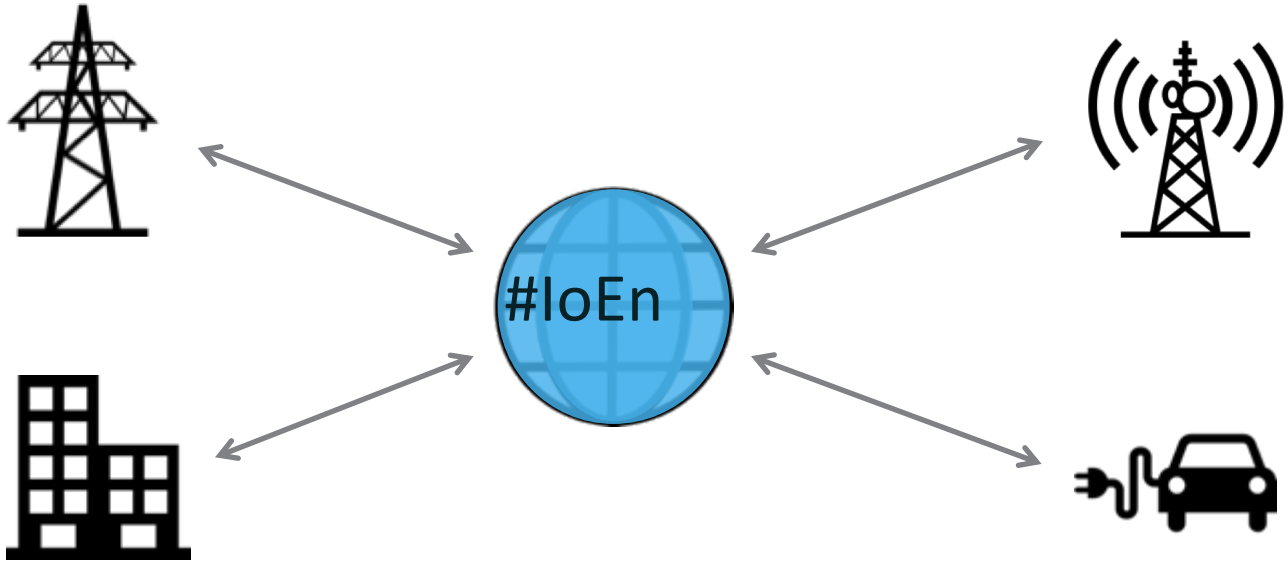
Solar Storage Systems & the Internet of Energy for Bases and Forward Operations

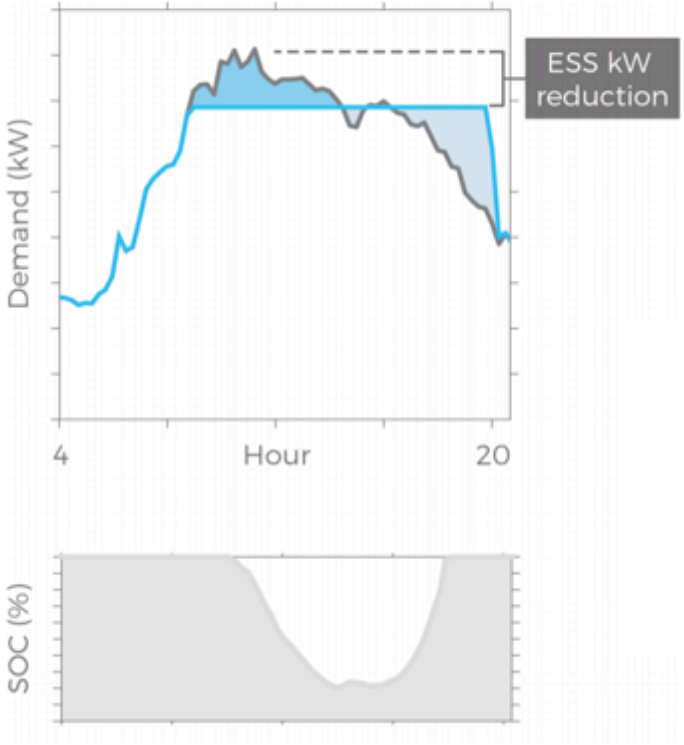
Dr. Ryan Wartena
Co-Founder & President
Geli
January 11, 2019
Naval Postgraduate School
Energy Academic Group

Emergence of the Internet of Energy



Energy Services from Networked Assets

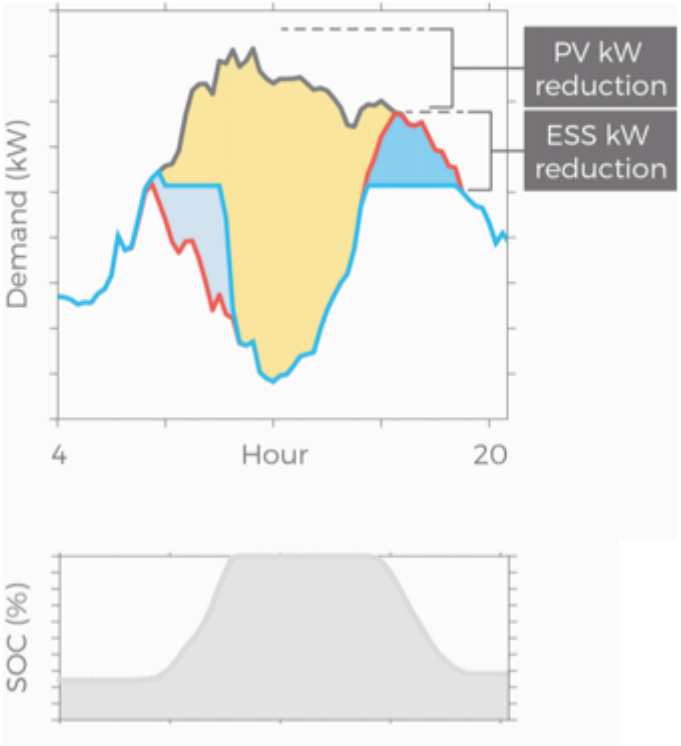
Demand Charge Management



The Geli Demand Charge Management Energy Application discharges the battery to mitigate peak load events. Geli's algorithms take into account historic use patterns, weather forecasts, and utility tariff schedules.

- Gross Building Load
- Net Building Load Post-Storage
- Battery State of Charge
- Battery Charges
- Battery Discharges

Demand Charge Management with Solar PV



The Geli Demand Charge Management Energy Application discharges the battery to mitigate peak load events. Geli's algorithms take into account historic use patterns, weather forecasts, and utility tariff schedules.

When paired with solar PV, the Geli Demand Charge Management Energy App charges the energy storage system on solar PV generation whenever possible to maintain compliance with the 30% Investment Tax Credit (ITC).

Internet of Energy Ecosystem

Retailers & Developers

BORREGO SOLAR

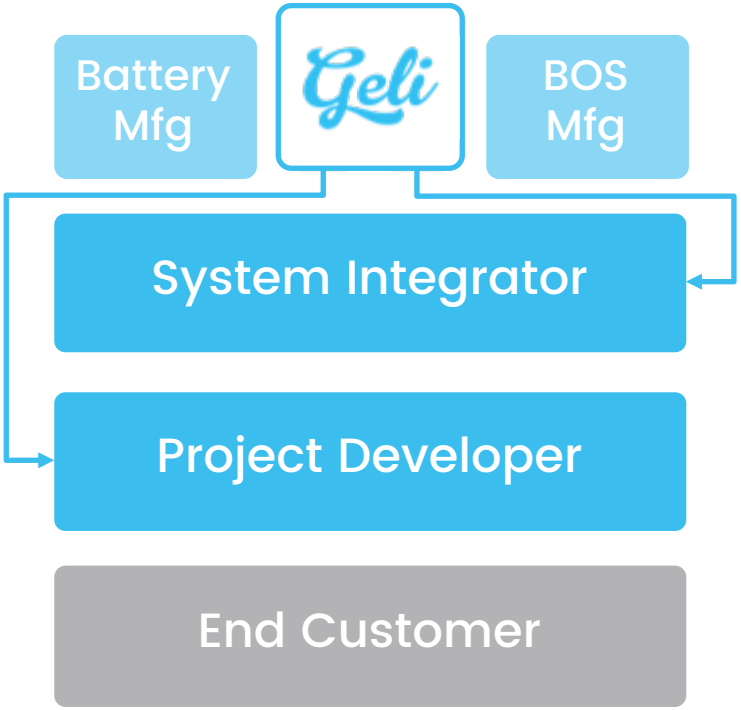
AECOM

origin

Shell

Vector

NEXTera ENERGY RESOURCES



System Integrators

NEXTracker

LOCKHEED MARTIN

SIEMENS

ABB

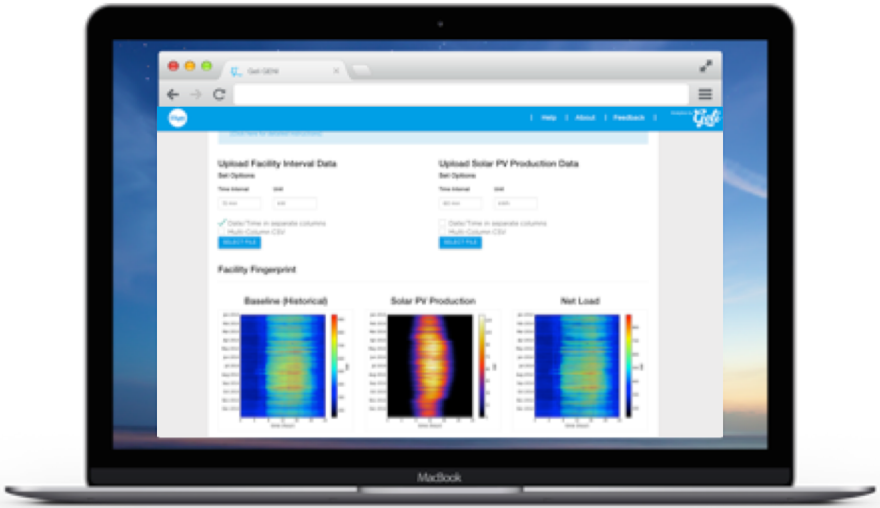
SUNGROW

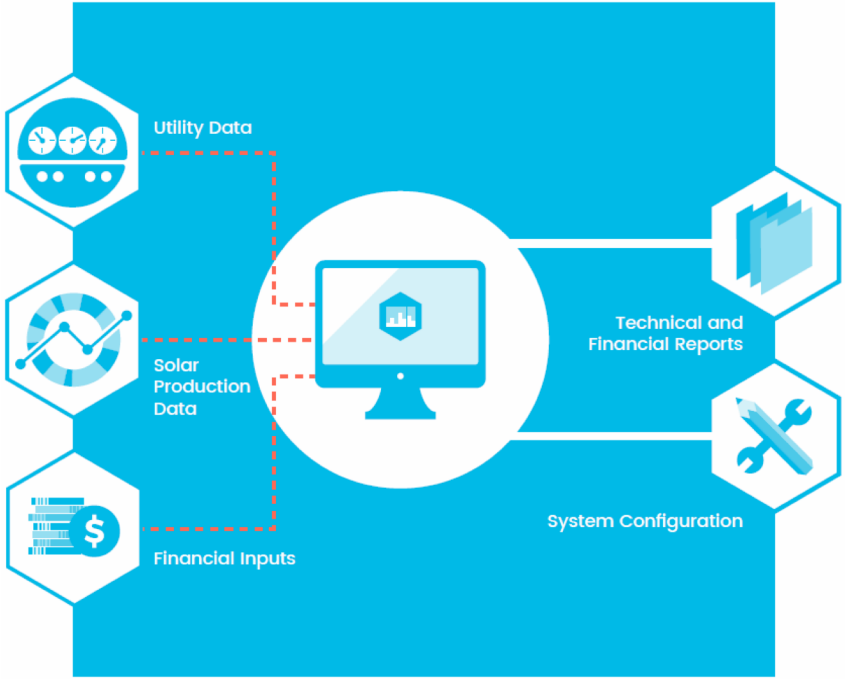
Energport

DELTA

LG Chem

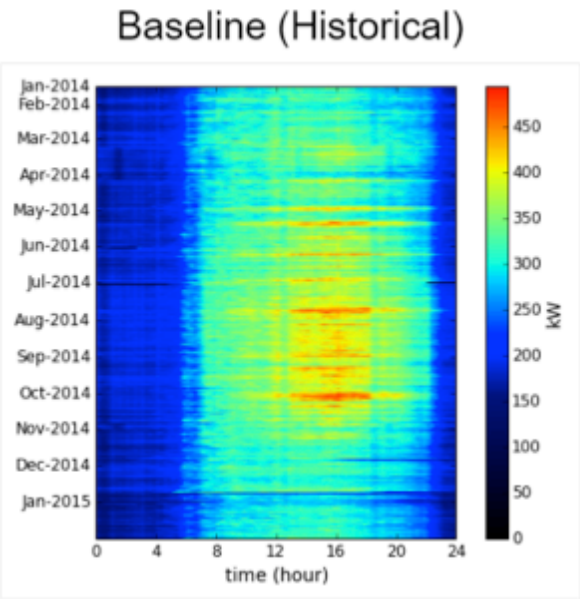
Geli ESyst

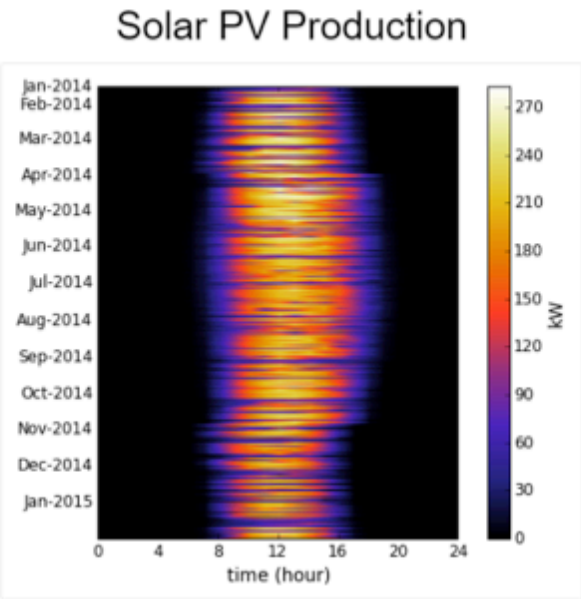


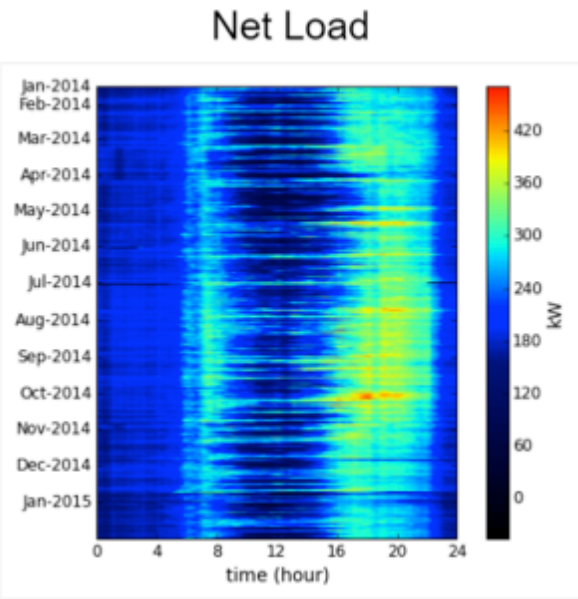


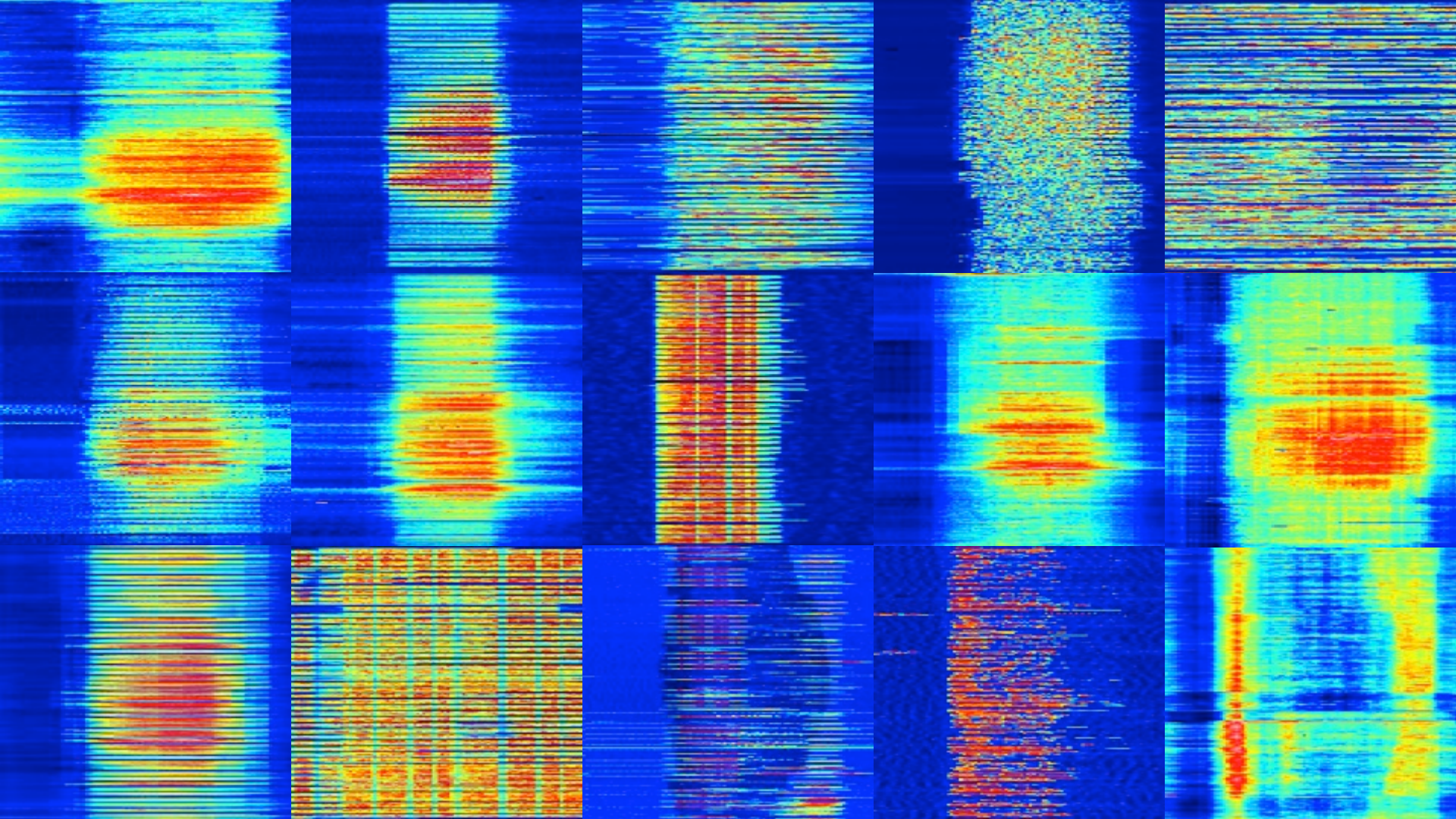
Available at http://esyst.geli.net

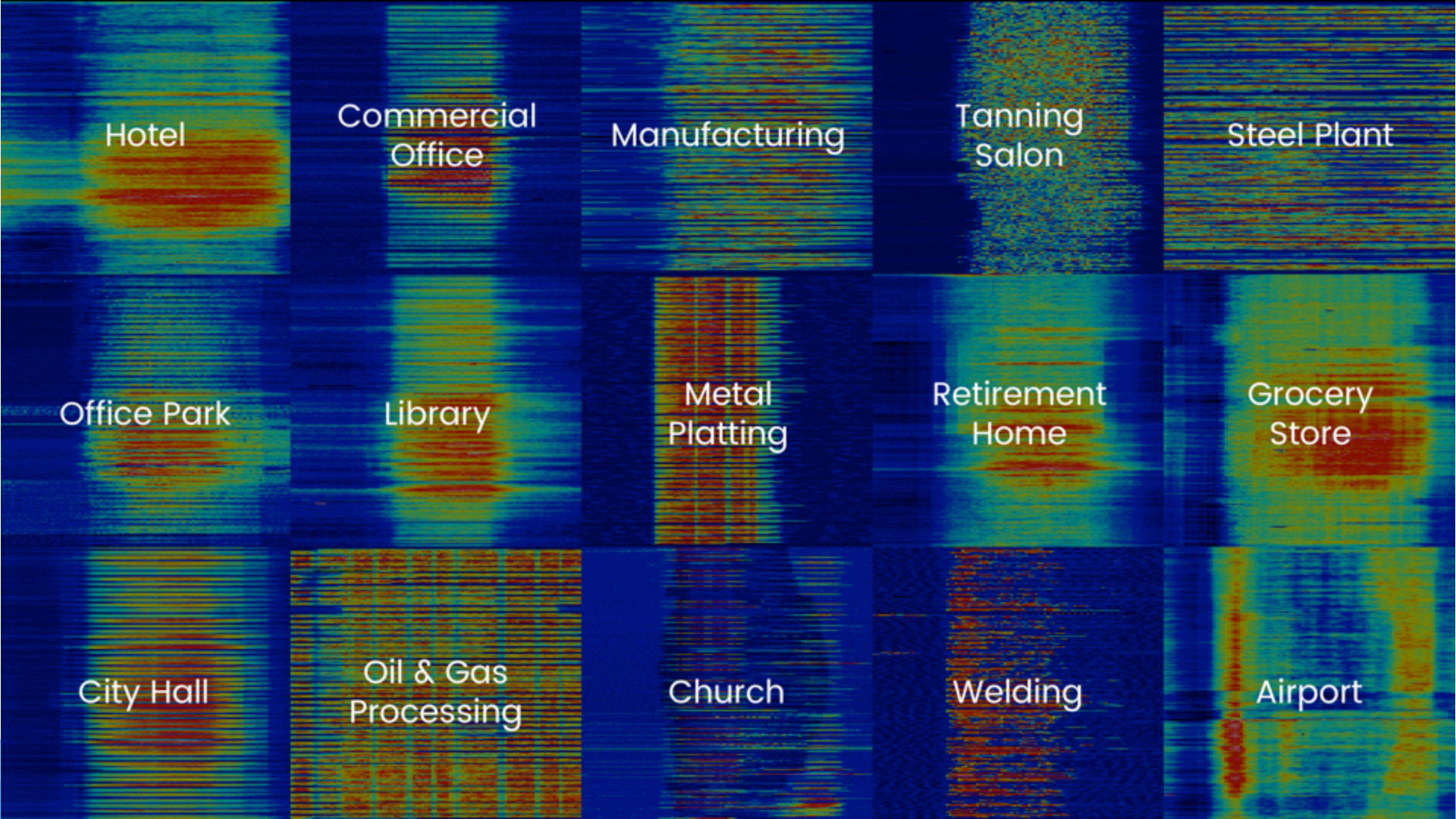
Facility Load Fingerprint







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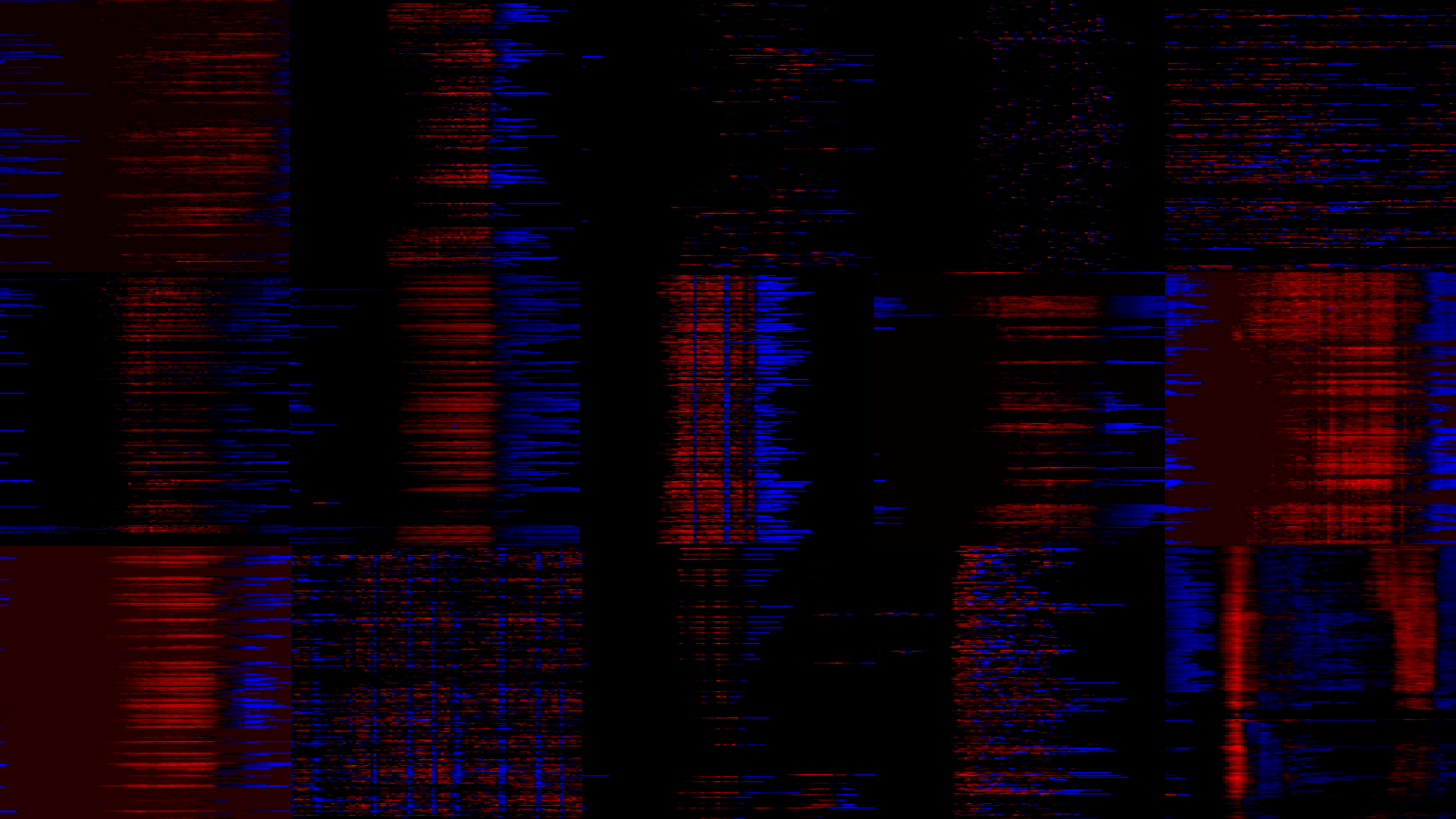
Commercial Office
Manufacturing
Tanning Salon
Steel Plant
Office Park
Library
Metal Platting
Retirement Home
Grocery Store
City Hall
Oil & Gas Processing
Church
Welding
Airport



Why is Geli different?

Platform Solution

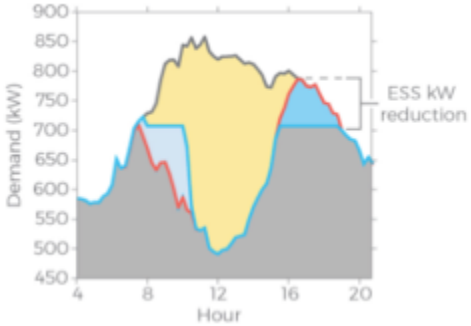
- System Sizing and Financial Proforma
- Run-time Optimization
- Fleet Aggregation & Dispatch

Life Cycle Management

- Bankable Performance
- Traceable Operation
- Battery Health Management

Future Proof

- New Battery & PCS Solutions
- New Applications (BTM, FOM)
- VPP Multi-Level Co-Optimization of Value Streams (BTM, FOM)



TESLA ENERGY

SAMSUNG SDI

LG Chem

Geli Products

ADAPTIVE ENERGY STORAGE OPERATING SYSTEM FOR MULTIPLE ECONOMIC SERVICES

(12) **United States Patent**
Wartena et al.

(10) Patent No.: US 9,817,376 B1
(45) Date of Patent: Nov. 14, 2017

Design Time

Geli ESyst
Industry-leading energy storage site analysis & revenue forecasting software

Run Time

Energy Operating System (Geli EOS)
Energy storage run-time automation software for multiple economic services

Global Energy Network Interface (Geli GENI) Energy storage management & Virtual Power Plant software

Geli's Solution – Spanning the Life Cycle

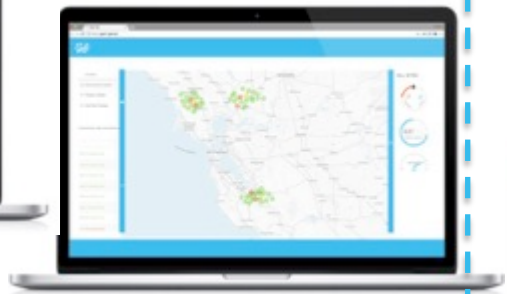
System Sizing and Financial Proforma

Geli ESyst

Run-time Optimization

Geli EOS

Fleet Aggregation and Dispatch



Geli GENI

In Pilot

Guaranteed Performance

Bankable system designs,
Run-time optimization, VPP aggregation

Geli ESyst

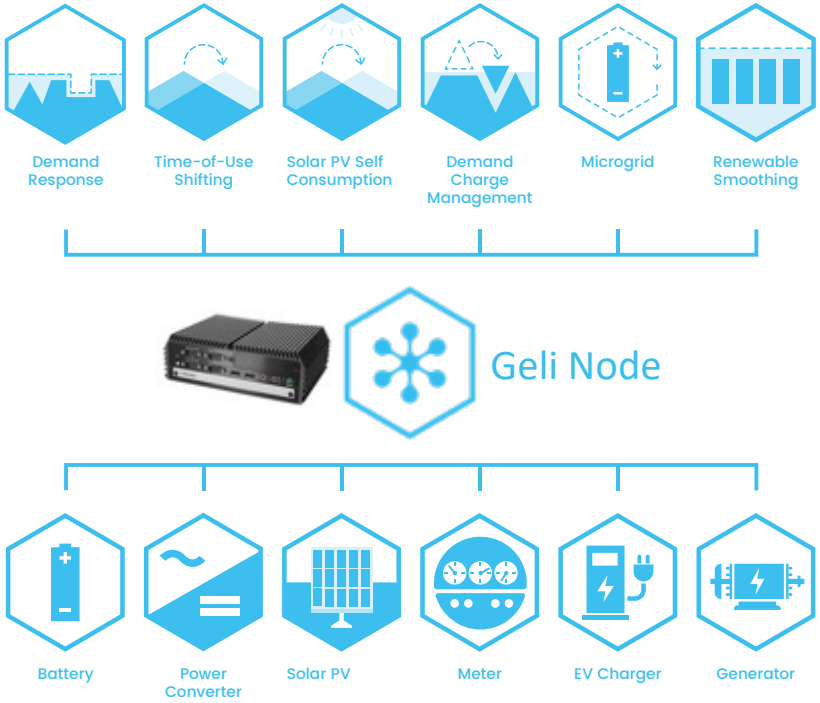
Design Time, System Sizing

- 1,800 developers
- 1+ GWh analyzed
- 10,000+ tariffs & custom tariff feature enables globalization
- 100+ hardware combinations

Notable Users:

Energy Applications:

Machine-learning algorithms, energy services



Energy Drivers:

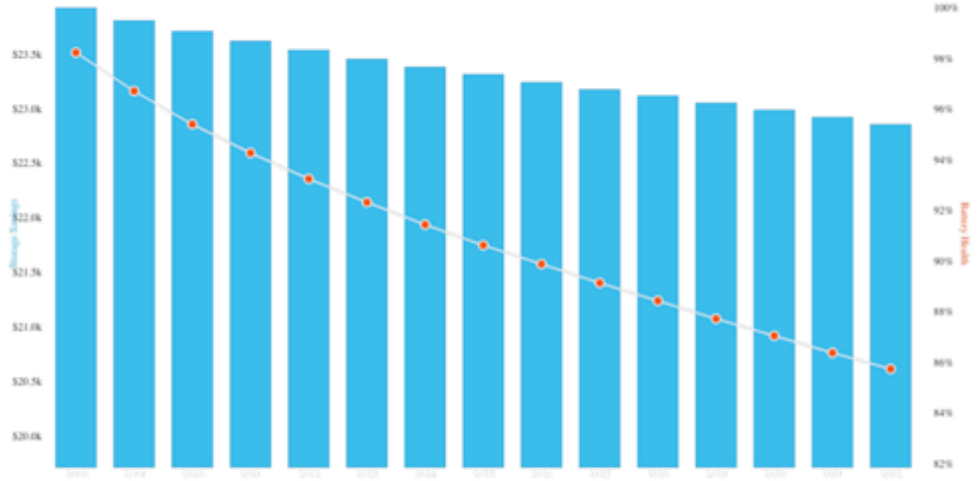
Modbus, CANbus, RS-485… almost any device

Geli EOS

Run-time Optimization

- Energy Apps delivered:
  - Peak shaving / DCM
  - TOU Shifting
  - PV Self Consumption
  - Demand Response
- Cloud & On-Site control

Battery Health



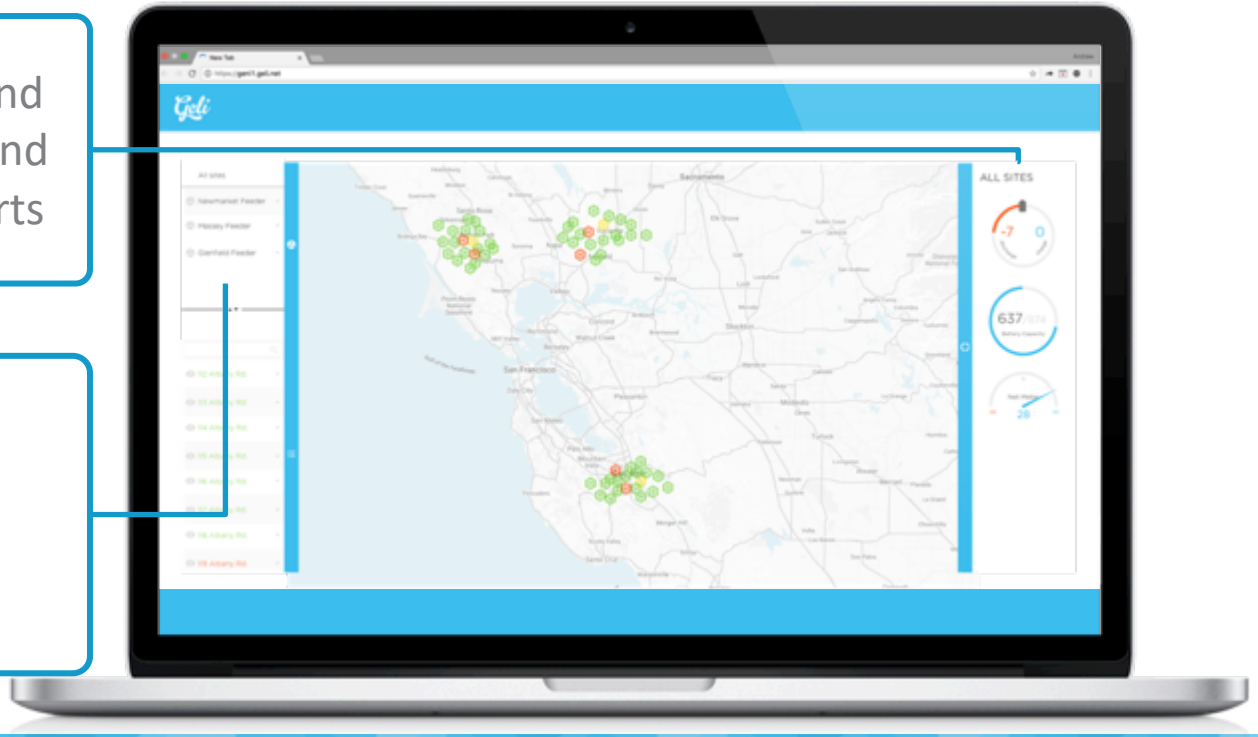
With every project simulation Geli Esyst generates a battery health model. Combining anticipated lifetime battery cycles, charge and discharge rates, and OEM-supplied degradation curves enables Geli to predict what the economic impact will be as the effective capacity of the battery decreases over time.

Battery warranties vary by vendor and can be tied to years, number of cycles, or both.

Geli GENI: Manage Sites & Networks

Management – View fleet and individual system statistics and generate performance reports

Analytics
Battery Health
Warranty Compliance
O&M Interface
Regulatory Reporting



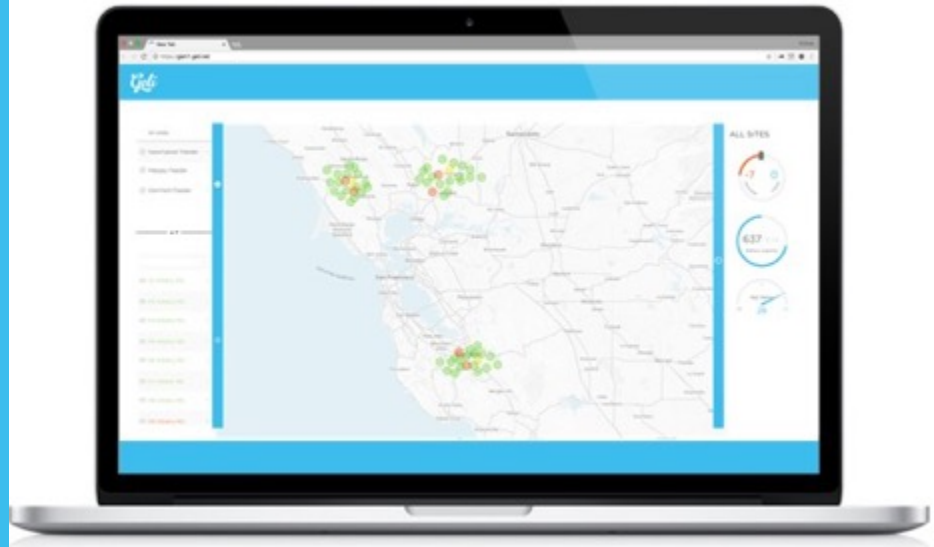
Geli VPP

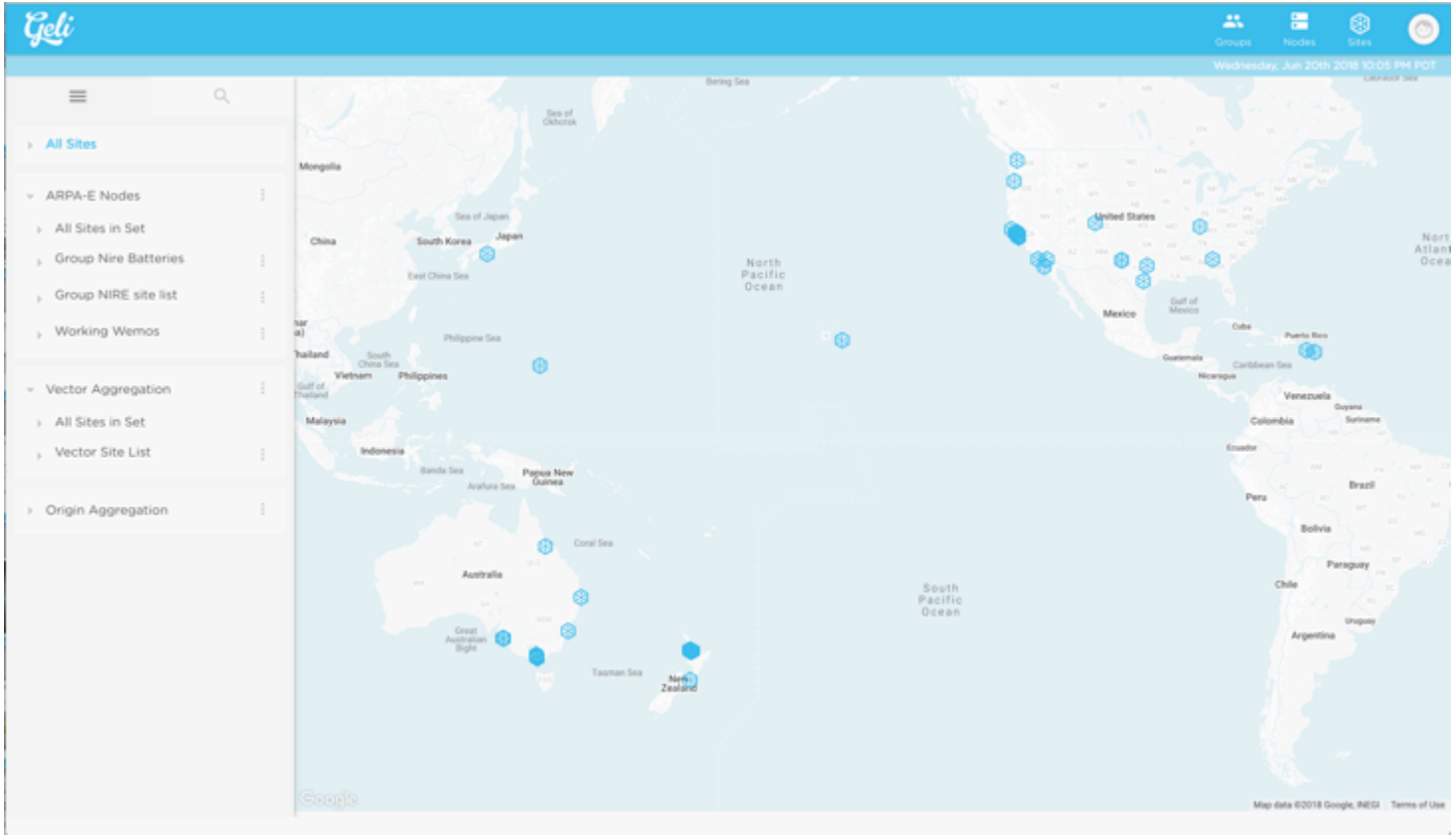
Fleet Aggregation & Participation

- Virtual Power Plant Aggregated Fleets Access
  - Behind the meter
  - Front of meter

    ….value streams

- Energy Services
  - Group & Sub-Group systems for strategic market participation
  - Forecasting & Scheduling




Geli
Groups
Nodes
Sites
Wednesday, Jun 20th 2018 10:05 PM PDT
All Sites
ARPA-E Nodes
All Sites in Set
Group Nire Batteries
Group NIRE site list
Working Wemos
Vector Aggregation
All Sites in Set
Vector Site List
Origin Aggregation
Bering Sea
Sea of Okhotsk
Mongolia
China
South Korea
Japan
Sea of Japan
East China Sea
North Pacific Ocean
United States
Mexico
Gulf of Mexico
Cuba
Puerto Rico
Guatemala
Caribbean Sea
Nicaragua
Venezuela
Guyana
Suriname
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Argentina
Uruguay
Philippine Sea
South China Sea
Vietnam
Philippines
Gulf of Thailand
Malaysia
Indonesia
Banda Sea
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Google
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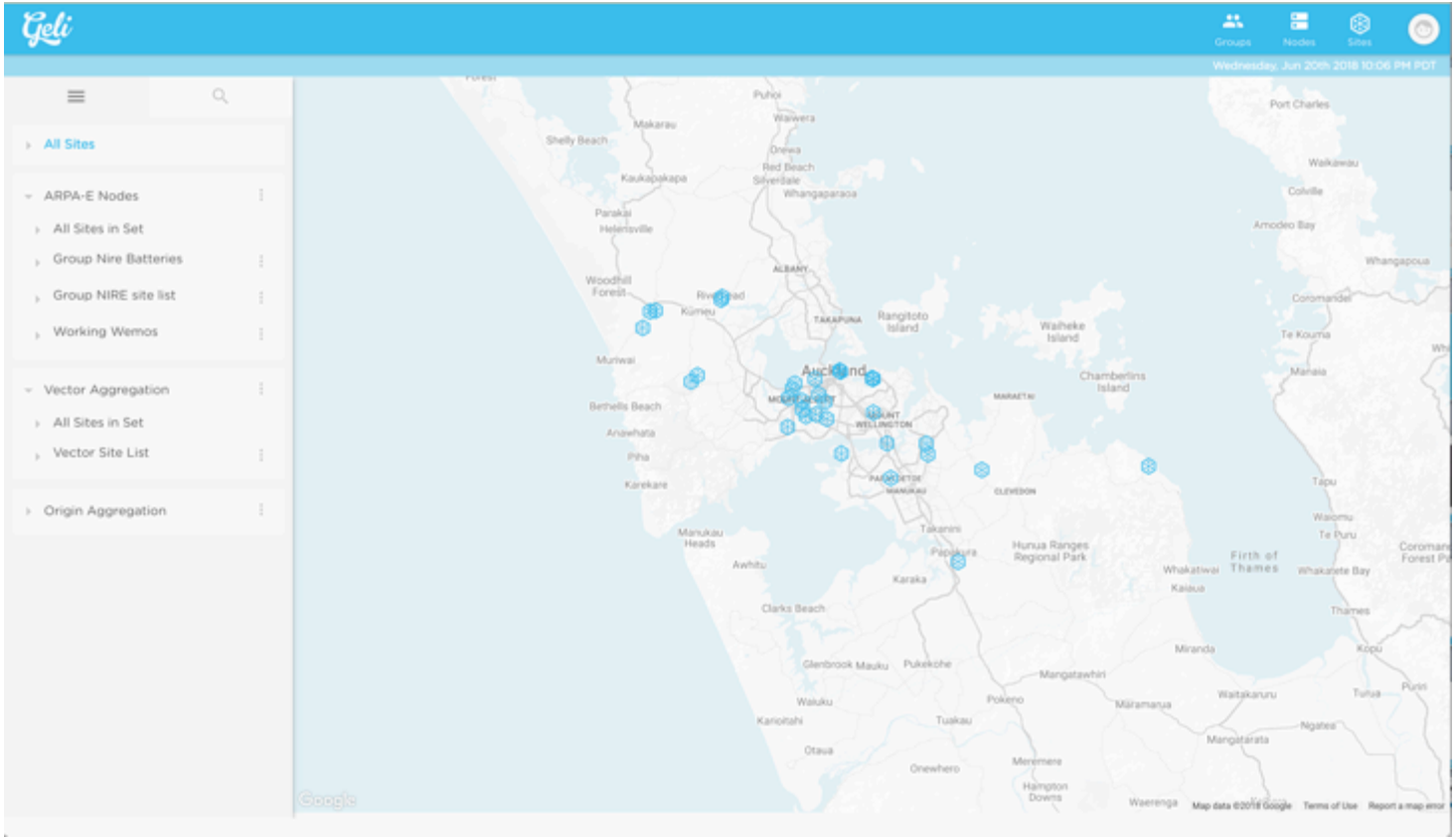
Geli
Groups
Nodes
Sites
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All Sites
ARPA-E Nodes
All Sites in Set
Group Nire Batteries
Group NIRE site list
Working Wemos
Vector Aggregation
All Sites in Set
Vector Site List
Origin Aggregation
Auckland
Puhoi
Waiwera
Makarau
Shelly Beach
Onewa
Red Beach
Silverdale
Whangaparaoa
Kaukapakapa
Parakai
Helensville
Port Charles
Waikawau
Colville
Amodeo Bay
Whangapoua
Coromandel
Te Kouma
Manaia
Woodhill Forest
Riverhead
Kumeu
ALBANY
TAKAPUNA
Rangitoto Island
Waiheke Island
Chamberlins Island
Muriwai
Bethells Beach
Anawhata
Piha
Karekare
MANUKAU
CLEVEDON
Tapu
Waiomu
Te Puru
Manukau Heads
Awhitu
Takanini
Papakura
Hunua Ranges Regional Park
Firth of Thames
Whakatiwai
Whakaiti Bay
Kaiaua
Karaka
Clarks Beach
Thames
Miranda
Kopu
Glenbrook
Mauku
Pukekohe
Mangatawhiri
Waitakaruru
Tuhua
Waiuku
Pokeno
Māramarua
Kaniotahi
Tuakau
Ngatea
Mangatarata
Otaua
Meremere
Onewhero
Hampton Downs
Waerenga
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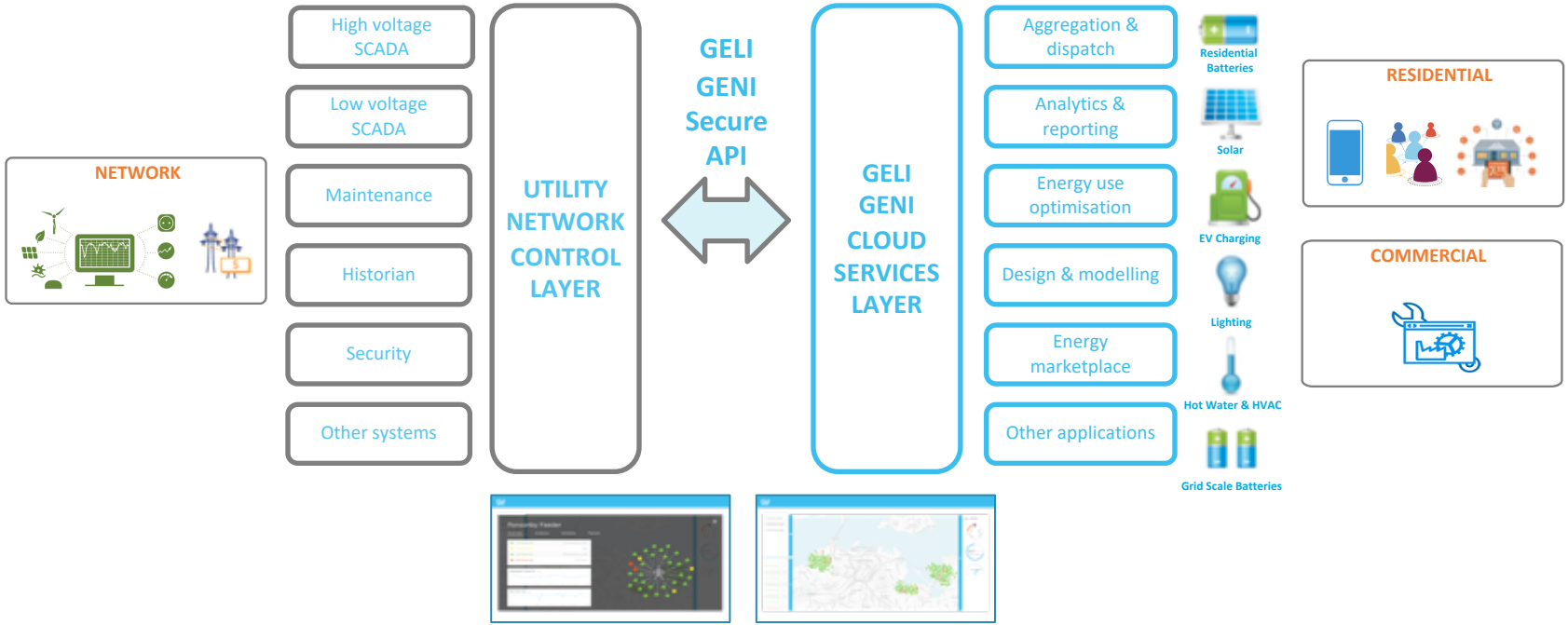
Network Value Proposition: Interoperable Aggregation

NETWORK-SIDE CONTROL PLATFORM

Optimizing network demand and forecasts

CUSTOMER-SIDE CONTROL PLATFORM

Optimizing customer demand and forecasts



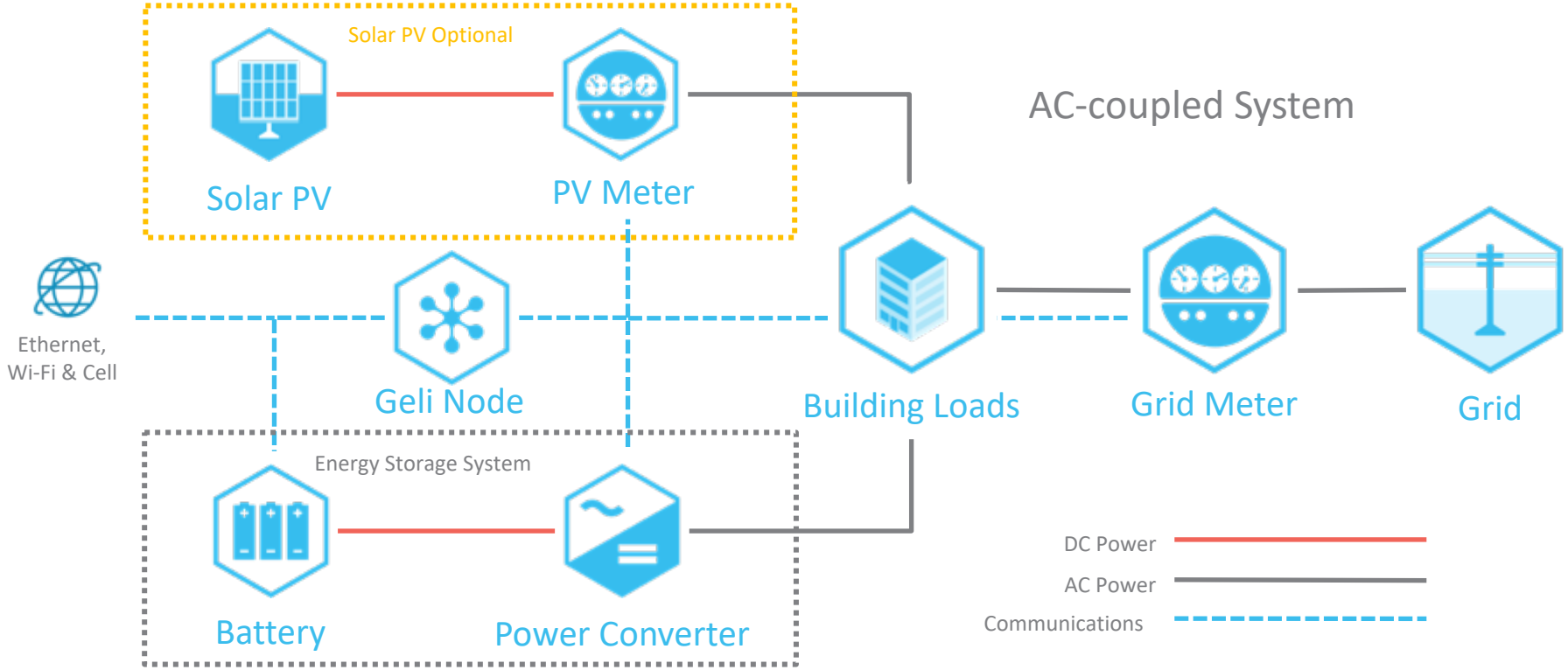
Geli provides secure connection to DERs & Enables new business models for Utility

Geli Demand Charge Management Energy App Spotlight

- Multiple forecasting algorithms for load & distributed generation
- Optimized algorithmic performance for NEM and non-NEM tariff architectures
- SGIP and ITC compliance
- Rapid payback and enhanced NPV compared to naïve DCM solutions

ESS & PVS Single Line Diagram

PVS = Solar Photovoltaic Energy Storage Systems

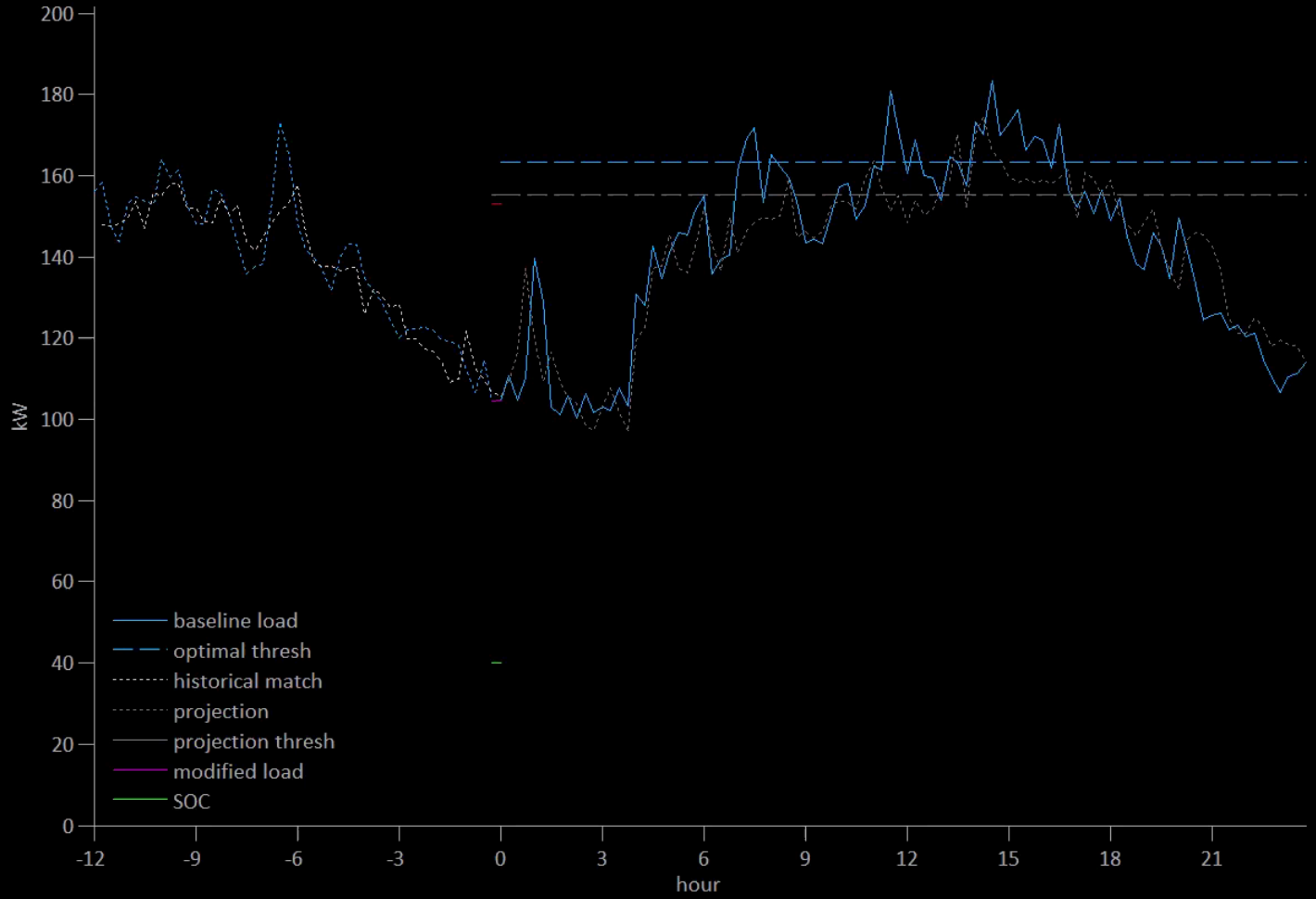


Solar Storage UPS for Logistics Facility

For Energy, Demand, and Reliability Services

- 60kW 135kWh ESS
- 300 kW solar PV array
- Demand Charge Management Energy Application
- UPS Backup Power Energy Application
- Solar Self-Consumption Energy Application
- Time of Use Energy Shifting Energy Application


Groups
Nodes
Sites
Wednesday, Jan 9th 2019 1:34 PM PST
All Sites
DEPENDABLE HAWAIIAN EXPRESS
January 9, 2019 1:34 PM PST
Dashboard
Overview
DCM
Analytics
Rules
Load (kW)
Baseline Load
Load Post Solar
Net Load (Post Solar and Storage)
PV (kW)
PV Generation
Battery (kWh)
Battery SOC
Billing Cycle
16 Aug, 2017 to 15 Sep, 2017
Period
24H
1W
All
REPORT
IMAGE
DATA
9/5/17 2:04:38 pm
US/Pacific
9/5/17 2:04:38 pm
Baseline Load
139.45 kW
Load Post Solar
-71.33 kW
Net Load (Post Solar and Storage)
-71.33 kW
PV Generation
No Data
Battery SOC
89.10 kWh
Tariff
Utility - Southern California Edison Co
Tariff Name - TOU-GS-2-B


200
180
160
140
120
100
80
60
40
20
0
kW
-12
-9
-6
-3
0
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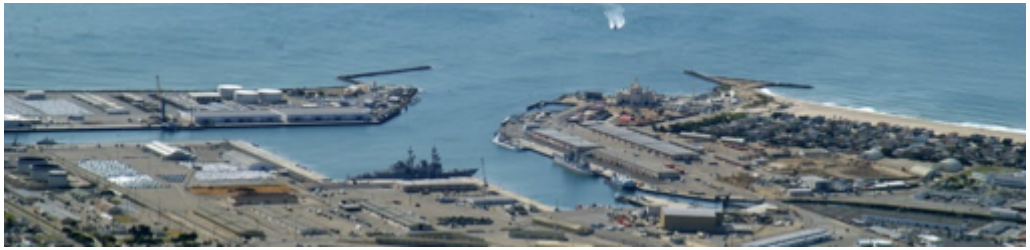
6
9
12
15
18
21
hour
baseline load
optimal thresh
historical match
projection
projection thresh
modified load
SOC

Port Hueneme Naval Base

Imergy is pleased to be a part of this project with Foresight Renewable Solutions, Geli, and the U.S. Navy. For military personnel, energy security can mean the difference between life and death. This Smart Grid project will pave the way for more secure energy solutions at mission critical military and other facilities.

- Bill Watkins, CEO Imergy Power Systems



Est. Completion:
Q4 2015

Port Hueneme Naval Base

Port Hueneme Naval Base

Hawaii Microgrid: 200kW PV, 1MWH ESS

Projects Review: Campus Microgrids

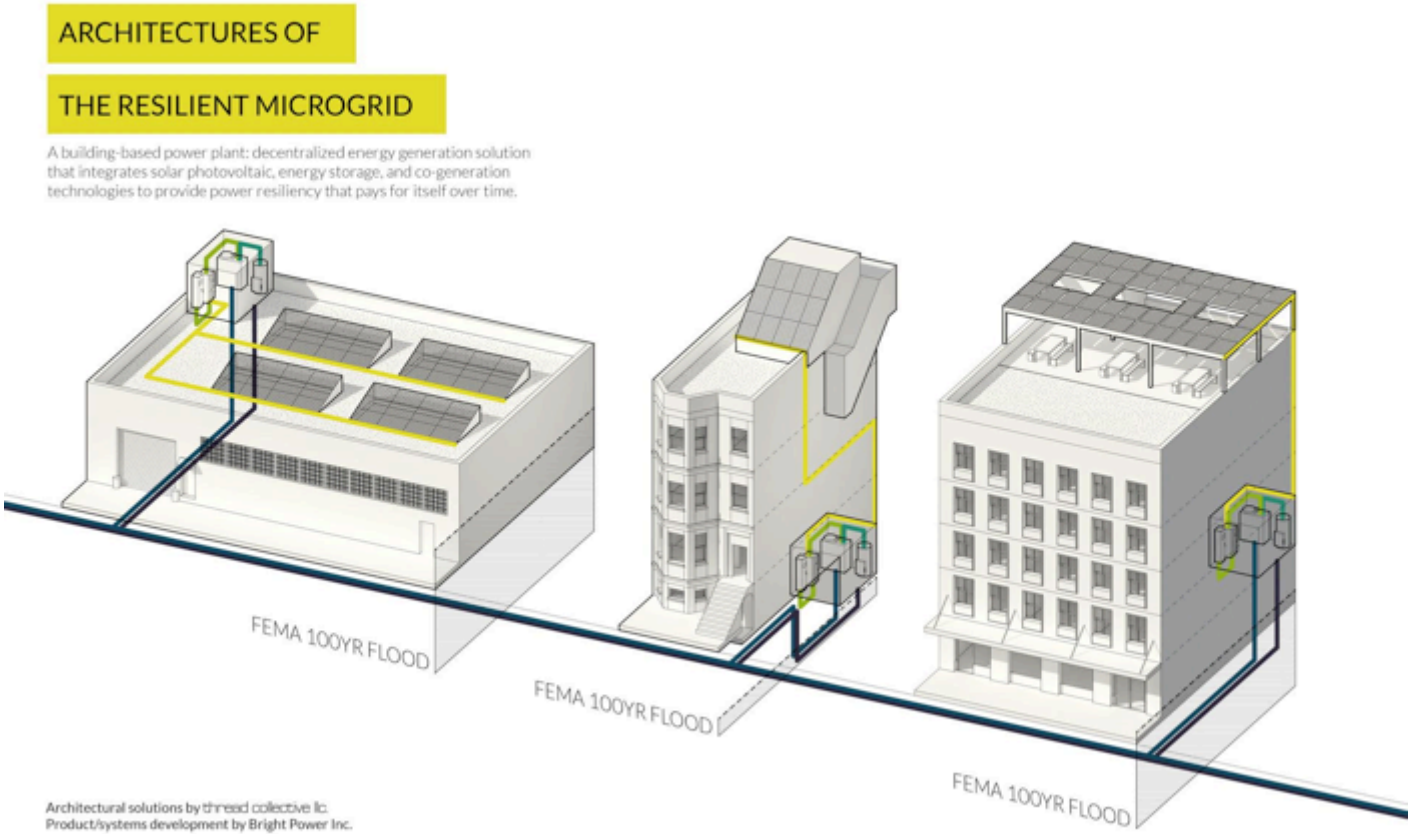
Las Positas Community College Microgrid 2MW Peak
2.3MW DC PV & 200 kW / 1MWh kWh ESS
Integrating w/ Trane Chillers & Thermal Storage
Model for IEEE2030.7 Microgrid Operations
Provide DR and Capacity Market services

PVS Project Review:
St. Croix Apartment Complex Microgrid

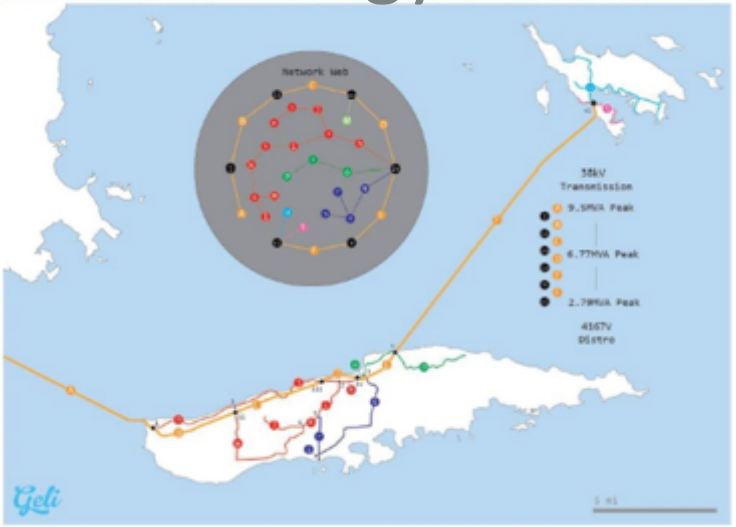
Microgrid System Provides

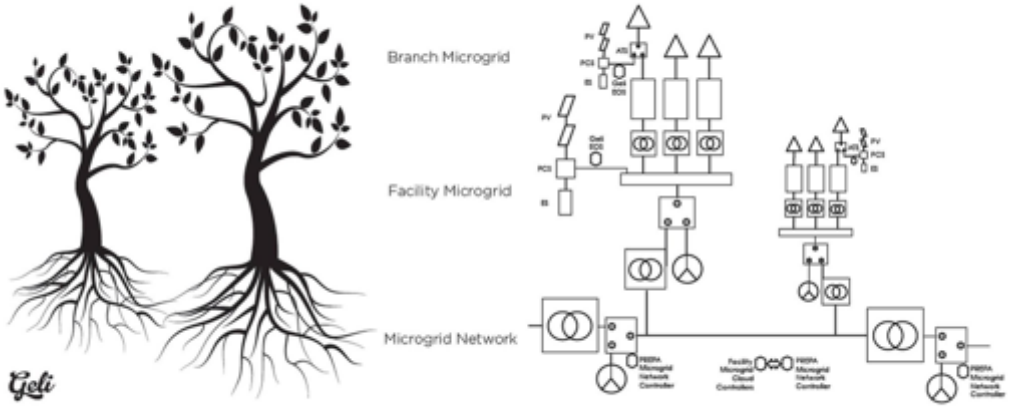
- PV: 163kW
- ESS: 250kW/655kWh
- GENERATOR: 2 x 100kW
- 24/7 Power for Apartment Complex
- Solar PV self-consumption
- Solar PV management
- Energy services for site not reached by Utility

NY RISE Resilient Energy Hubs



Island Energy Networks Design





Proposed Microgrid Topology = Branch Microgrids + Facility Microgrids + Microgrid Network

Economic viability of the Microgrid Network - There are five (5) major economic value streams we have identified: (1) facility demand charge management, (2) self-consumption of locally generated renewable energy, (3) a reduced dependence on diesel generators, (4) provision of dispatchable energy services such as demand response, (5) support of critical services and loads for the community during extreme weather & power outages. We will provide results on the economic performance of our Scalable Microgrid and Microgrid Network designs as part of the final report if awarded this grant. The proposed Microgrid Network has a peak load of 9.5 MVA and peak capacity of 14.5 MVA. We have modeled the overall Microgrid Network. A 18.4 AC MW PV system coupled with 2 MW of biomass generation and 12 MW / 60 MWh of energy storage would allow for 100% renewable operations.

Vieques 2014