2018 IRP Contemporary Issues Technical Conference

Distribution System Planning

IA Overview

Utility Customers

40+

Customer Load Shapes

500 million+

- Market leader in Distribution Grid Analytics software for Planning, Operations, Demand-Side Management, DER Valuation
- Products deliver **granular, actionable intelligence** to utilities and others to bridge long-range forecasting with near-term operational needs
- Patented architecture and methodology, based on least-cost principles
- Scalable platform for emerging system regulations in California, New York, Massachusetts, Texas, Arizona, Hawaii and other jurisdictions
- **Acquired by Willdan Inc in July 2017; 2016 Greentech Media Grid Edge Winner/2015 Fierce Innovation Award**

Customers Include:

Duke Energy, CPS Energy, Southern California Edison, NES, PG&E, DTE Energy, SDGE A Sempra Energy utility, FortisBC, Seattle City Light, ComEd, Hawaiian Electric, Xcel Energy

Integral Analytics

Relevant IA Software Track Record (since 2011)

- LoadSEER is a proven, core application serving Integrated Grid Planning, Distribution Planning, Corporate Fcst/DER at:
  - Pacific Gas & Electric
  - San Diego Gas & Electric
  - Seattle City Light
  - Hawaiian Electric
  - Fortis, Nashville Electric, CPS Energy, others.

- LoadSEER for regulatory requirements:
  - Cited by California PUC as benchmark load forecasting application for Distribution Resource Planning, Hosting Capacity Analysis (2016-17)
  - HECO Grid Modernization Strategy to Hawaii PUC (2017/2018) and as forecasting solution for landmark EV strategy (2018)
  - Presented by NV Energy to Nevada PUC as part of Distributed Resource Planning requirement (2018)
- DSMore Cost-Effectiveness Software:
  - 30+ states have approved methods for utilities
  - In use at **NiSource, IPL and Duke**

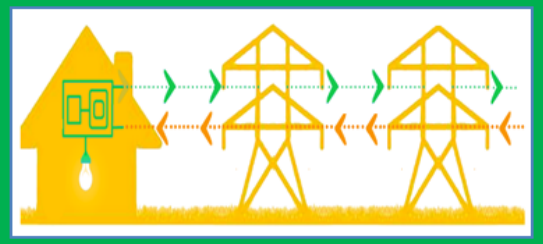
IA Integral Analytics

A Brief History of Distribution Planning

- **Last 50 Years:**
  - A stand-alone function within the utility (a “spoke”)
  - Typically an annual process to allocate corporate load forecast to substation/feeder
  - Used to prioritize capital projects and support asset management
  - Primarily utilized peak load history and weather normal for forecasts (data poor)
  - Typically used averaging to allocate load growth below the substation
  - Concerned with engineering integrity/reliability, not value/cost

- **Next 20 Years:**
  - Evolution to Integrated Grid Planning, linking capital to operations (the “hub”)
  - Amidst flat/declining system load growth, distribution-level volatility
  - Multi-directional powerflow from DER mandates dynamic scenario forecasting
  - Must leverage significant recent investment in data sources and telemetry
  - Hourly resolution load shapes required to understand reliability impacts
  - DERs as capital substitutes
  - Avoided distribution costs and value of locational DER required
  - Portfolio Manager role

Next 5 Years in Distribution Planning



Modernize distribution system to accommodate expected DER growth through two-way power flow

Include granular DER scenarios into load planning and determine grid benefits or costs

Provide valuation metrics and DER-based cost effective capital alternatives

Identify Optimal Locations for deployment of DERs

Foundational Layer: Circuit-Level Load Forecasting

Integral Analytics

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
7. Locational Value and Risk Metrics

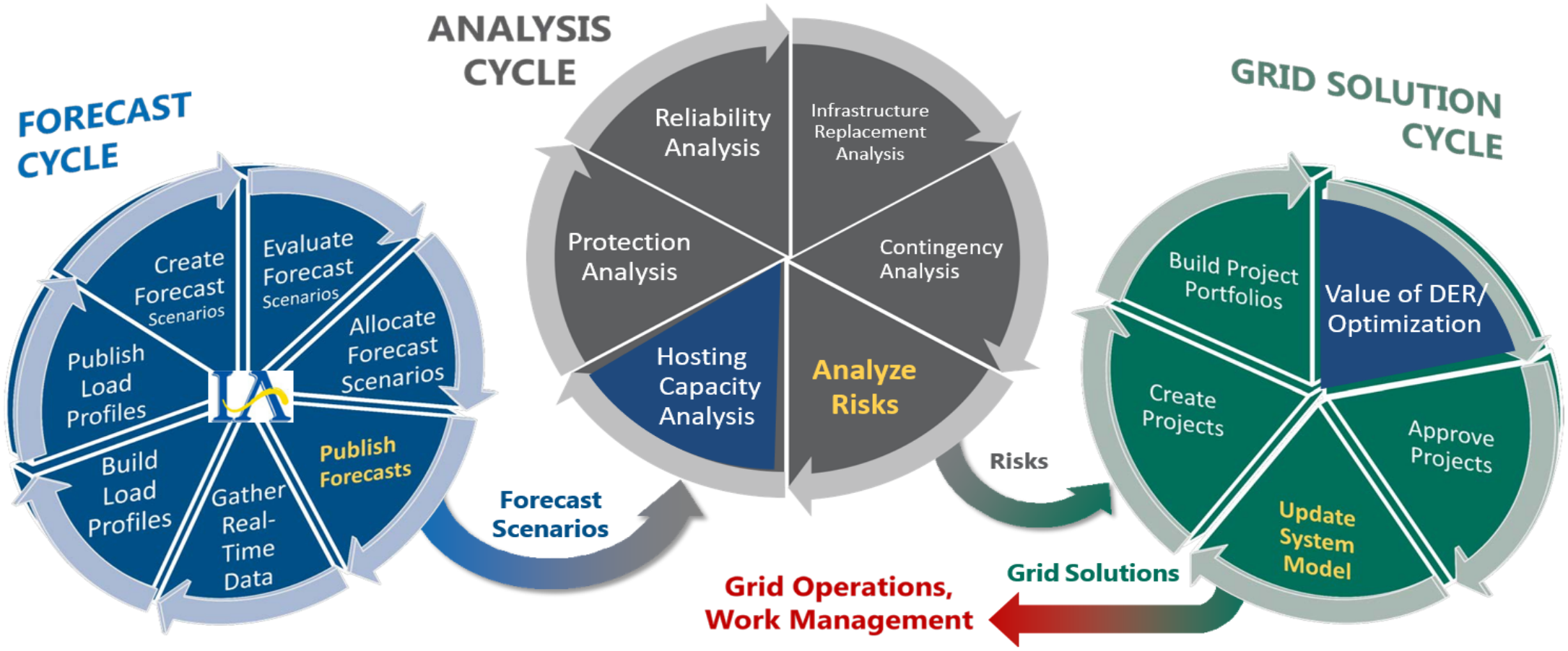
IA Integral Analytics

Integrated Grid Planning: The "Must-Haves"

Capability	Conventional Wisdom	Status	Where?
Nodal, 8760 Load Forecasting with Powerflow	Data transfer and quality prohibitive	Commercially available	PG&E, CPS Energy, SDG&E, Seattle City Light, others
Hourly Batch ICA	Too computationally-intensive	Commercially available Q3 2018	PG&E, SDG&E
Embedded DER Penetration Impact	Hard to reconcile corporate fcst to feeder level	Commercially available	PG&E, SCE, CPS, Hawaiian Electric
DER Avoided Cost Project Value/Optimization	Locational value measurement	Commercially available Q3 2018	Hawaiian Electric, PG&E, Seattle, CPS
Dynamic Data and Network Topology Refresh	System Integration and Data Management Challenge	Commercially available	Nashville Electric, PG&E, FortisBC, Hawaiian Electric

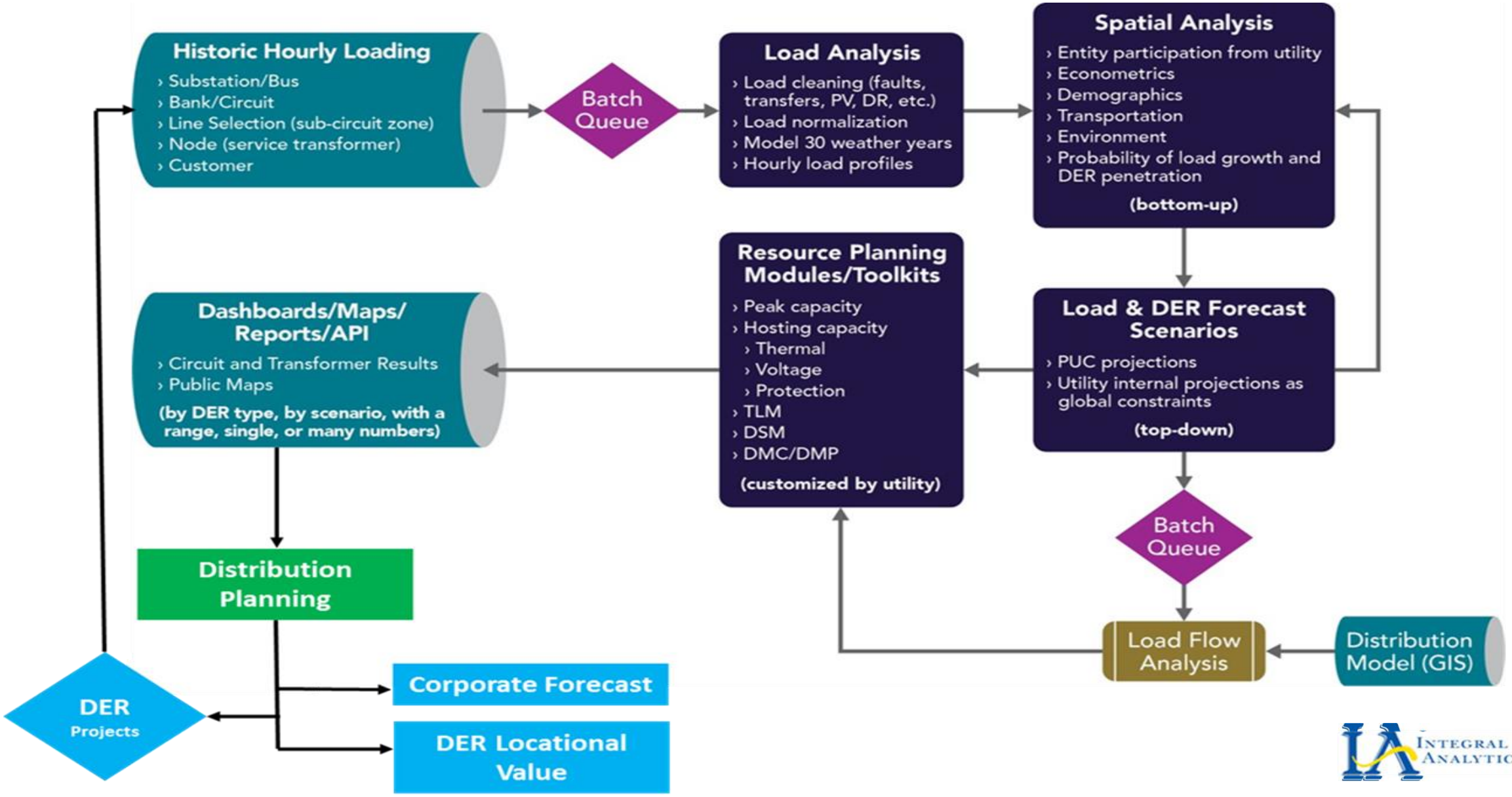
Integral Analytics

Integrated Grid Planning: Dynamic Cycles

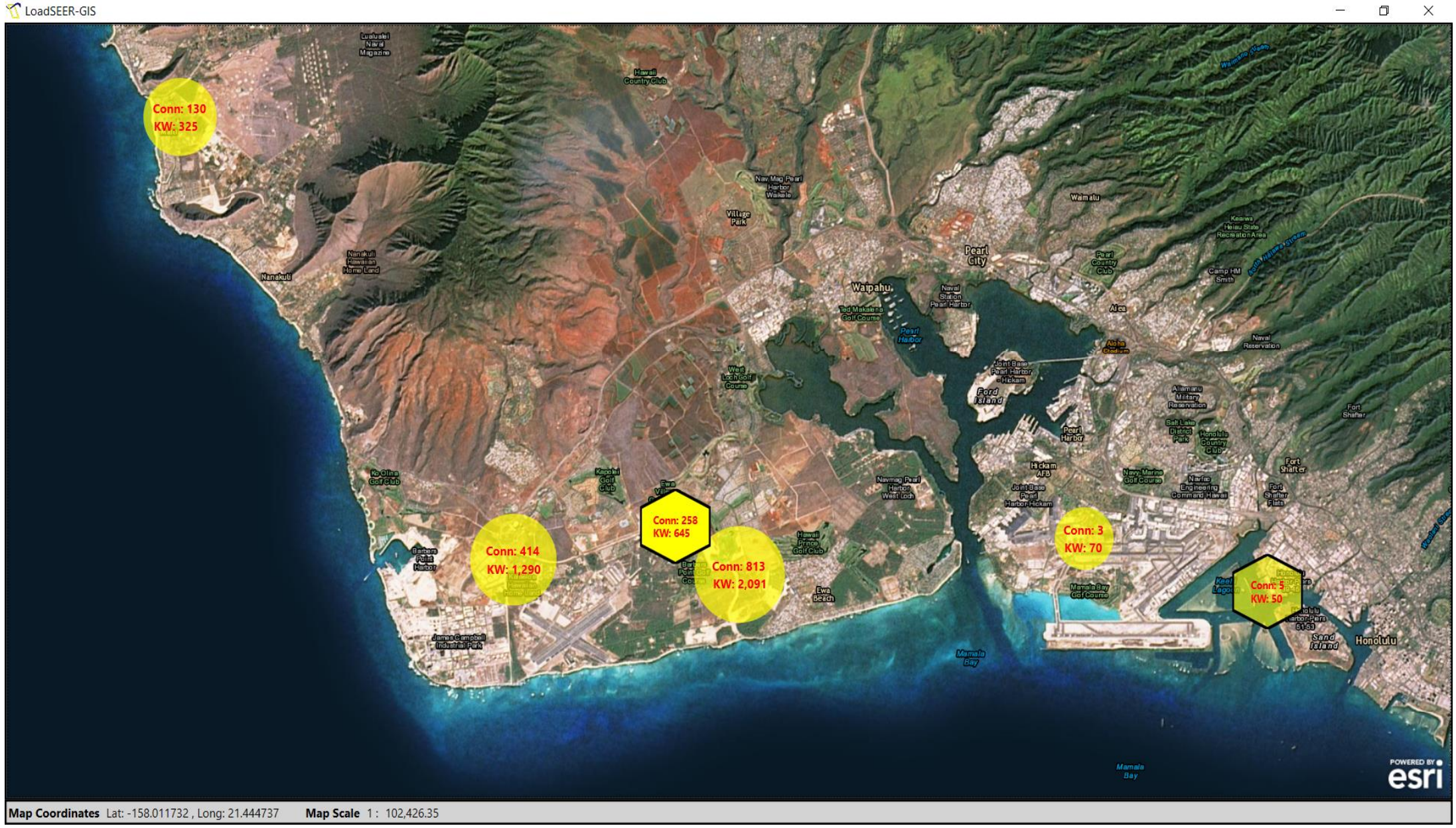


Integral Analytics

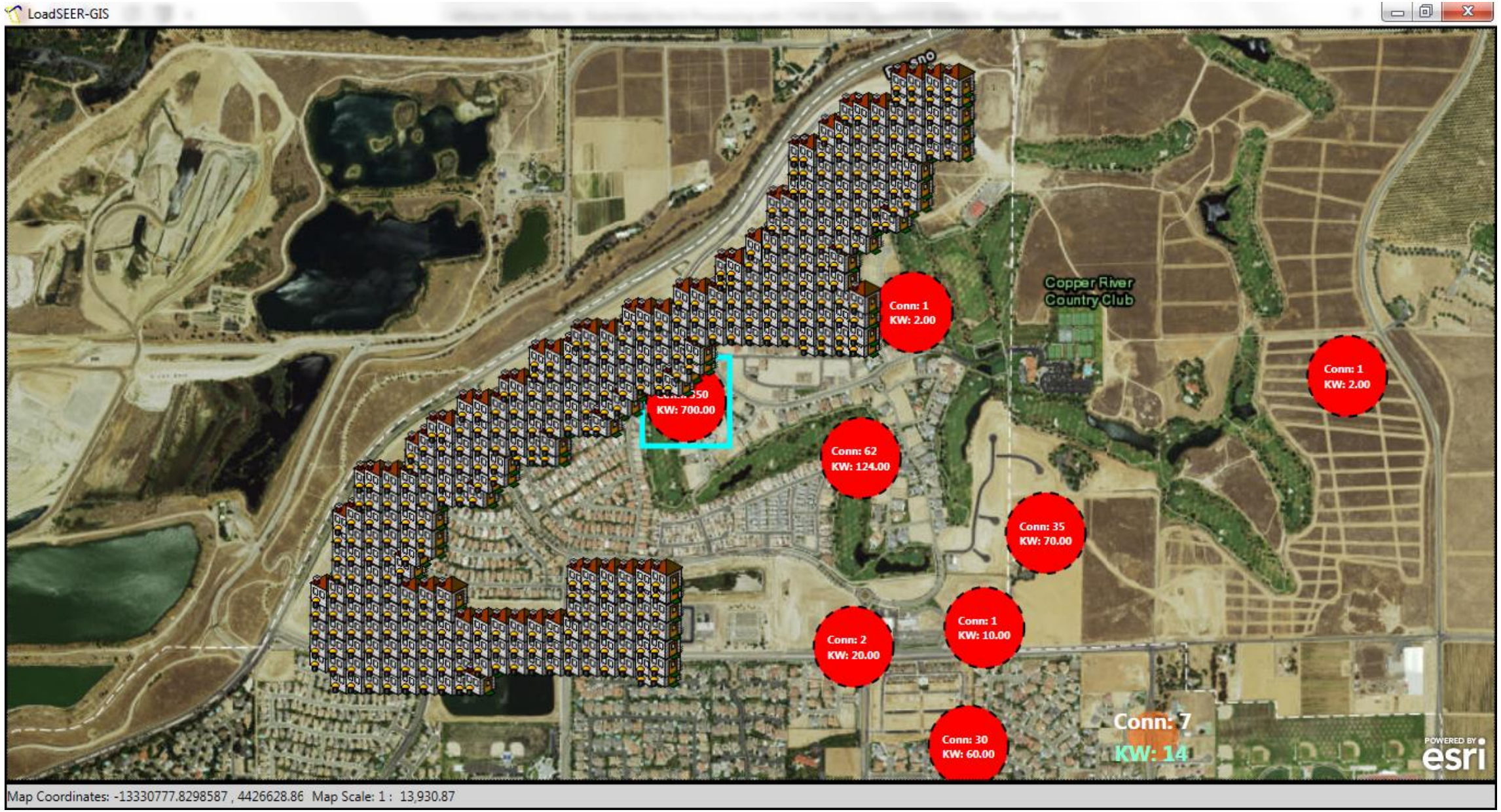
Integrated Grid Planning: The Process



Geospatial Load and DER Forecasting

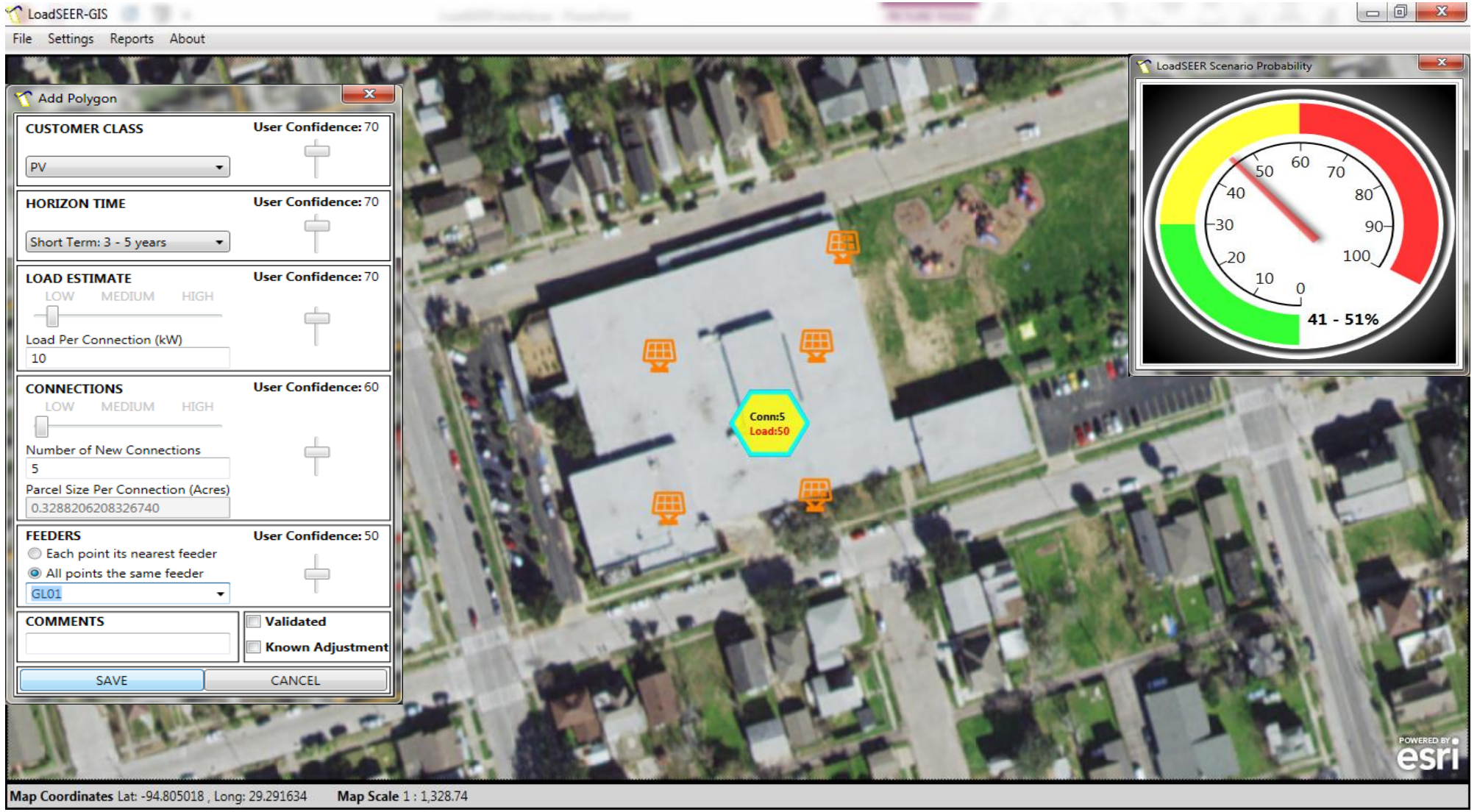


Enabling Engineering Expertise: Local Knowledge



Nodal Growth + DER + Powerflow = Holistic

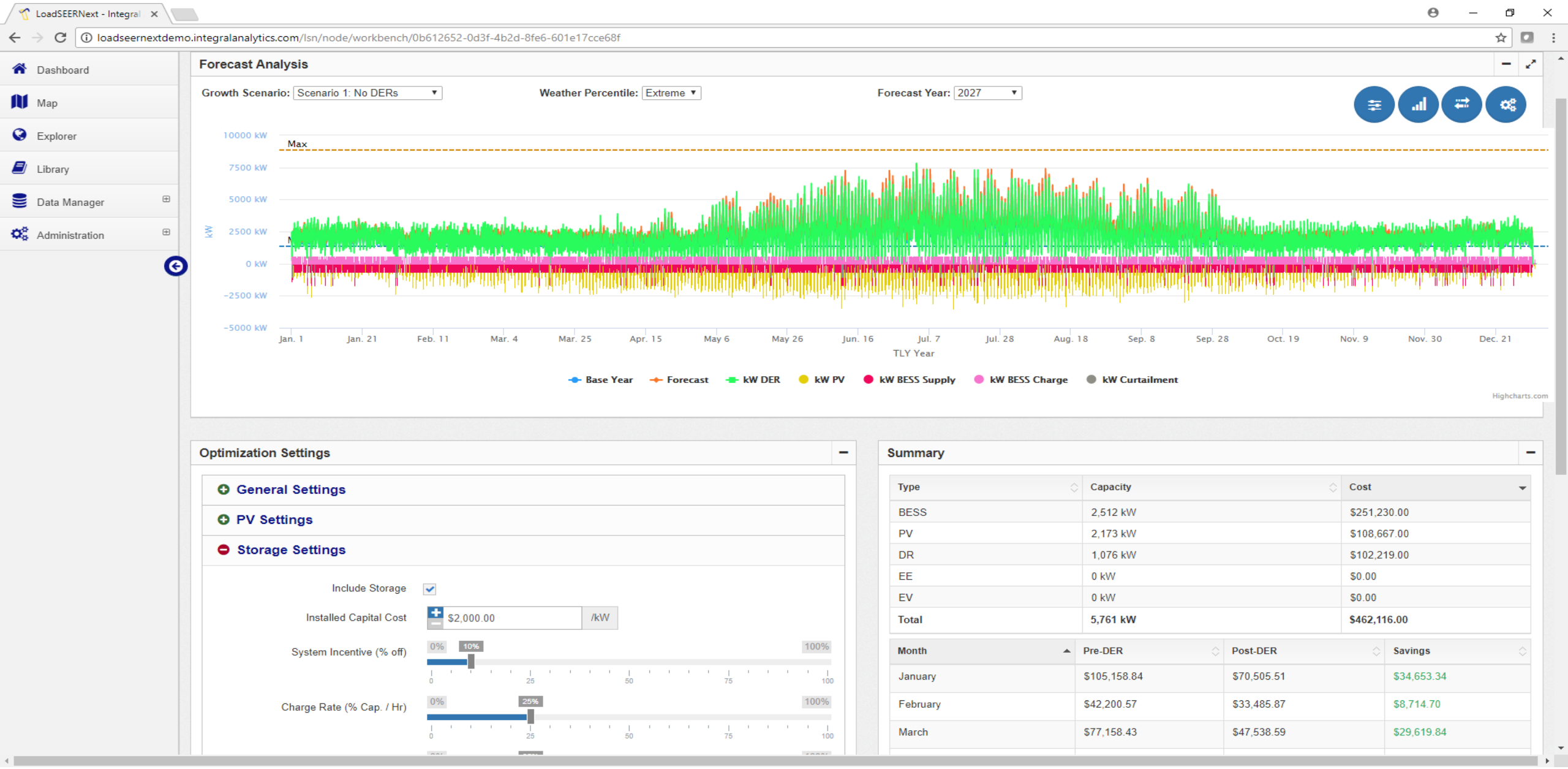
Evaluating Premise-Level Solar/Microgrids



Integral Analytics

Producing Detailed Load Profiles: Long-Range

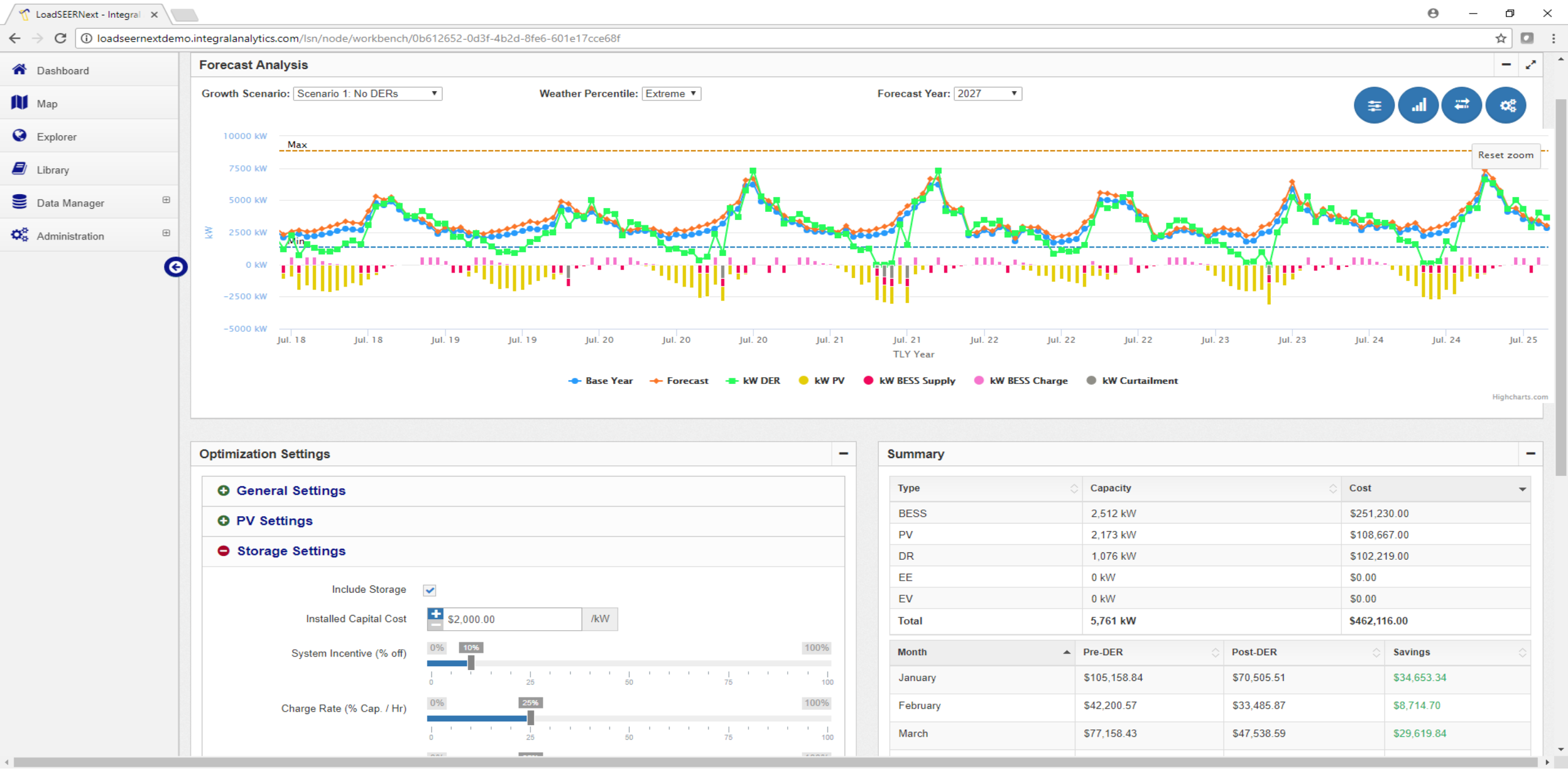
8760, Multi-Year Circuit Load Shape and DG Production



Type	Capacity	Cost
BESS	2,512 kW	$251,230.00
PV	2,173 kW	$108,667.00
DR	1,076 kW	$102,219.00
EE	0 kW	$0.00
EV	0 kW	$0.00
Total	**5,761 kW**	**$462,116.00**

Month	Pre-DER	Post-DER	Savings
January	$105,158.84	$70,505.51	$34,653.34
February	$42,200.57	$33,485.87	$8,714.70
March	$77,158.43	$47,538.59	$29,619.84

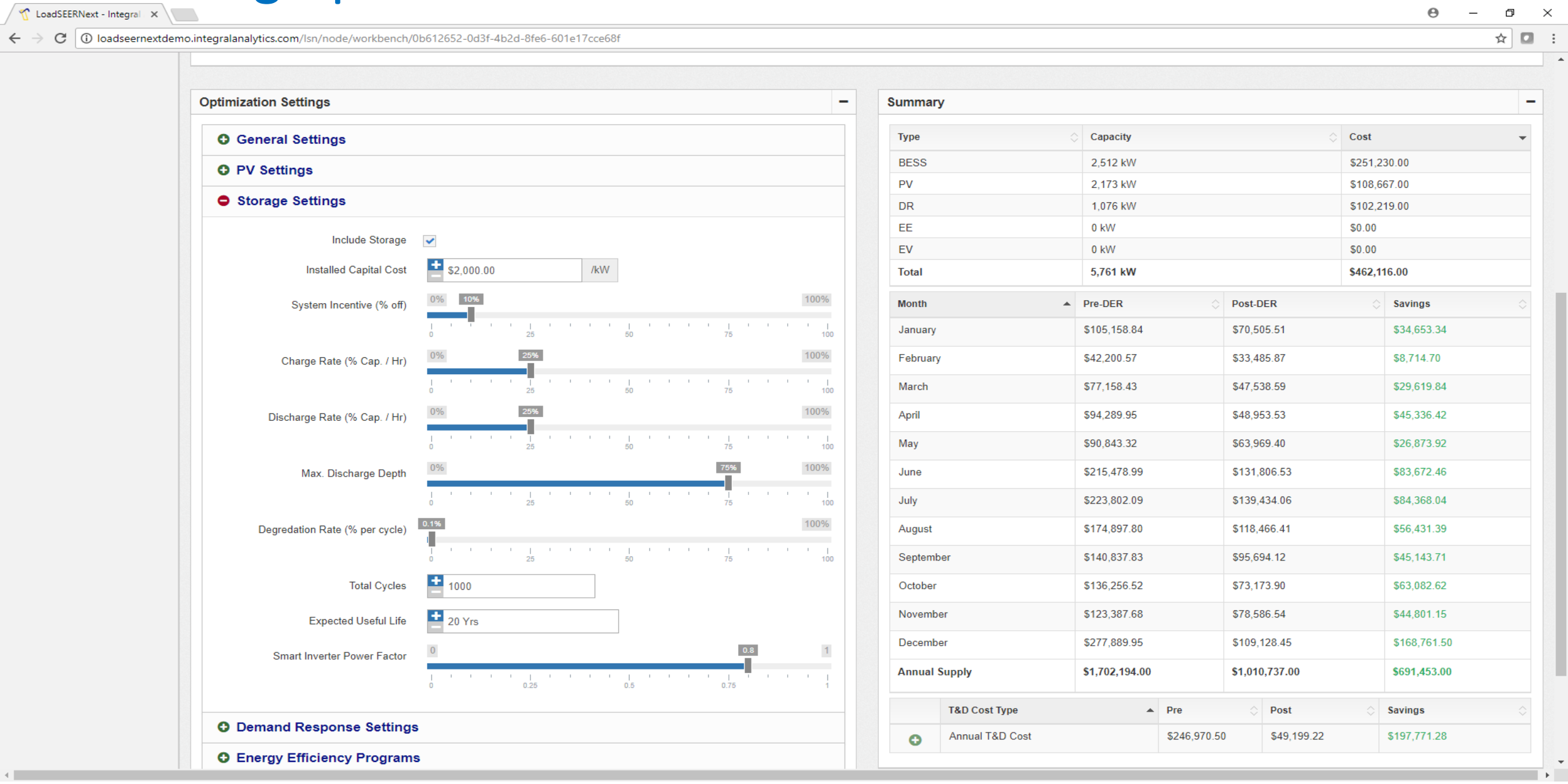
Circuit Risk Evaluation



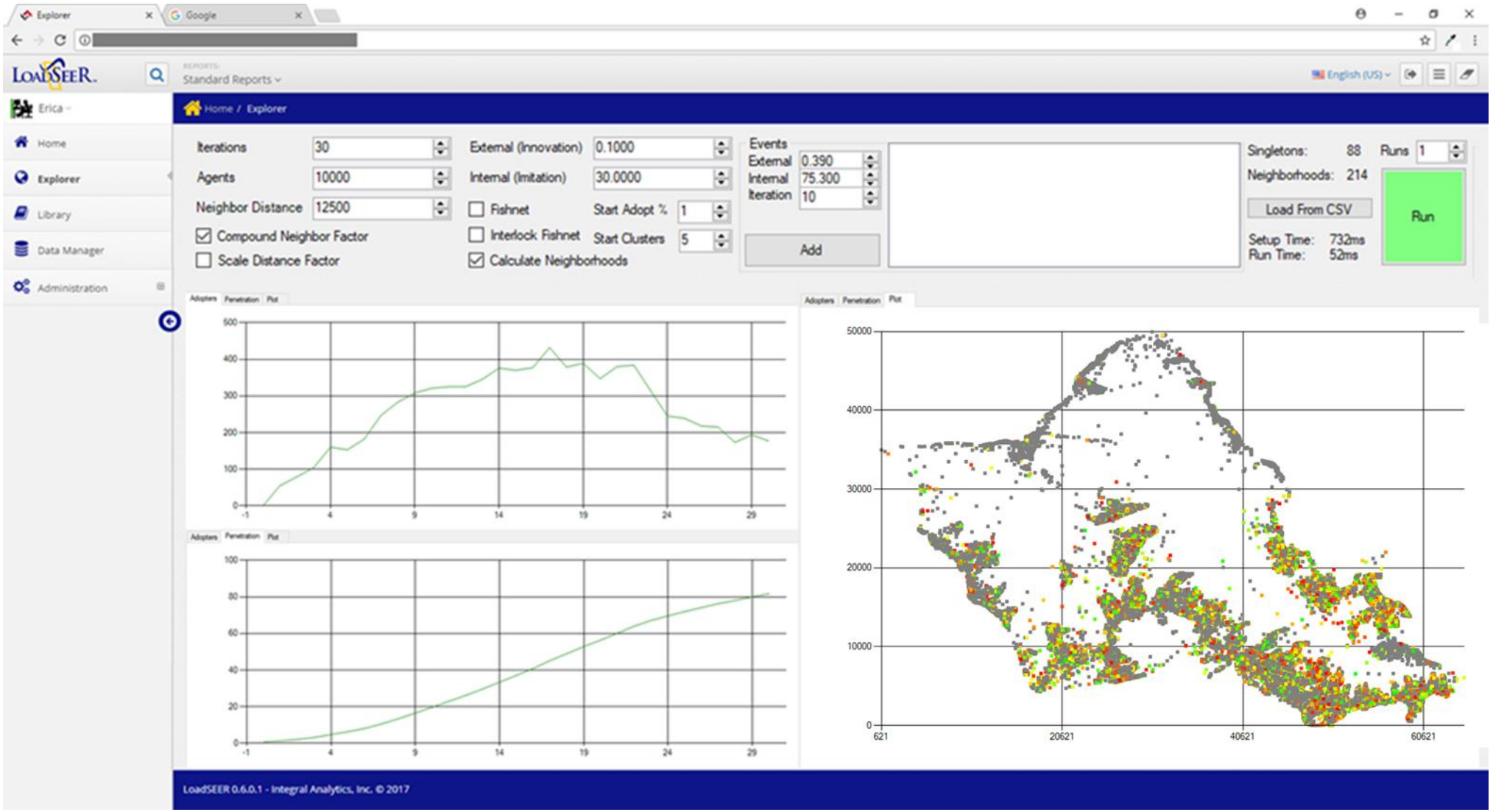
Type	Capacity	Cost
BESS	2,512 kW	$251,230.00
PV	2,173 kW	$108,667.00
DR	1,076 kW	$102,219.00
EE	0 kW	$0.00
EV	0 kW	$0.00
Total	**5,761 kW**	**$462,116.00**

Month	Pre-DER	Post-DER	Savings
January	$105,158.84	$70,505.51	$34,653.34
February	$42,200.57	$33,485.87	$8,714.70
March	$77,158.43	$47,538.59	$29,619.84

Building Optimal Distributed Portfolios



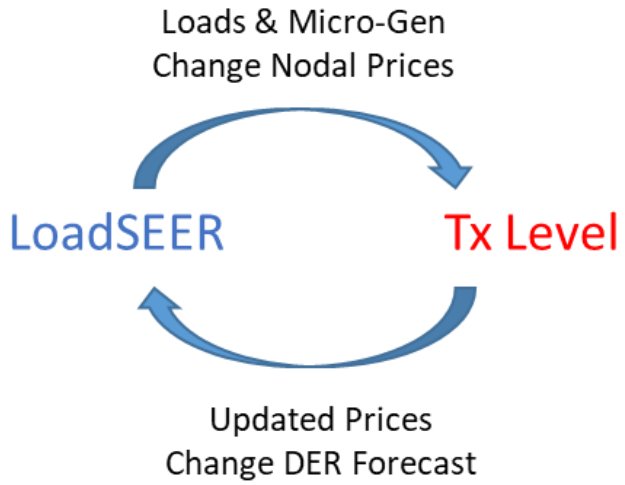
Electric Vehicles on Oahu: Agent-Based Modeling



Integral Analytics

Key Integration Value Points: Bridging to IRP

- Dynamic Distribution Planning integrates with Production Cost, Transmission and Capacity Expansion models similarly to the API interfaces used with distribution powerflow tools.
- Traditional IRP planning tools, such as Aurora, Plexos or System Optimizer, can interact with dynamic planning at the nodal (bus-level) and/or the zonal level (load control area / or congestion zone area), creating a much richer and more granular analysis.
- The IRP tool “area demand” points to this time-series data, referencing the loads which are dynamically aggregated to the desired node, and will adjust the IRP tool load vs. generation mix at the nodal level.



Integral Analytics

Key Takeaways

- The days of static studies and Excel are limited
- Dynamic, granular planning is available
- AMI is not required to implement nodal intelligence
- Scale computing is removing barriers
- PV, BESS and especially EV will mandate sophistication
- Planners are now portfolio managers
- Regulators should seek, embrace and de-risk innovation
  - Adopt “DRP” approach to planning (CA, NY, NV, HI)
  - TDSIC as path to standard deployment
  - ROE enhancement for capital efficiency