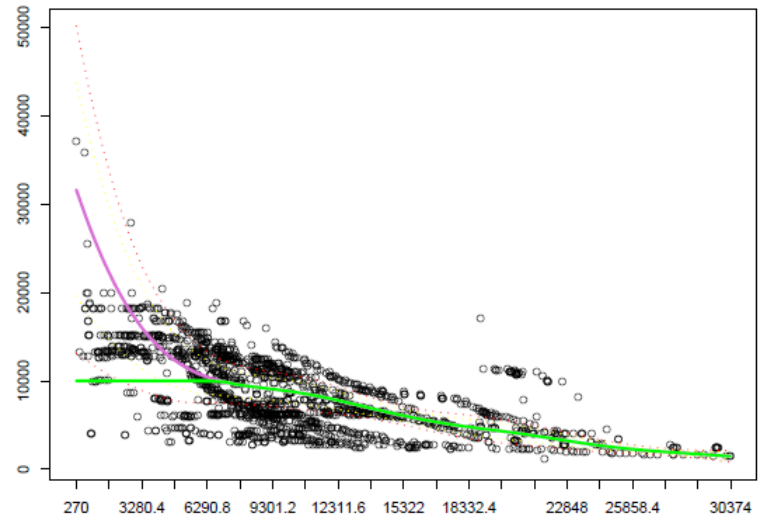
Batch Integration Capacity Analysis (grid-constrained)

Object Type	Object Name	ID	Shape Name	2016 MW	2016 Limiting Hour	2017 MW	2017 Limiting Hour	2018 MW	2018 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



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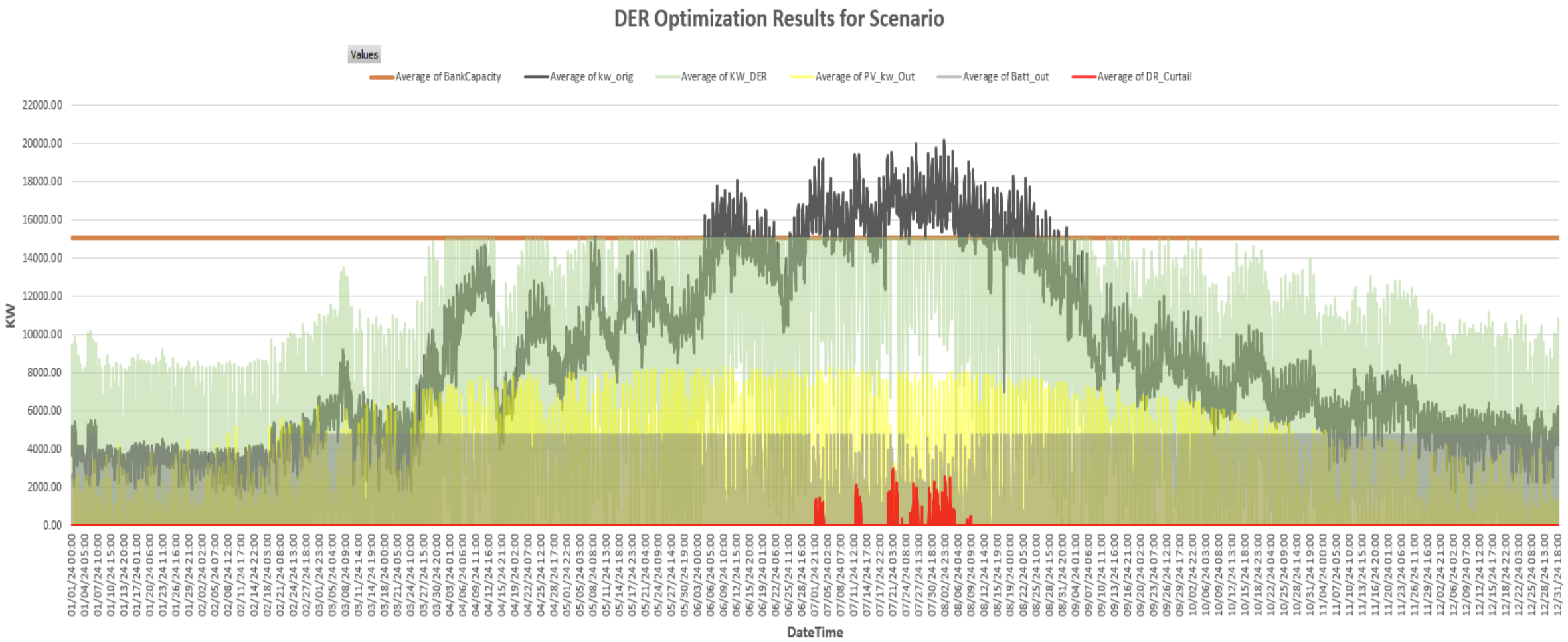
Circuit DER Optimization: Least Cost Meets Grid Needs



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

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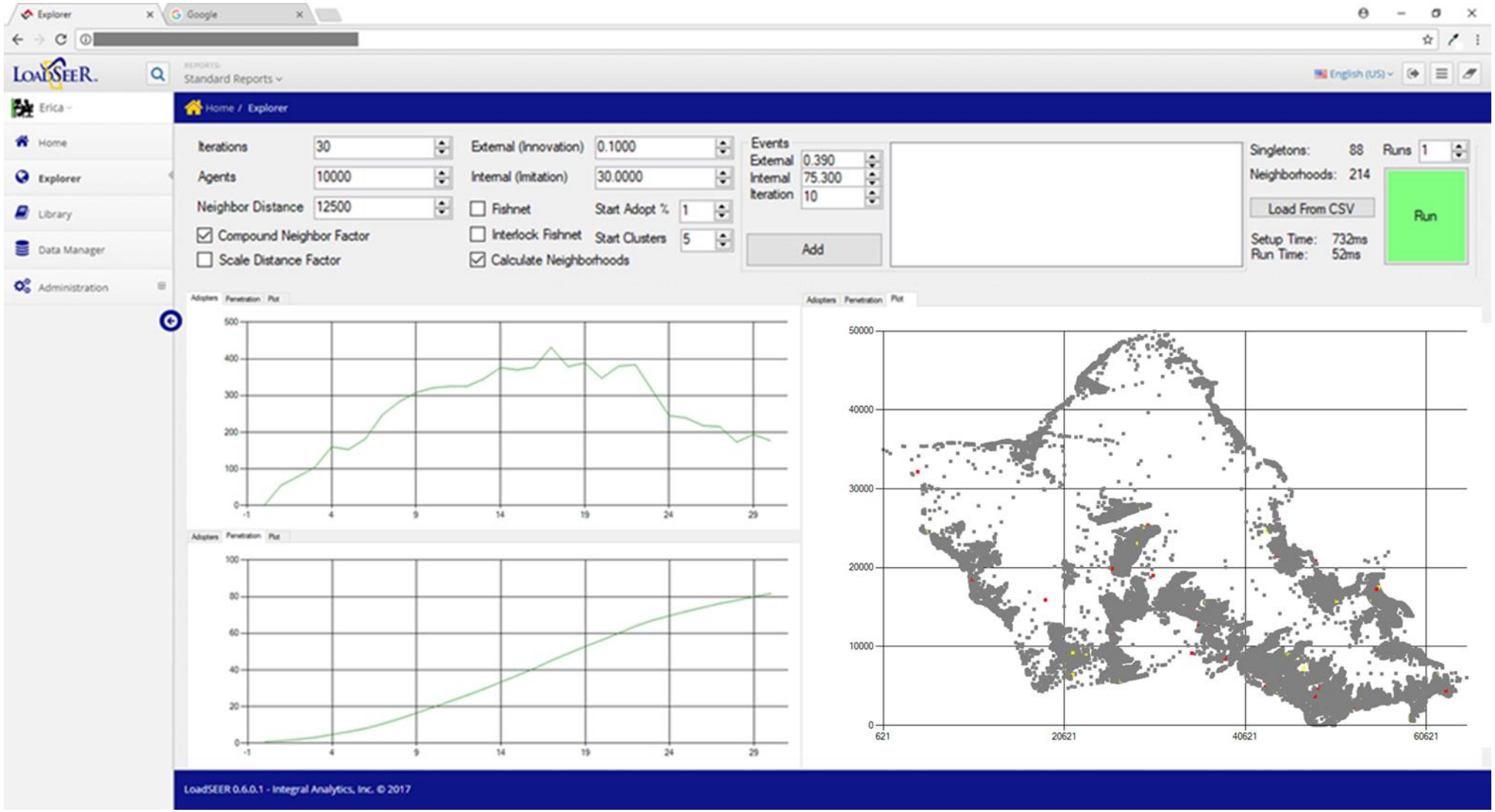
Electric Vehicles on Oahu: Agent-Based Modeling



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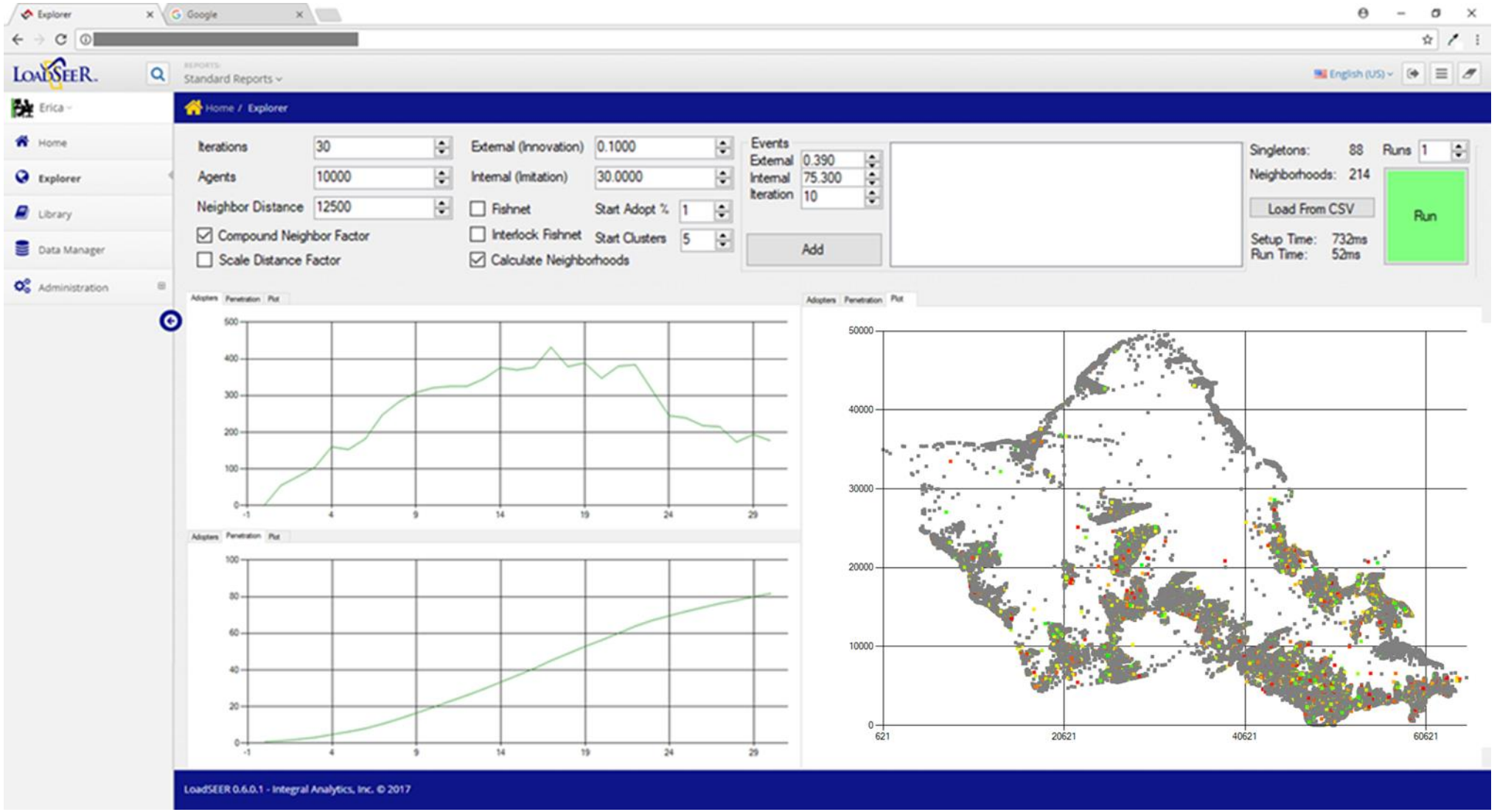
Electric Vehicles on Oahu: Agent-Based Modeling (Year 5)



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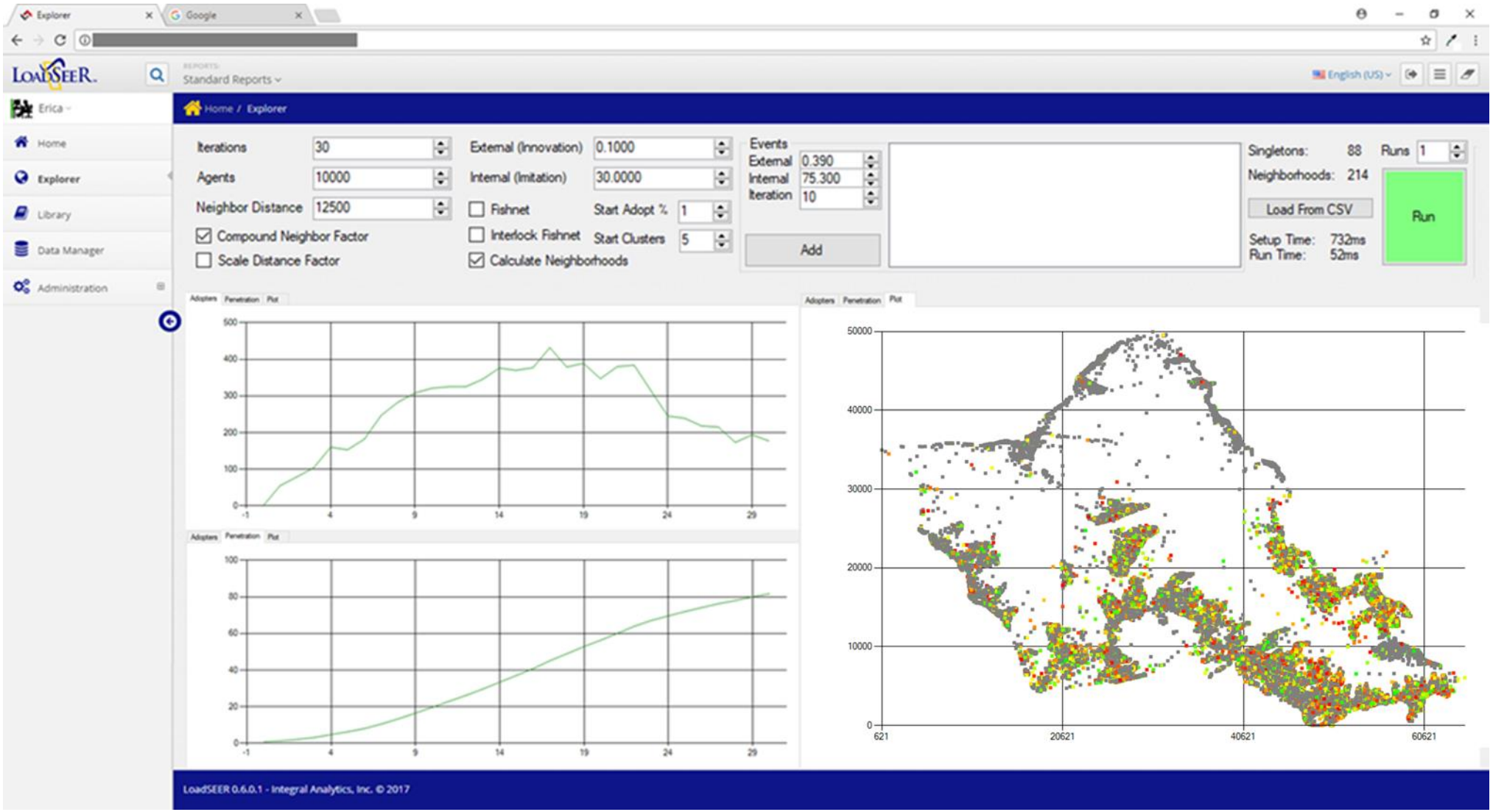
Electric Vehicles on Oahu: Agent-Based Modeling (Year 8)



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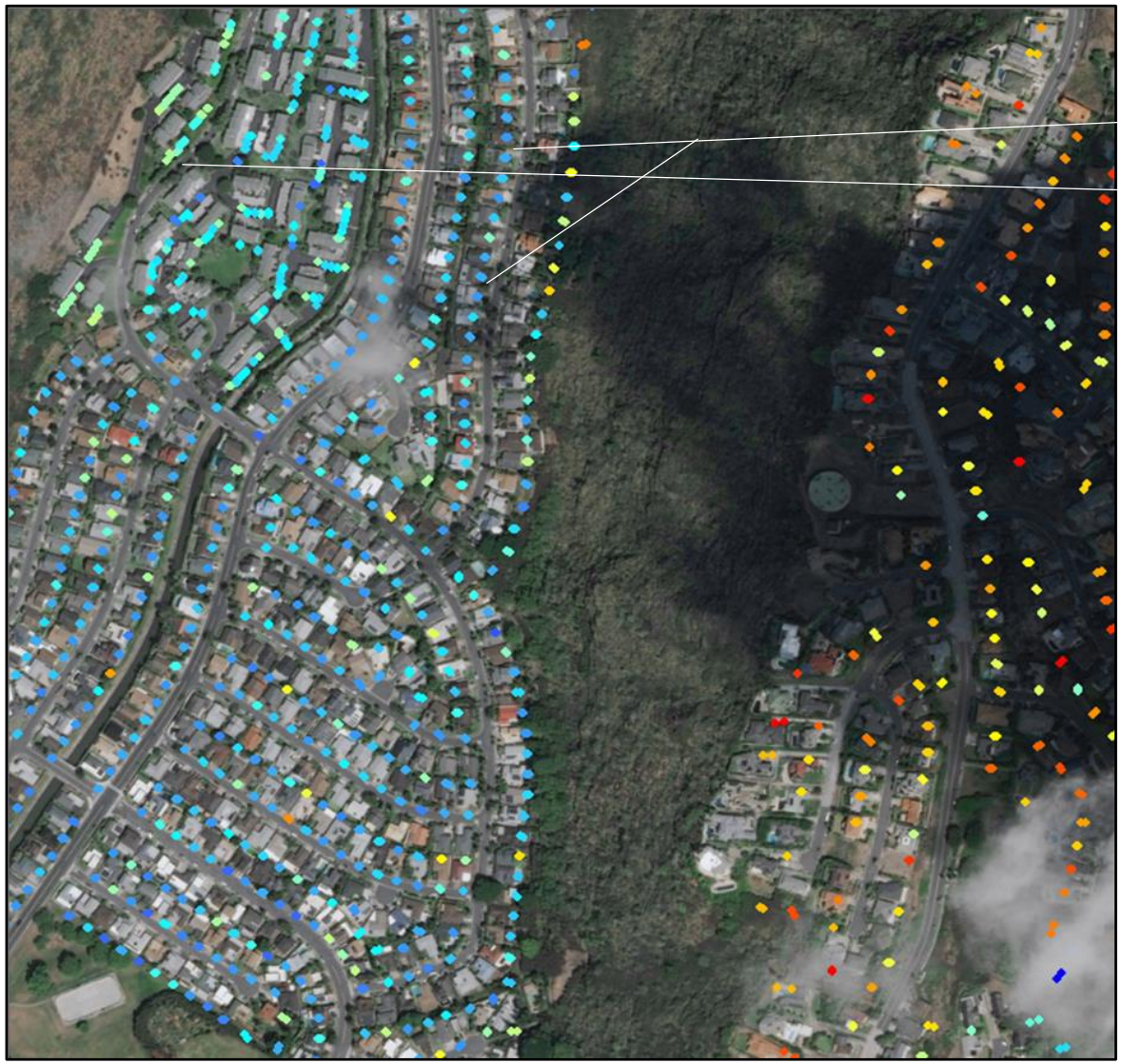
Agent-Based Modeling: DER Propensity to Feeder Integrity



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

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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