SolarCity
Power forever.

Renewable Energy Integration for Islands

May 25th, 2016

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Agenda

9:30 – 10:00	Introductions
10:00- 10:15	SolarCity Overview
10:15- 10:45	Growth of Renewables on Hawaii
10:45- 11:00	Break
11:00- 11:45	Grid Engineering Solutions – Hawaii
11:45-12:30	Utility Scale Solutions
12:30-1:30	Lunch and Questions

TESLA

SPACEX
Space Exploration Technologies

SolarCity

Our Vision

To create the most compelling energy company of the 21st century by delivering cleaner, cheaper power through distributed generation.

SolarCity is the #1 full-service Commercial solar provider in America*

Major Corporate Statistics:

9	Years of experience
26	States with installations
80+	Operation centers
400+	School installations
1,600+	MW installed
2,000+	Commercial projects
15,000+	Employees
$9 Billion+	Of solar projects

Key Business Model Differentiators:

Technology Leadership
Developed and / or acquired technology and IP at multiple segments of value stream.

Turn-key Solution
Manage all aspects of project life-cycle from origination through ownership / operations.

Financing Expertise
Pioneer financing vehicles, prove bankability, and scale with large institutional investors

* According to the Q1 2015 GTM Research U.S. PV Leaderboard.

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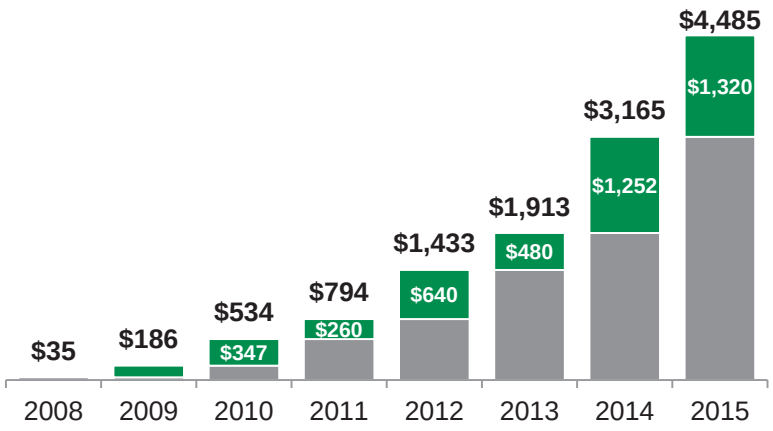
Financing Expertise

- $4.5B in tax equity raised since 2008, many repeat investors
- $1.3B raised in 2015 alone; continued standardization of transactions
- Developed and launched sophisticated financing structures (ABS)

SolarCity bridges the gap between institutional investors, technology, large pools of assets, and distributed customer operations

Tax Equity Raised ($M)*



Select Tax Equity Investors

Goldman Sachs
Google
Bank of America Merrill Lynch
US bancorp
JPMorgan Chase & Co.
Credit Suisse
Direct Energy
Rabobank
HONDA The Power of Dreams
PG&E Corporation

** Green denotes new investment funds raised in the period. Dark green represents cumulative fund raising from prior years. Financing amounts denoted in $ millions.. 2015 Amounts as of November 2015.*

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Turn-key Project Solutions

As we scale internationally, we plan to maintain this integrated business model while developing and / or acquiring necessary skills & workforce locally.

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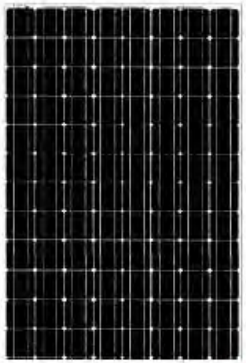
Technology Leadership

Solar Modules

- Triex Tunneling Junction
- High efficiency / low cost
- 24% target cell efficiency

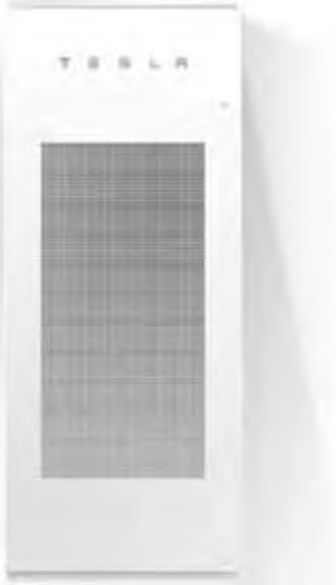


Mounting hardware and Balance of System

- Faster installation, lower cycle time
- Superior aesthetics

Software

- System design automation
- Energy production forecasting
- Logistics and resource management
- Utility rate tariff database
- Energy usage evaluations
- Customer account management
- Customer applications



Grid Control Systems

- Real-time energy monitoring
- Voltage control
- Energy storage integration

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Our Goal is to Build the Best Module on the Planet

World Record Panel: 355W at 22% efficiency

RETC SN	Remarks	Voc (V)	Vmp (V)	Isc (A)	Imp (A)	Pmax (W)	FF (%)	PT (°C)	Eff (%)
C-CA-1410-SIE-105-B	Indoor	48.788	41.760	9.033	8.500	355.000	80.552	24.730	22.043

- 99% Cell-to-Module Efficiency
- Highest Packing Density
- Minimum Series Resistance Loss
- Improved Shading Loss Protection
- No Light Induced Degradation (LID)
- Excellent Temperature Performance

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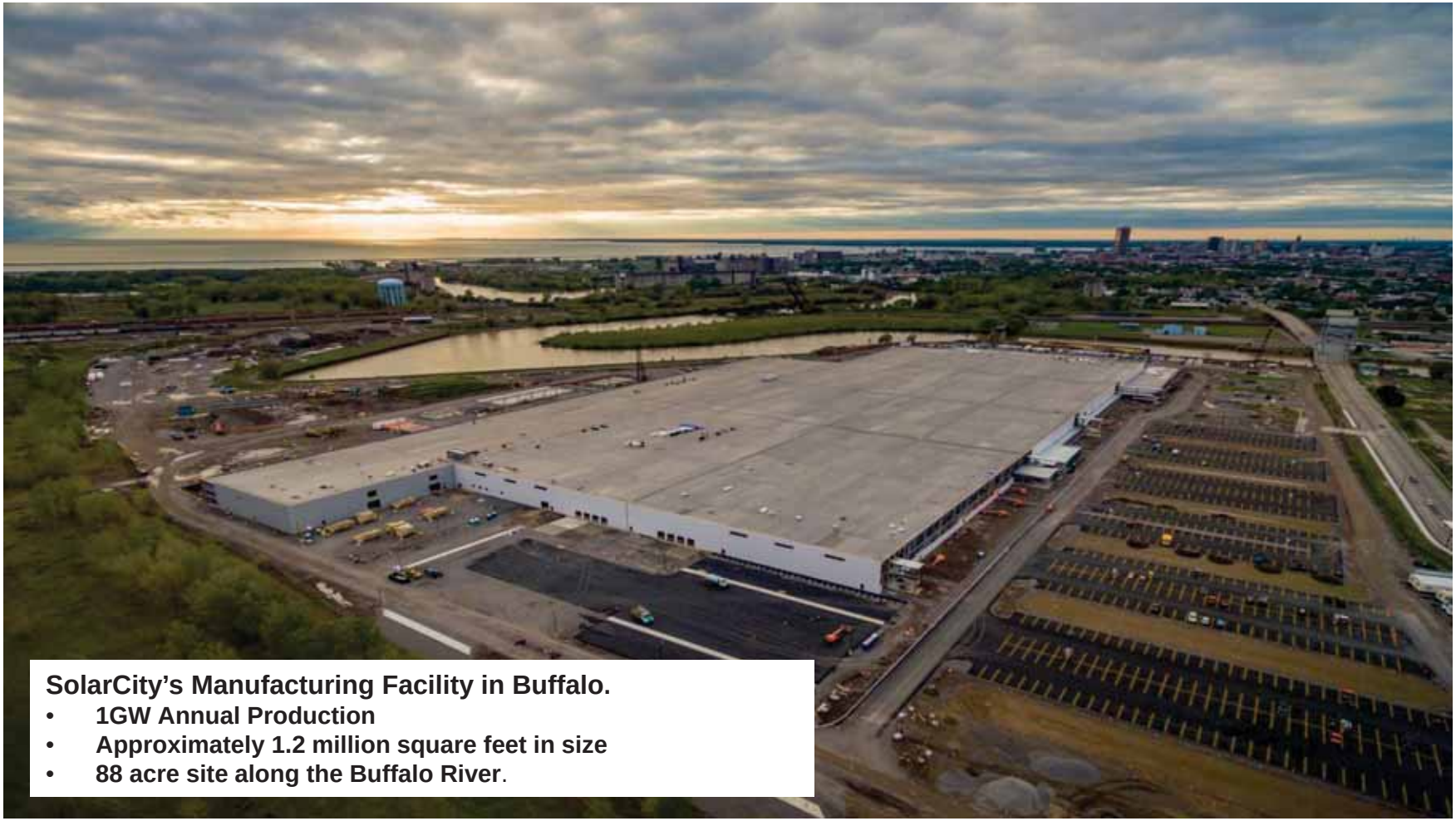
And to achieve breakthrough economics with a combination of technology, process efficiency, and scale



SolarCity's Manufacturing Facility in Buffalo.

- **1GW Annual Production**
- **Approximately 1.2 million square feet in size**
- **88 acre site along the Buffalo River**.

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Storage Technology Leadership

- SolarCity has worked with Tesla for 5+ years on batteries
- Developed suite of battery products + internal software
- Uses the same Li-ion “cell” packaging technology as the Tesla automobiles
- Fully integrated grid scale and distributed storage

Powerpack

- 250kW / 100 kWh blocks
- 100% DoD
- Fully scalable

Powerwall

- 6.4 kWh units
- 100% DoD

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Tesla PowerPack System

- Li-ion technology for performance and long-term reliable operation
- Capable of Grid-Connected and Off-Grid operation with fast transitions
- Widely deployed in commercial and utility applications
- Designed for outdoor use / pad mounted
- Integrated thermal management system
- Attractive aesthetics (no shipping containers)
- Can be easily expanded to accommodate load growth and project phasing (100 kWh building blocks, can scale indefinitely)
- 10 year workmanship and performance warranty

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Tesla Gigafactory

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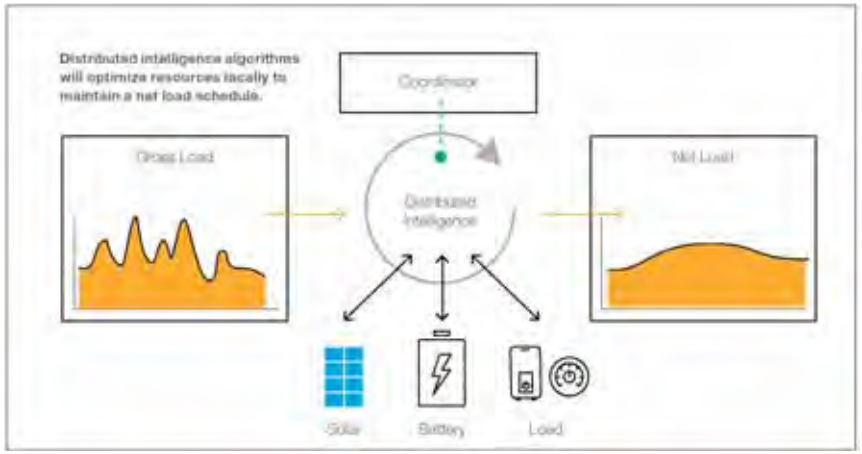
SolarCity Controls and Monitoring

Grid Connected Operation
- Energy off-set
- PV Smoothing
- Demand Charge reduction
- No-Export if needed

Grid Independent Operation
- Maintains electric system stability with high penetrations of renewables
- Integrates Solar, Battery System, and Diesel generator
- Load prioritization

Transitions
- Momentary disconnect transition
- Seamless reconnect
- Extensive experience working with Utilities

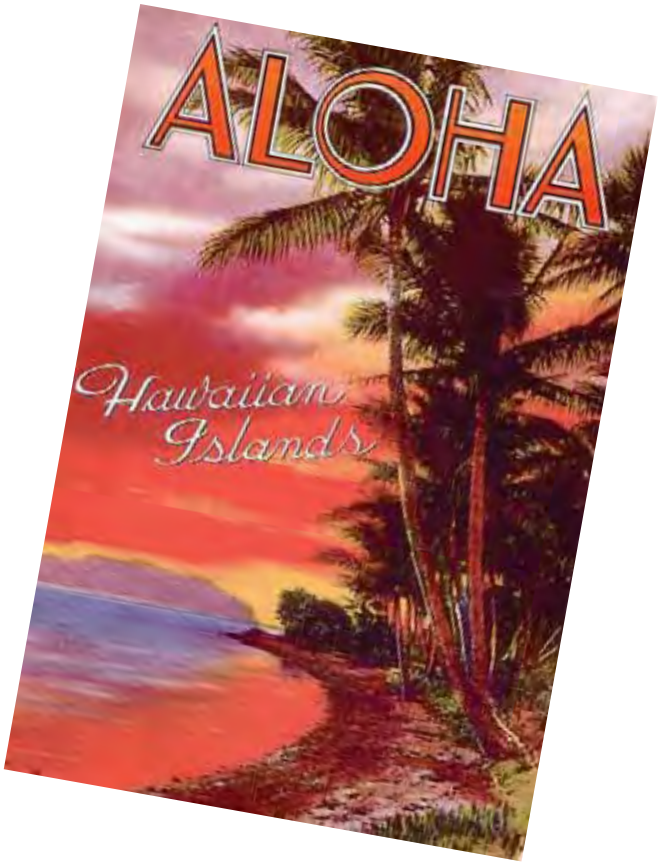
Monitoring
- Real time and historical monitoring
- Performance reporting



Growth of Renewables - Hawaii

Hawaii Regulatory Background

- Postcard from the future
- Challenging regulatory environment
  - *…because:*
    - Isolated grids
    - High solar & renewables penetration
  - *…demands:*
    - Collaboration with utilities & government
    - Development of new technical solutions
      - Brings more solar online
      - Adapts to shifting regulations
      - Provides value to customer
  - 100% RPS by 2045



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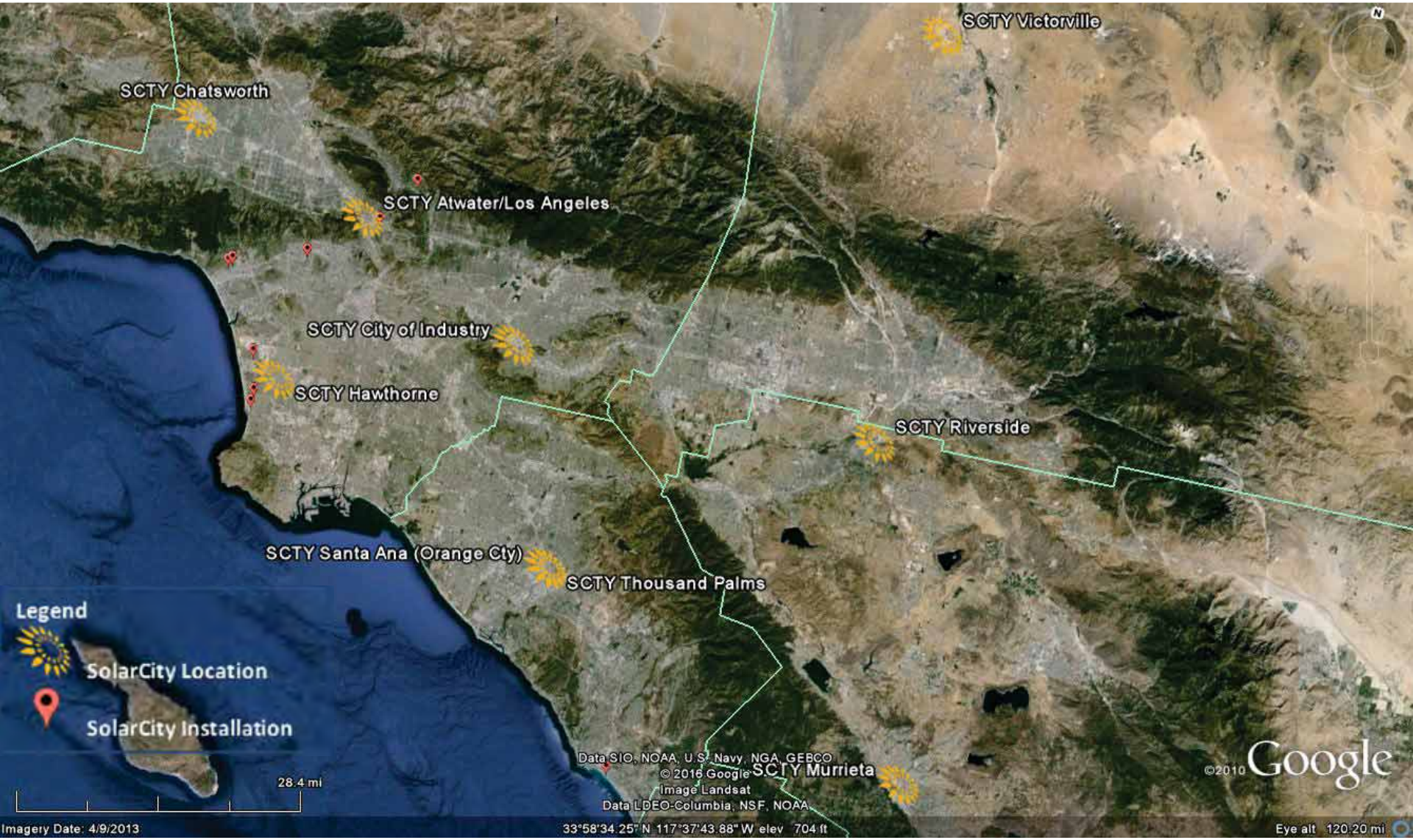
2007 = 84 kW



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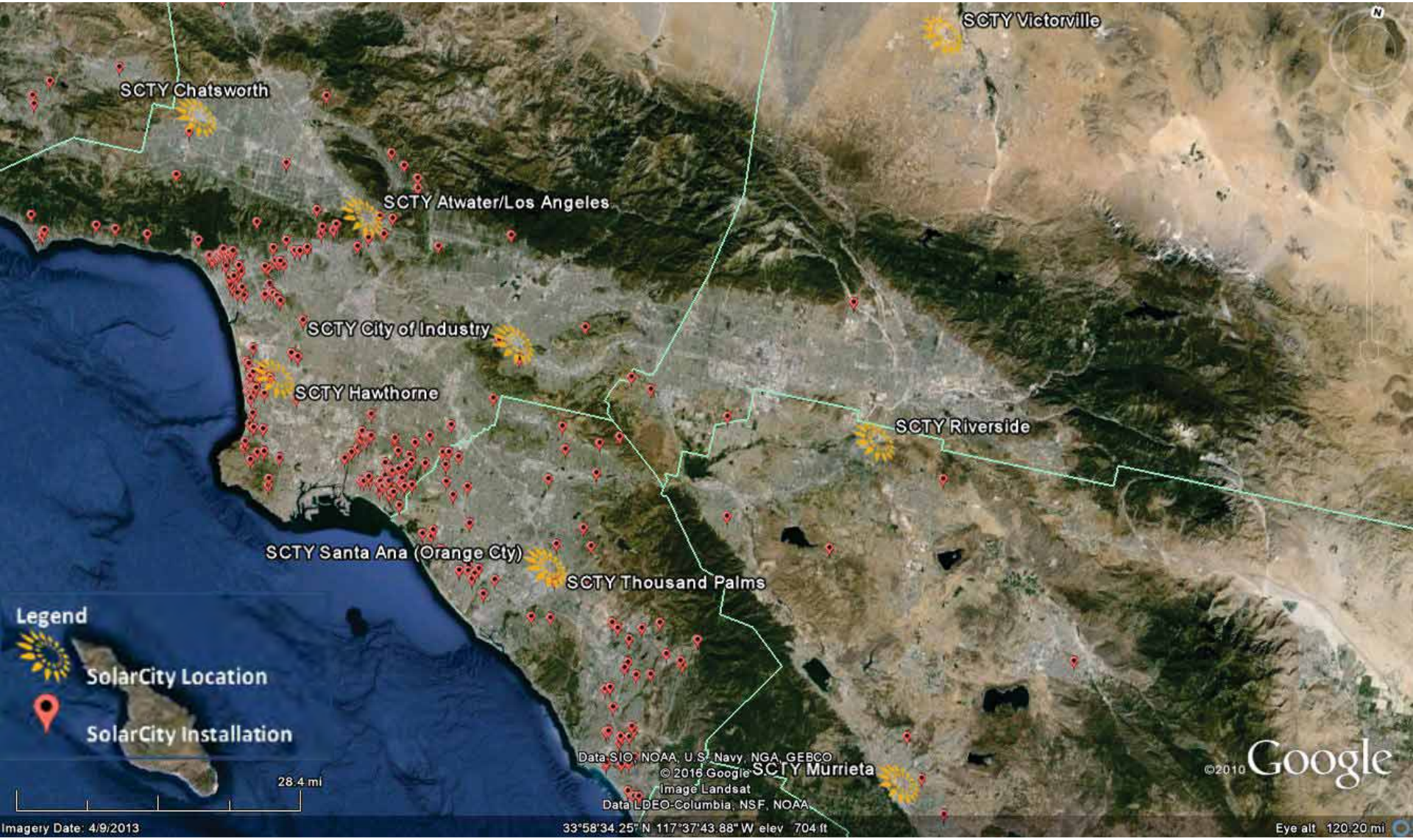
2008 = 1.8 MW



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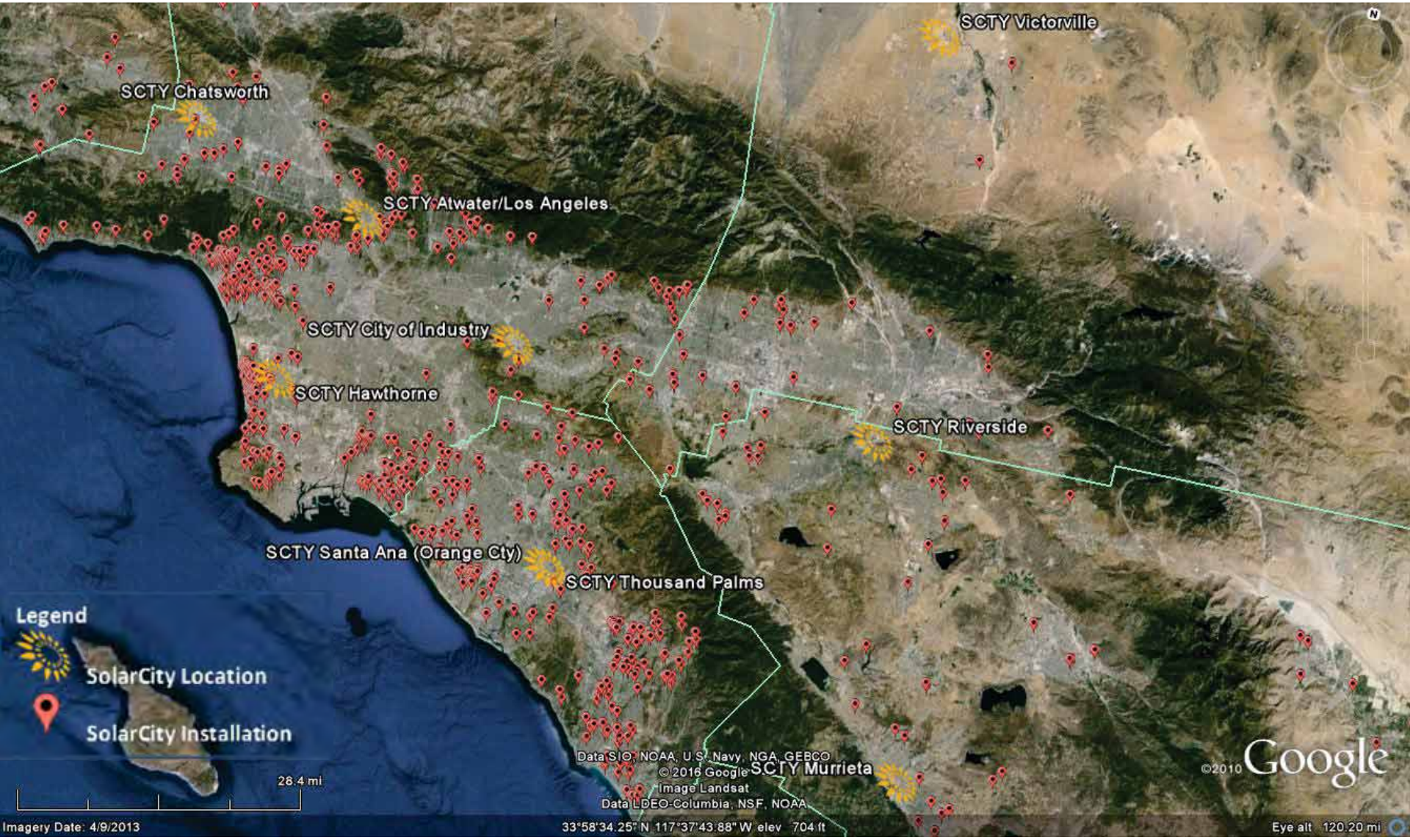
2009 = 5.5MW



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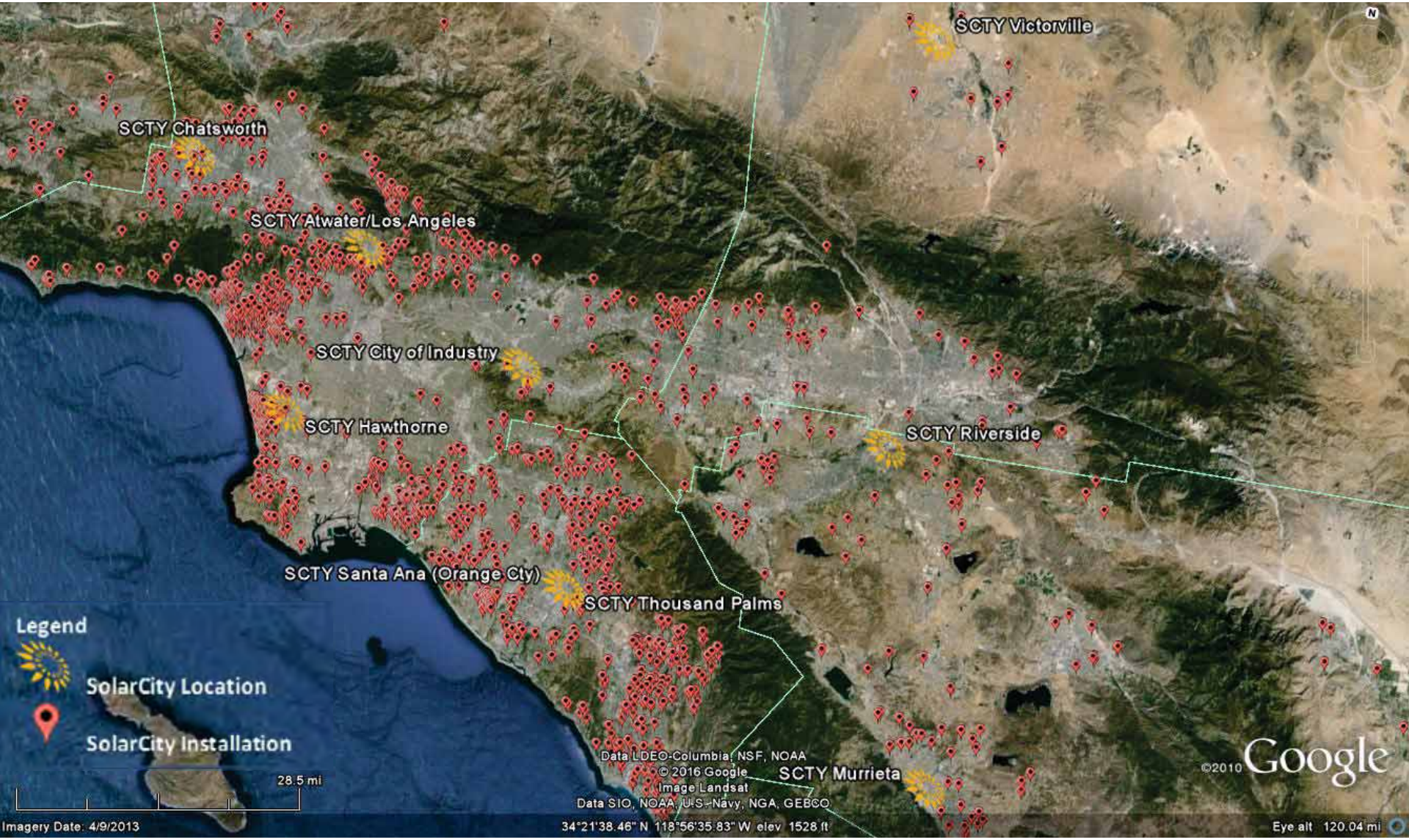
2010 = 12.7 MW



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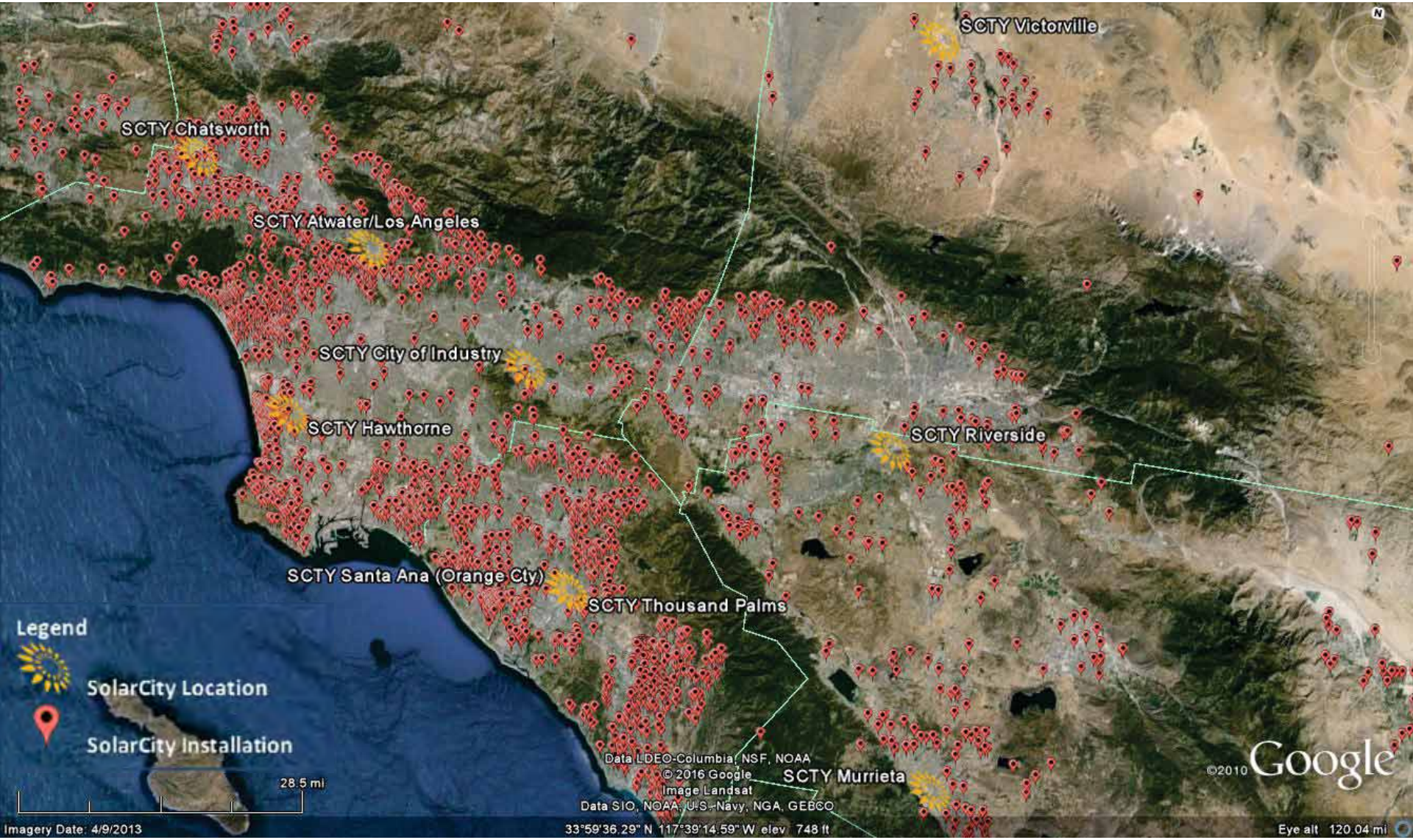
2011 = 36.0 MW



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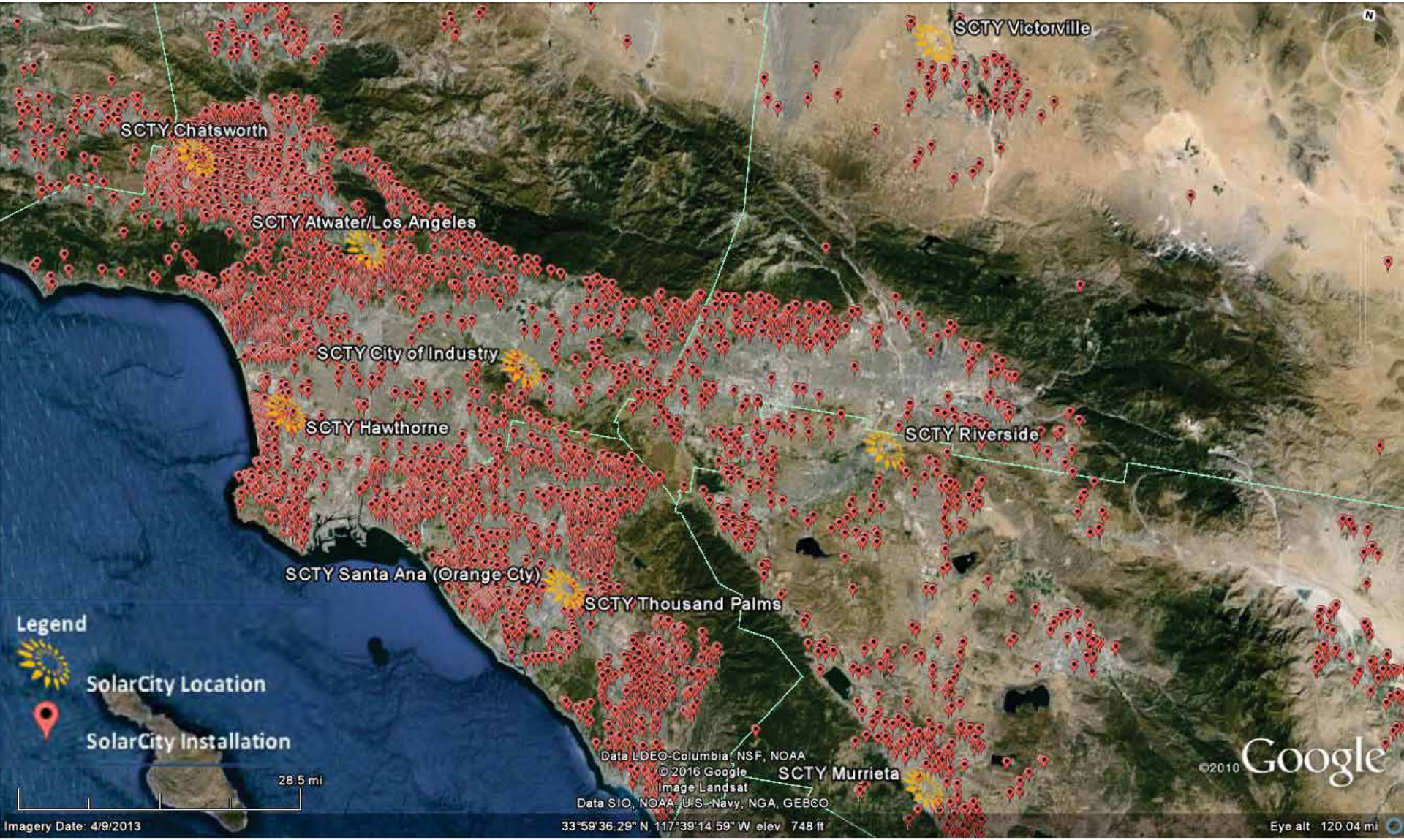
2012 = 73.2 MW



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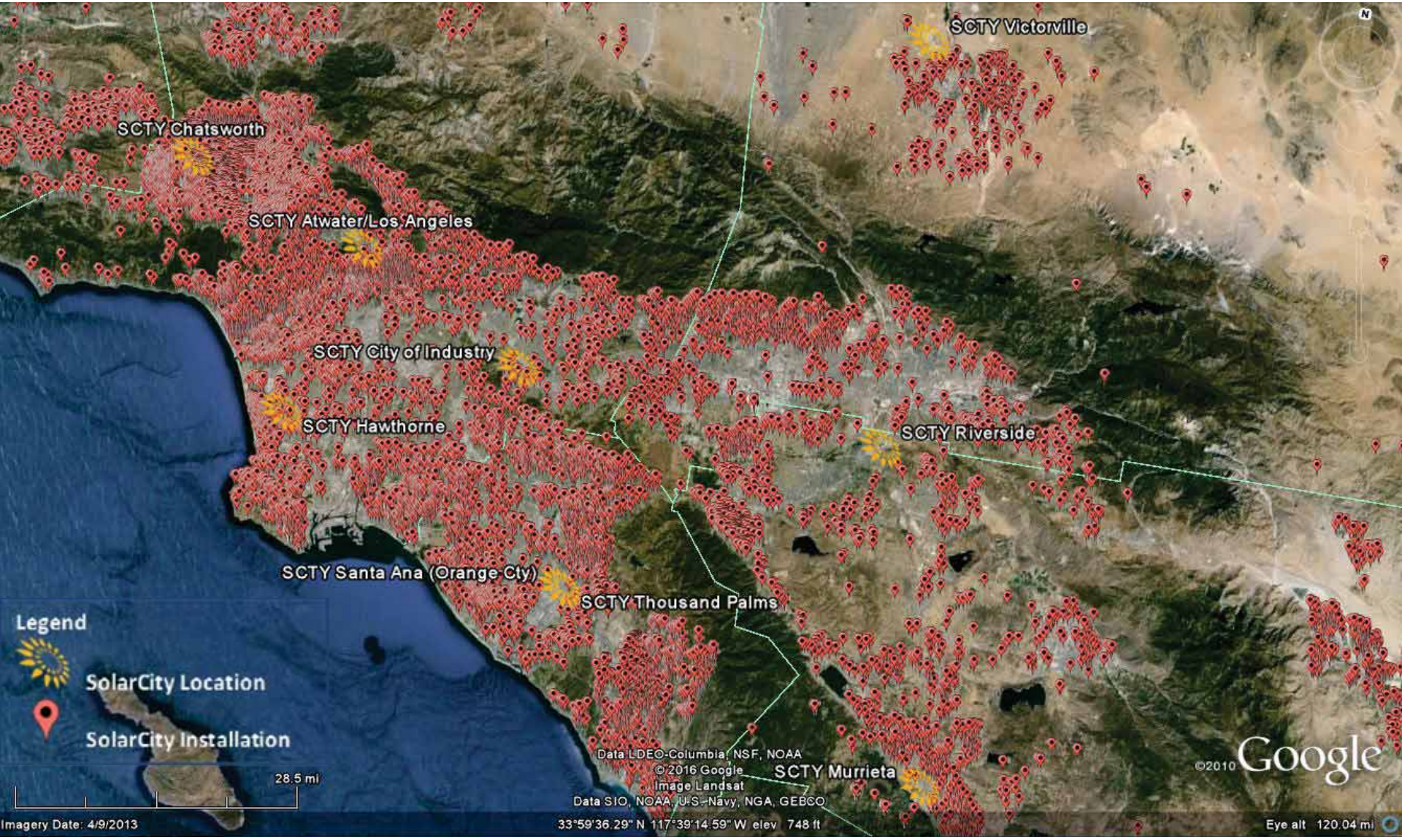
2013 = 130.9 MW



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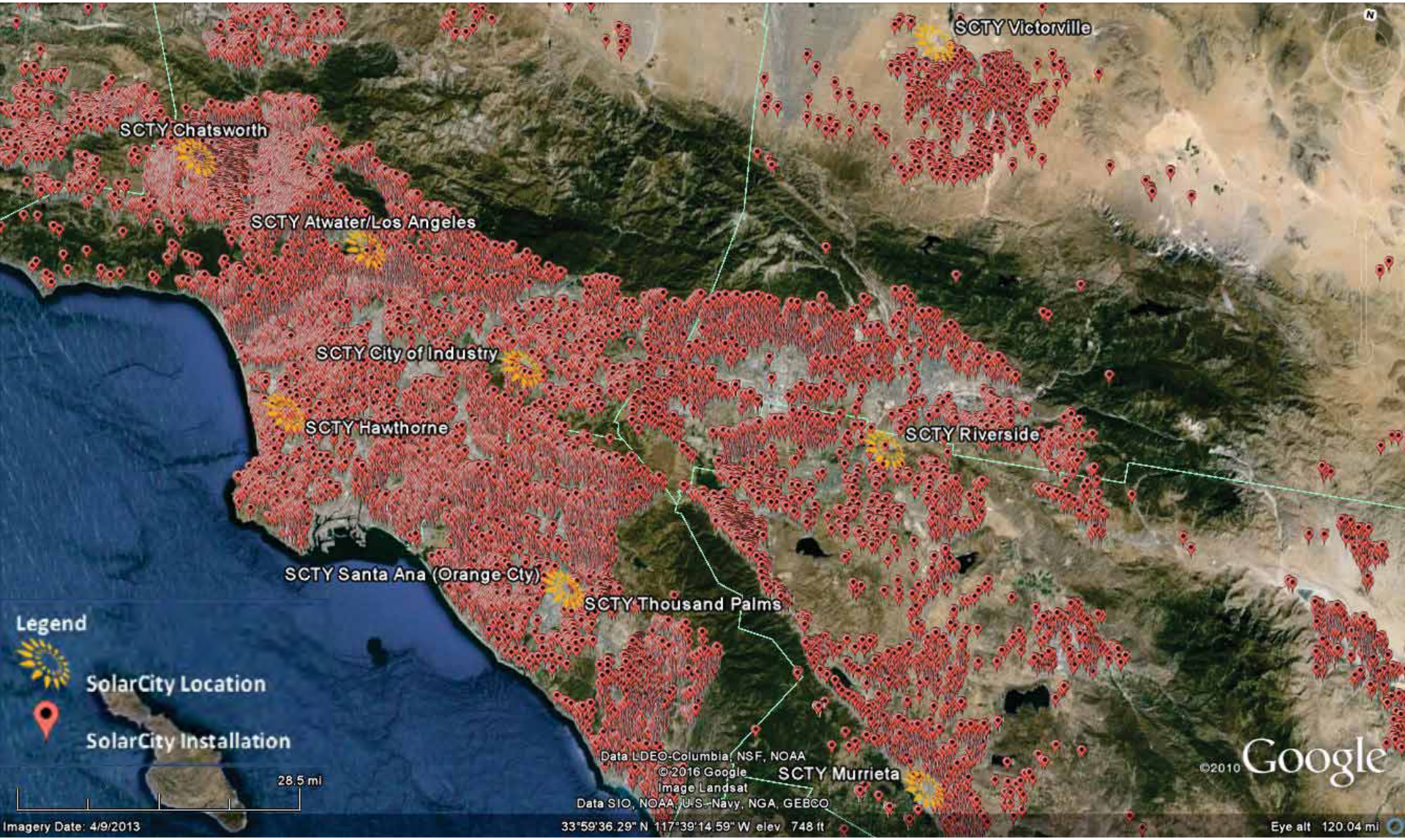
2014 = 211.5 MW



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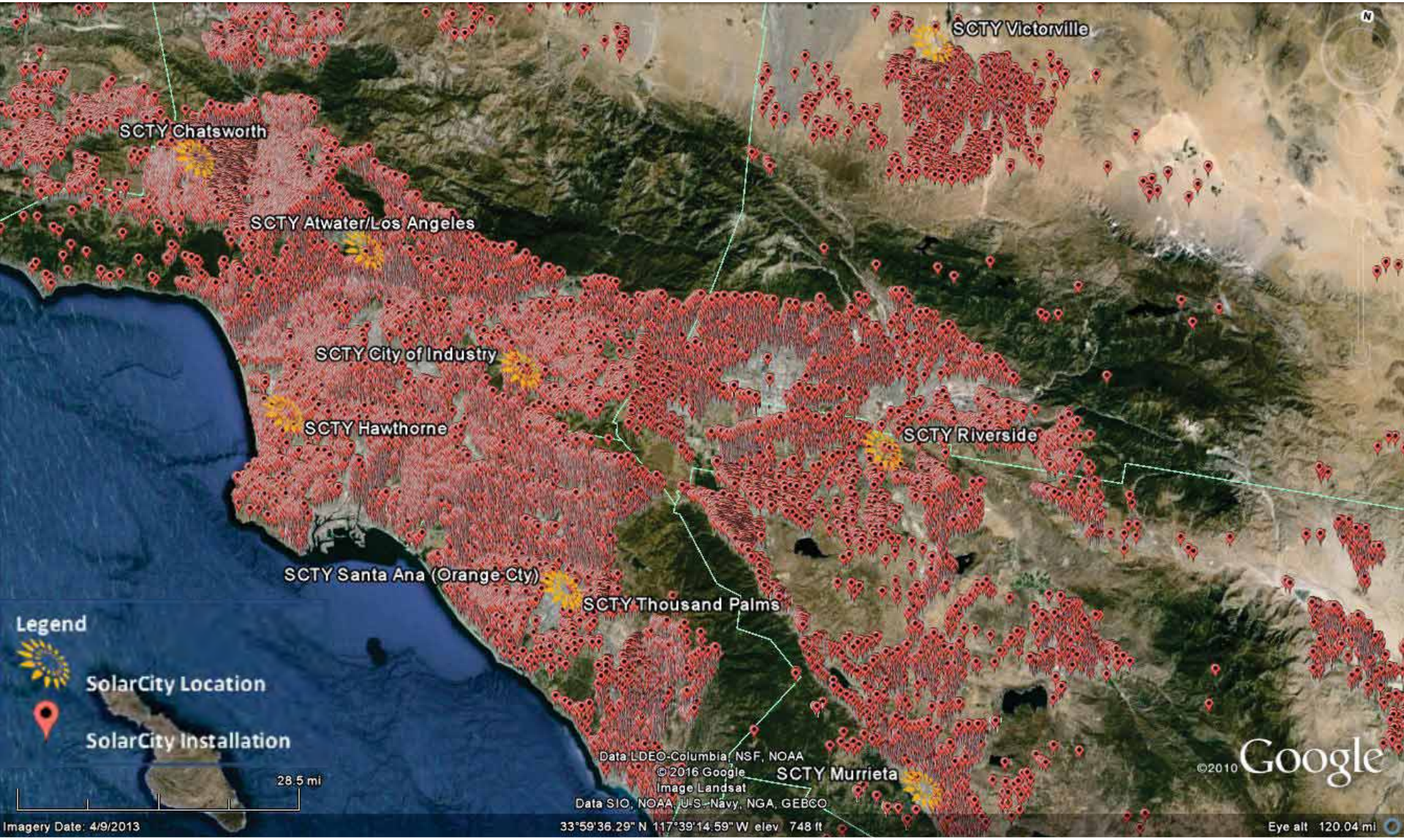
2015 = 309.2 MW



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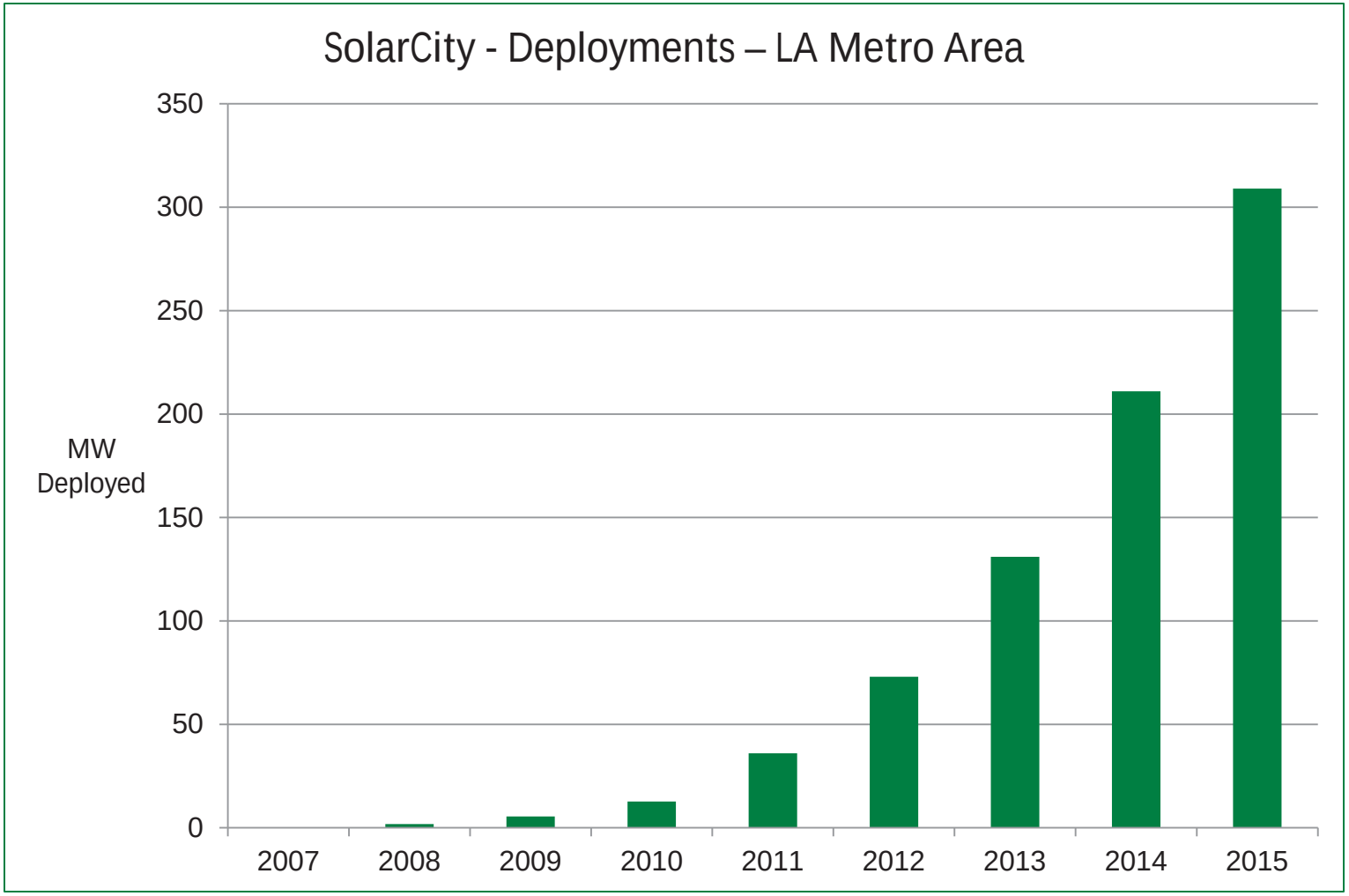
Solar Growth in Los Angeles Metro Area



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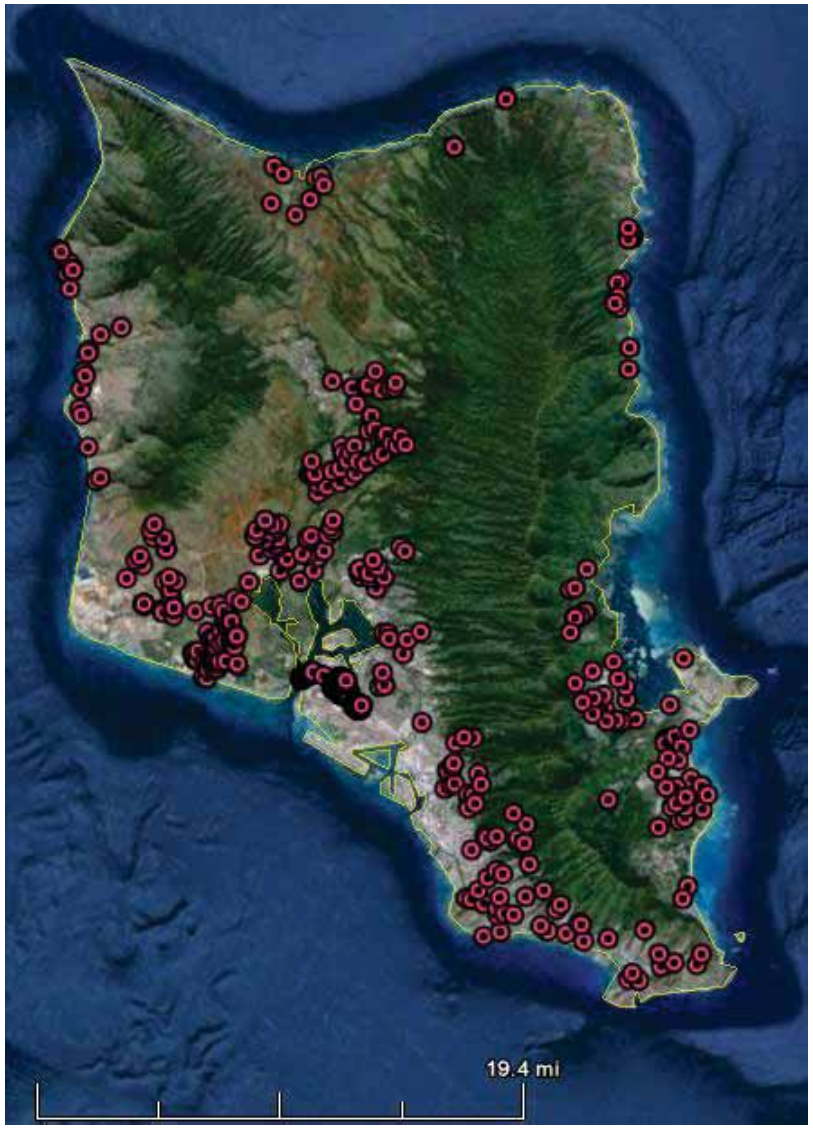
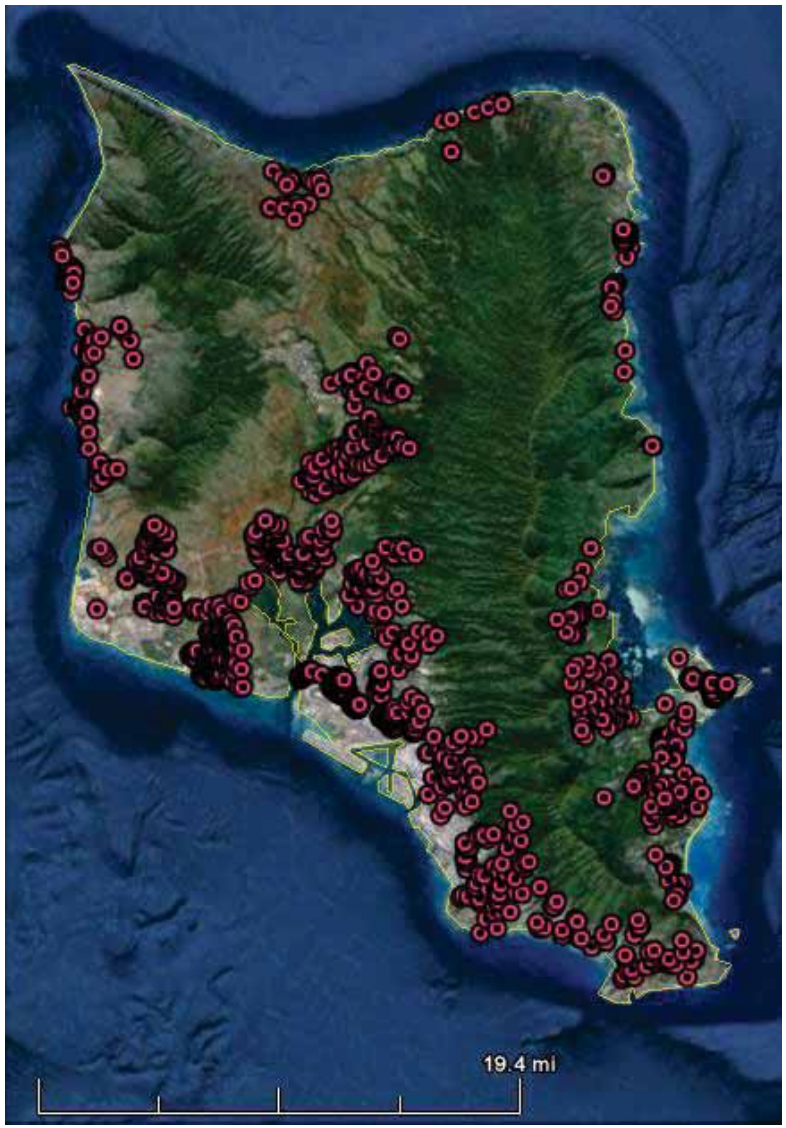
2011 = 0.5 MW

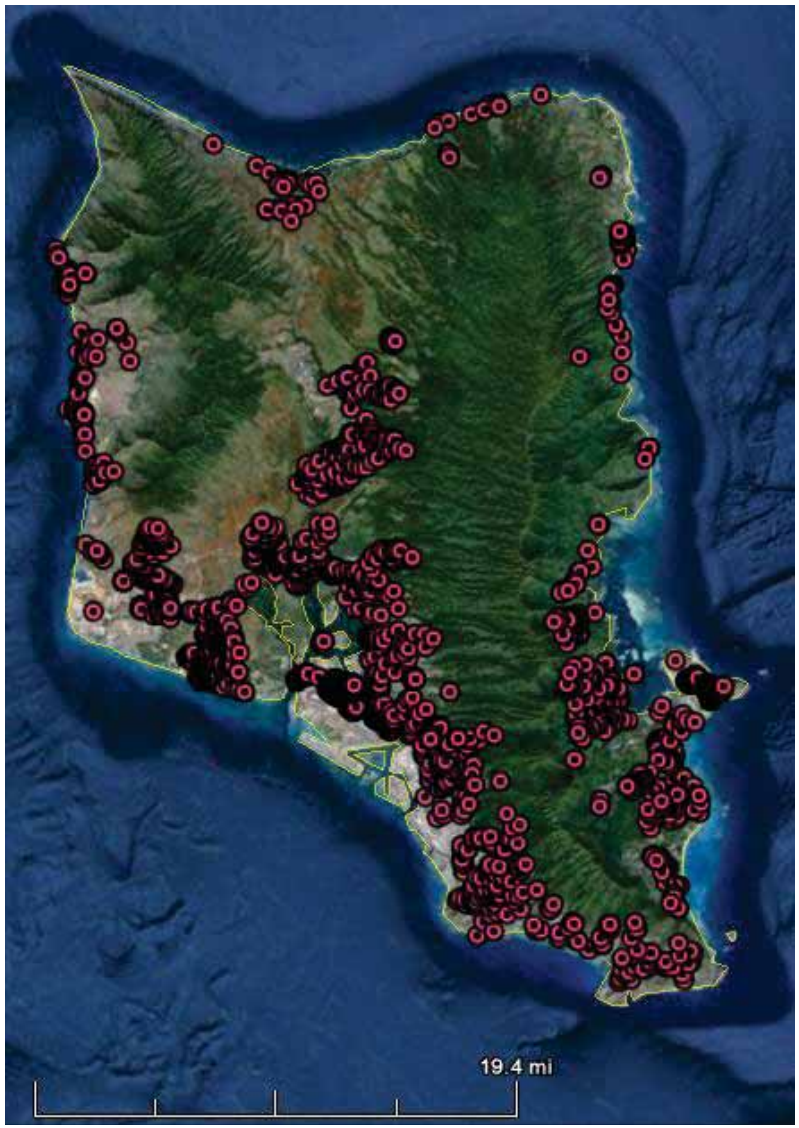
2012 = 7.5 MW



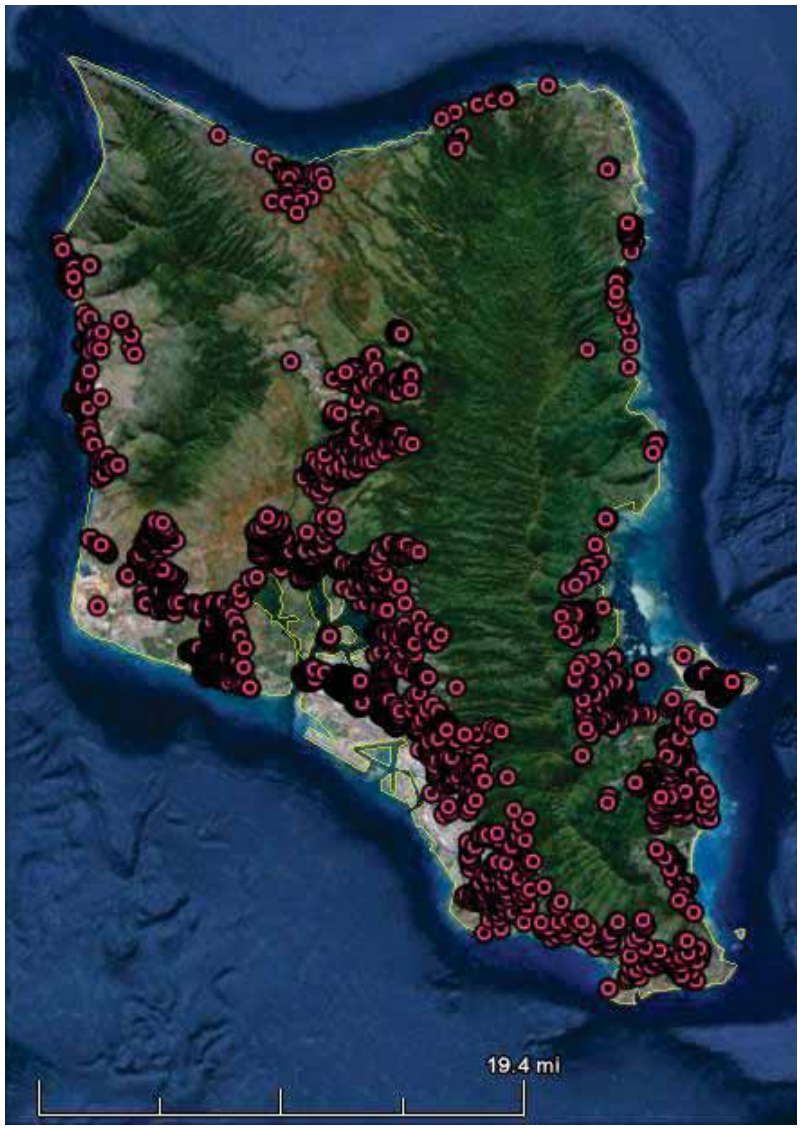
2013 = 18.7 MW



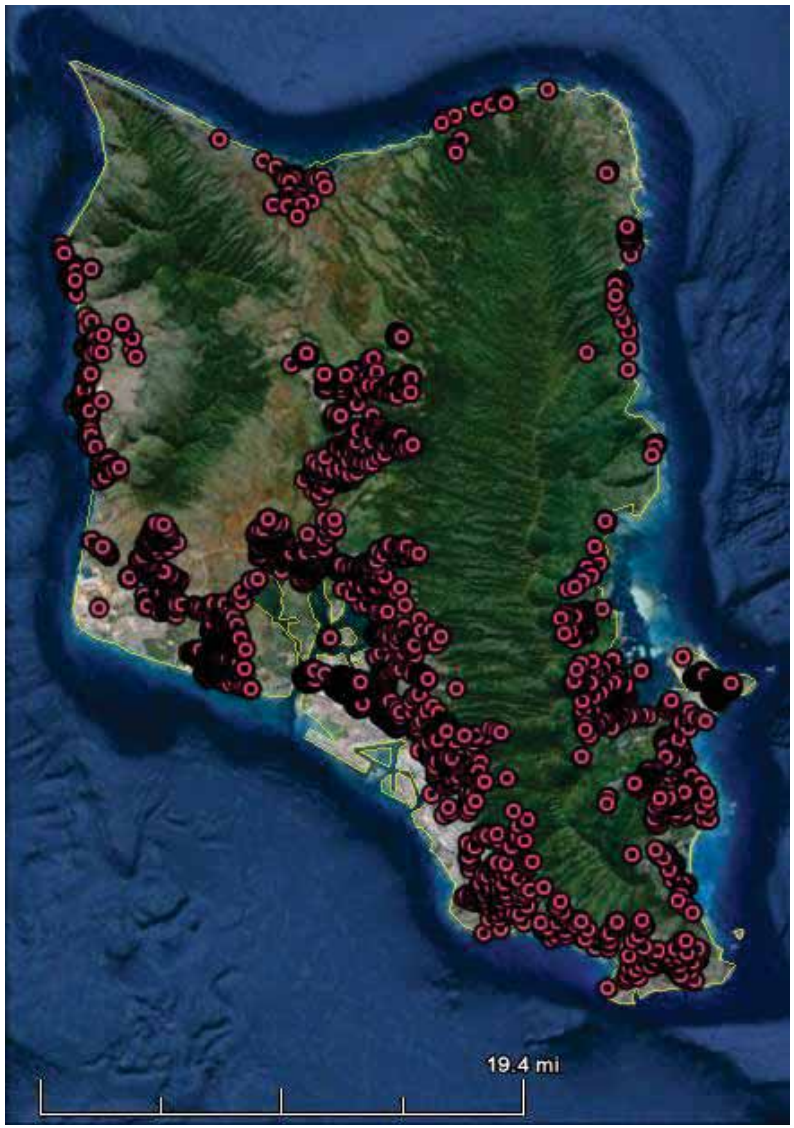
2014 = 47.9 MW

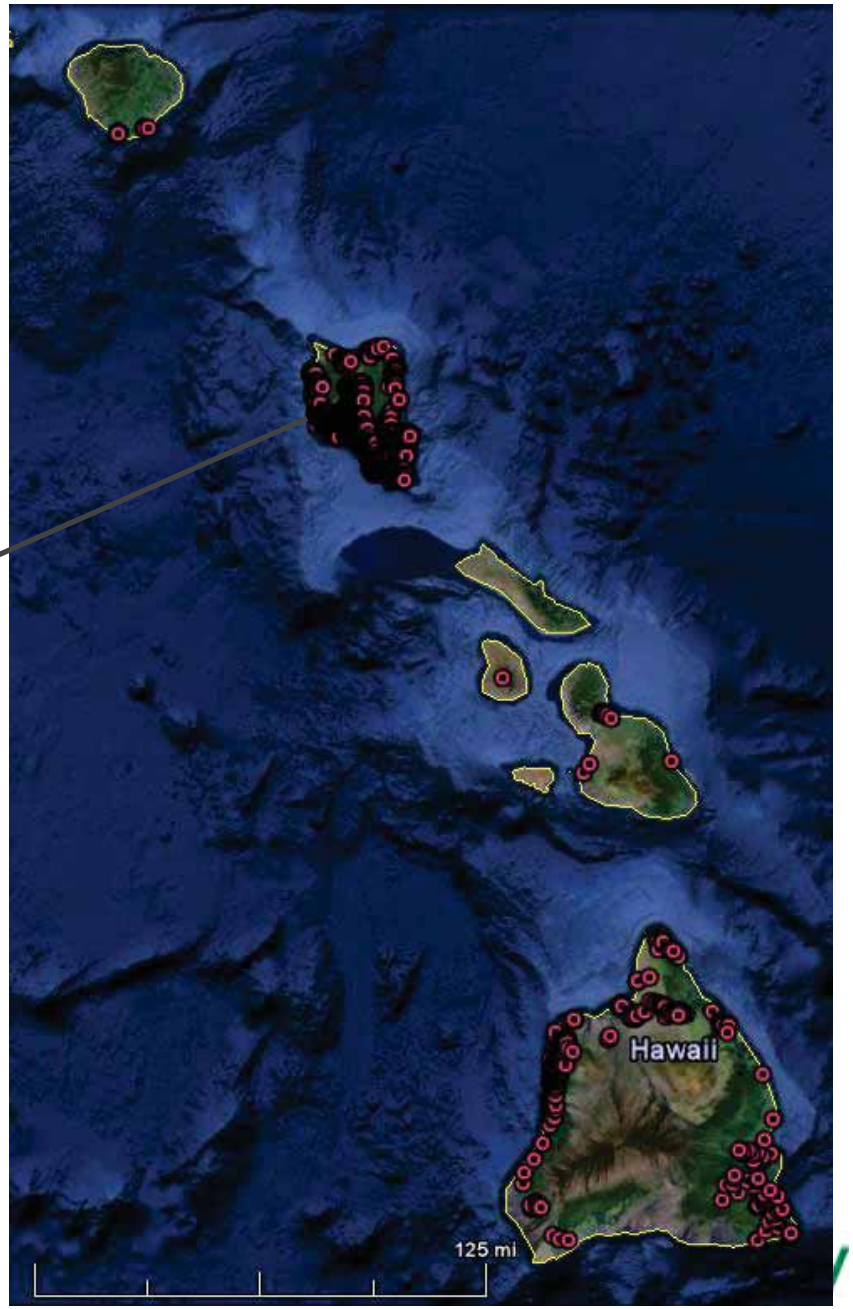


2015 = 56.1 MW

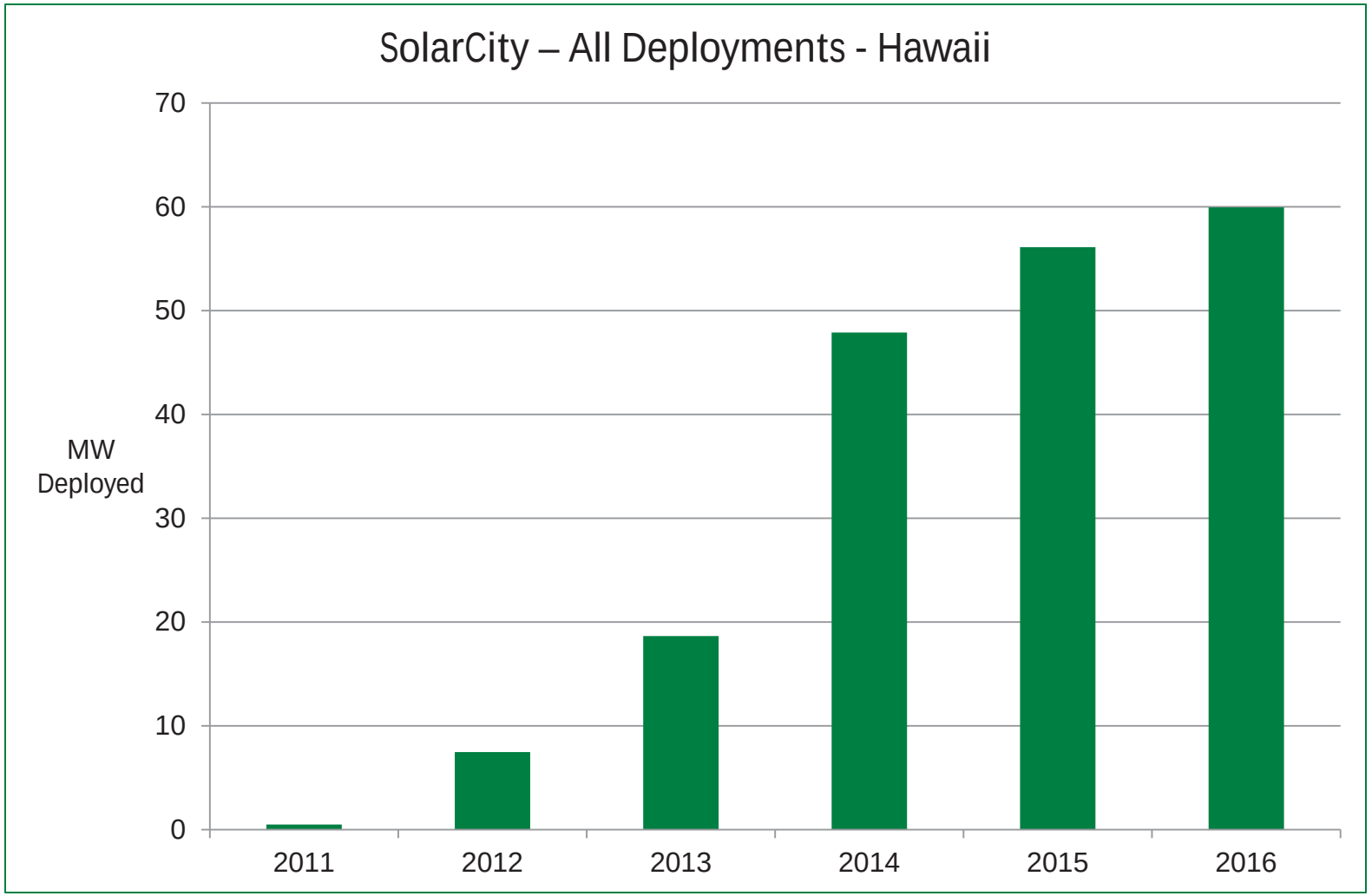


2016 = 59.9 MW





Solar Growth in Hawaii



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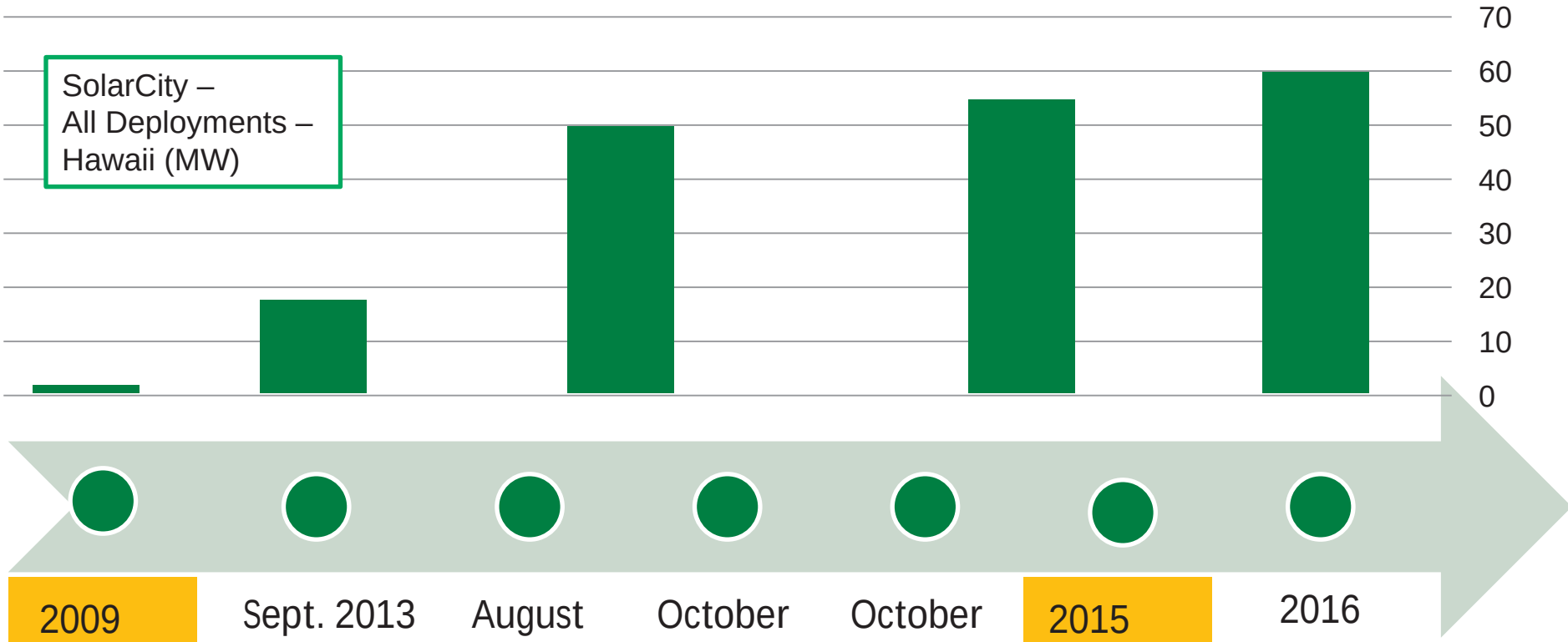
Timeline – Regulatory Events / SolarCity Growth in Hawaii



2009
- 40% RPS by 2030 introduced

Sept. 2013
- HECO announces moratorium on new rooftop solar; interconnection queue forms

August 2014
- Research begins w/ SolarCity, HECO, NREL

October 2014
- Study results dispel over-voltage concerns; HECO begins clearing queue

October 2015
- PUC eliminates Net Metering

2015
- 100% RPS by 2045 introduced

2016

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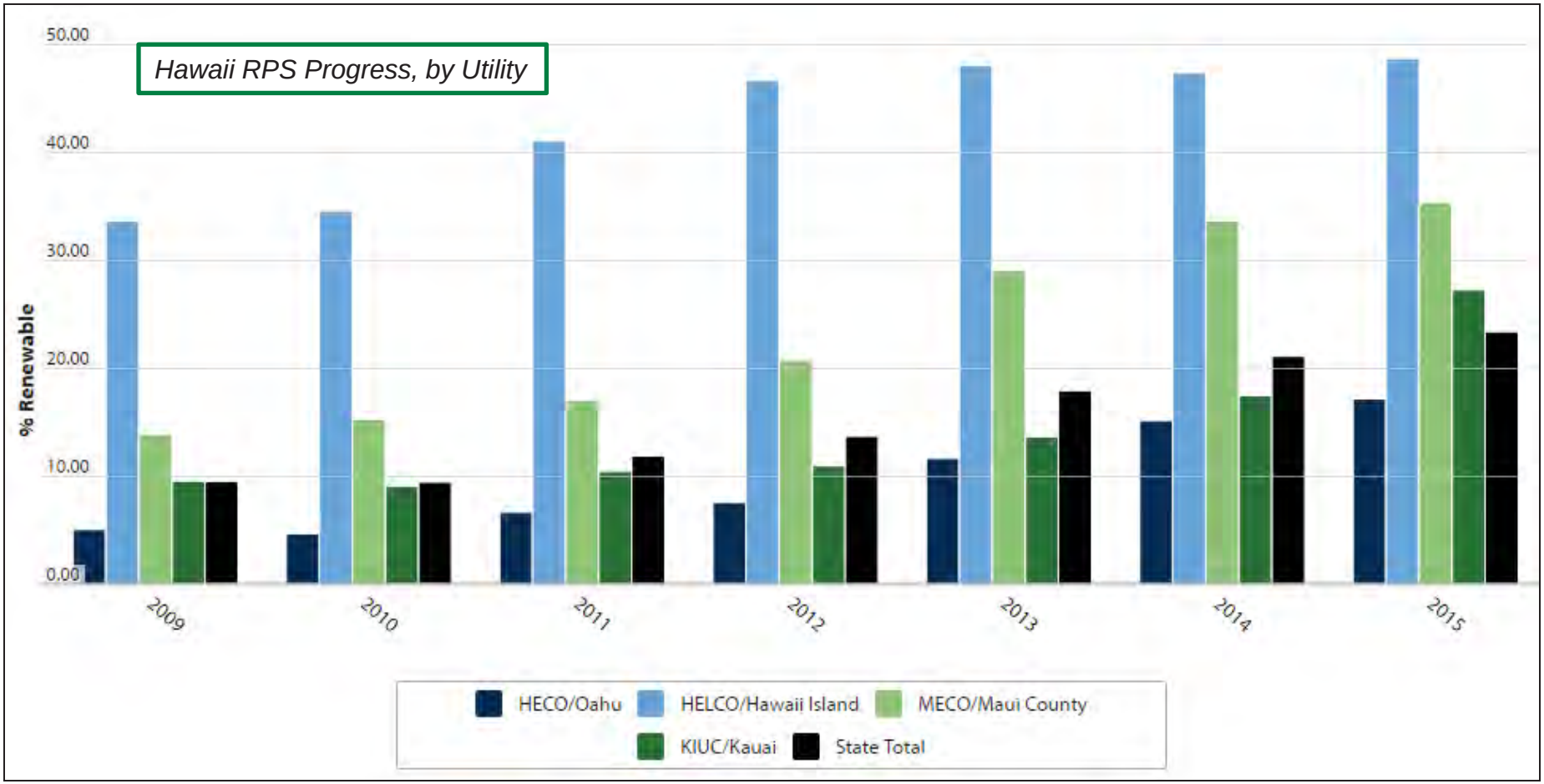
Renewable Portfolio Standard (RPS) Progress



For Reference, Progress of Major California Utilities: PG&E- 28.0%, SCE – 23.2%, SDG&E - 36.4%

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HECO Net Metering Eliminated – New Structures

- Net Metering eliminated in 2015 after 60,000 interconnections (grandfathered)
- Replaced with the following two customer options:

	Customer Grid Supply (CGS)	Customer Self Supply (CSS)
Market	Residential & Commercial	Residential & Commercial
Export?	Yes. Credited at wholesale rate.	Not compensated.
Remaining program capacity	18.5 MWac	Unlimited
Notes	Bill credits expire monthly. $25/mo minimum bill.	Energy storage (batteries) allowed.

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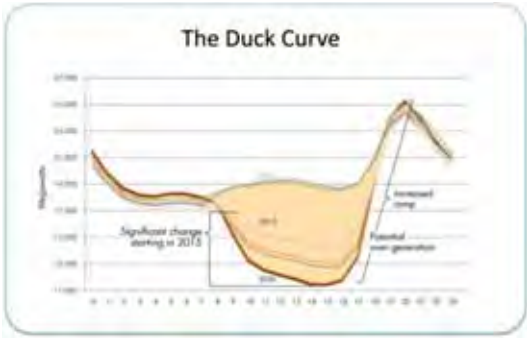
Road to 100% Renewables – Considerations

- Daytime net loads approach zero – solar only becomes infeasible – need storage
- Renewables shifting is essential
  - Behind the meter solar + storage (driven by customer economics)
  - Utility scale solar + storage (driven by RPS, utility economics)
- Regulatory / Tariff nuances are ever-changing – need flexible technological solutions
- Hawaii as test bed & proving grounds for mainland grids



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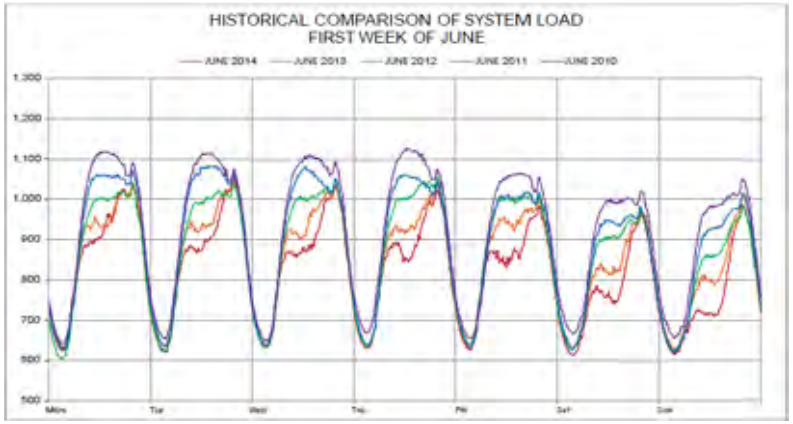
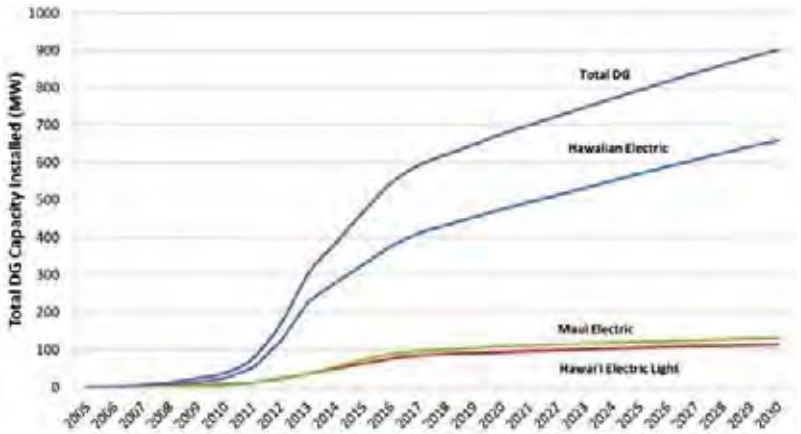
Grid Engineering Solutions - Hawaii

Renewable Resource Growth in Hawaii





Island Challenges.

The exceptionally high growth rate of DER in Hawaii raises potential interconnection and integration challenges, associated with system safety and reliability, and imbalance of supply and demand.

- System level impacts
- Transient Overvoltage
- Ground Fault Overvoltage
- Voltage violations
- Equipment overloads

Vision for the future.

To continue the support of additional renewables, the need for grid modernization in planning and mitigating technical barriers, while providing customer choice, maintaining cost-effectiveness, and the safe and reliable operation of the grid is a must.

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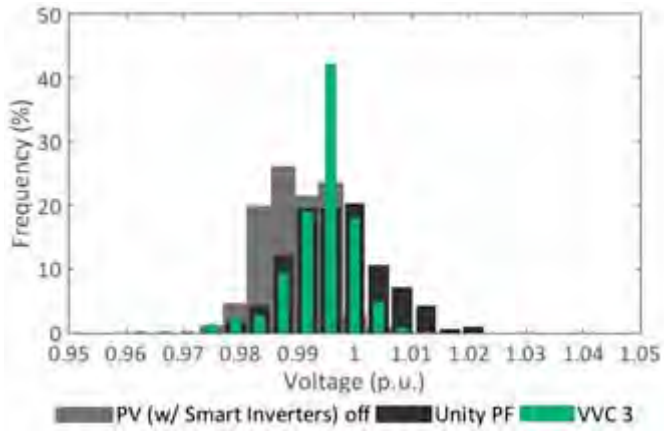
Addressing High Penetration of Renewable Resources in Hawaii



Load Rejection Overvoltage.

SolarCity, Hawaiian Electric (HECO), and National Renewable Energy Laboratory (NREL) cooperatively worked on examining Load Rejection Overvoltage related to generation to load ratio. Results effectively used to update HECO interconnection requirements from 120% to 250% of maximum daytime load PV penetration.

Ground Fault Overvoltage and Multi-Inverter Anti-Islanding.

SolarCity continues to collaborate with HECO and NREL in proving anti-islanding capability of multiple inverters, as well as providing technical justification for improving technical criteria and mitigation approaches involving grounding transformers.

Advanced Inverter Functionality.

SolarCity is actively engaged with inverter manufacturers to enable advanced inverter functionality that will support the approval of additional DERs in highly penetrated circuits.

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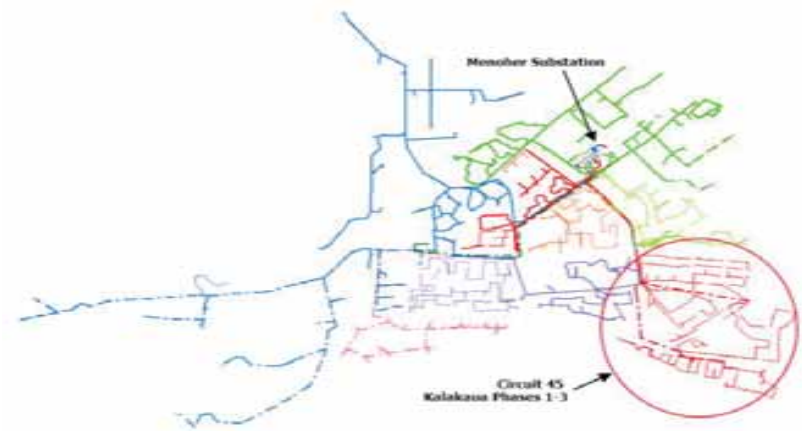
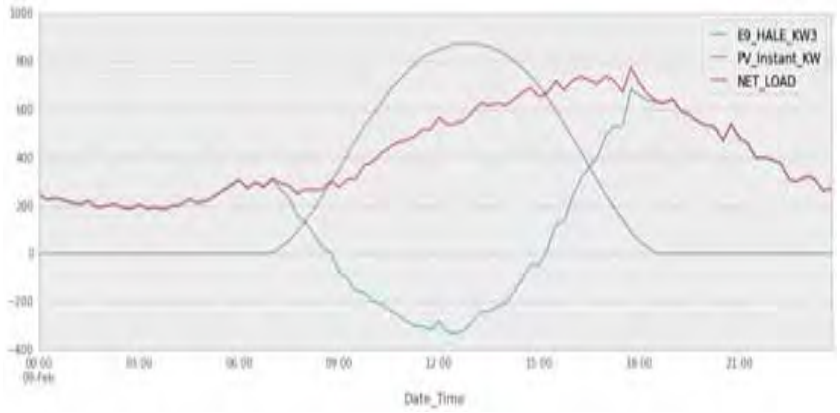
Addressing High Penetration of Renewable Resources in Hawaii





Distribution Impact Studies.

SolarCity has provided engineering services that assess the impacts of DERs on the distribution grid, employing the most up-to-date technical standards and technologies to ensure the safe and reliable operation of the grid with higher penetration circuits. We have the ability to build accurate models to simulate several case scenarios studying loading, steady-state and dynamic behaviors, and protection technical screens.

Self-Supply Tariff

SolarCity has provided technical guidance when drafting new language on non-export systems, to safely and reliably interconnect additional PV systems on HECO's highly penetrated circuits. Working with utility engineers and industry stakeholders, technical policy has been agreed upon that will enable customer's to install non-export systems that avoids several technical screens, allowing an expedited approval process.

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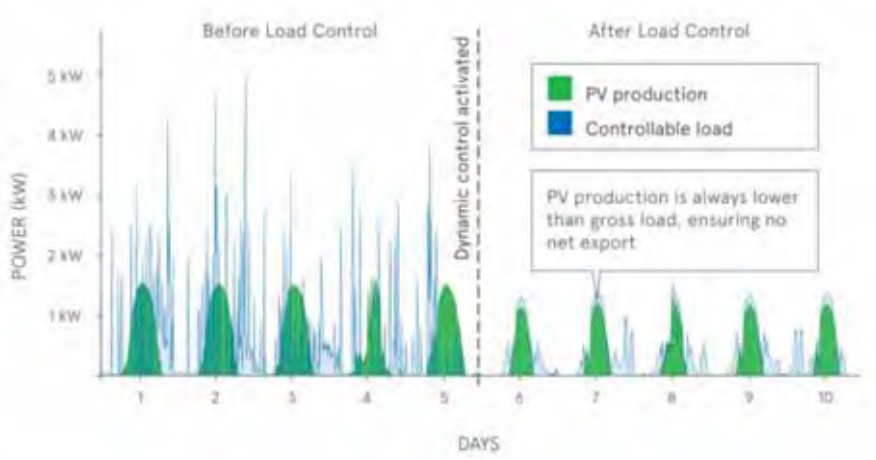
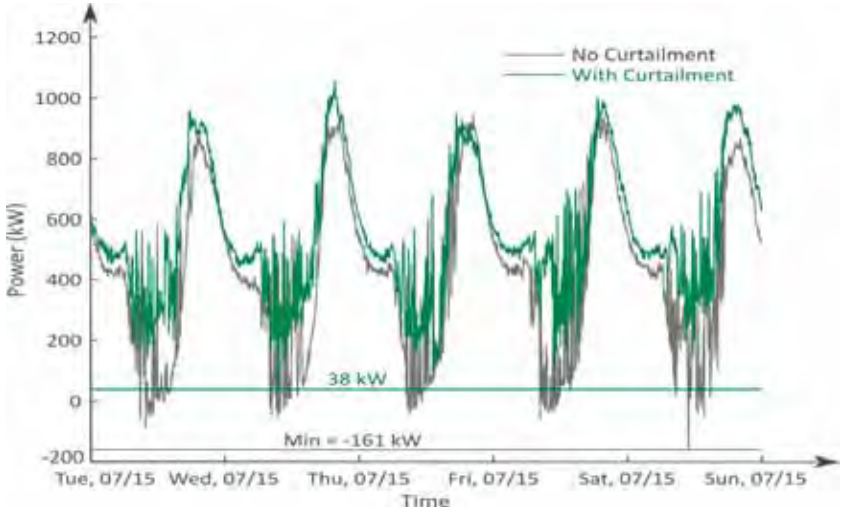
Customer Projects





Electric Water Heaters.

SolarCity has worked with a military customer, in a pilot project demonstrating the ability to control electric water heater (EWH) load consumption. By adjusting real-time power consumption, EWH's provide controllable loads that can be used to absorb on-site solar generation and avoid net energy export.

Dynamic Curtailment

Smart inverter PV curtailment utilizes dynamic power flow control, helping eliminate overloading and power flow challenges enabling integration of higher penetrations of DERs.

SolarCity GridLogic

Utilizing both dynamic load shifting and PV curtailment, SolarCity's DER control platform safely and reliably integrates high penetrations of DERs. Customers as well as utility operators can interface with these systems to provide aggregated grid services and alternative mitigation solutions.

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Smart Energy Home

SOLAR PANELS

apture energy from the sun and convert it to electricity to me.

HOME GATEV

The gateway allocates energy to maximize self-supply.

NEST LEARNING THERMOSTAT

t learns what temperature you like and builds a schedule

BATTERY

The battery stores your excess solar energy production for l

MYSOLARCITY APP

SmART WATER HEA

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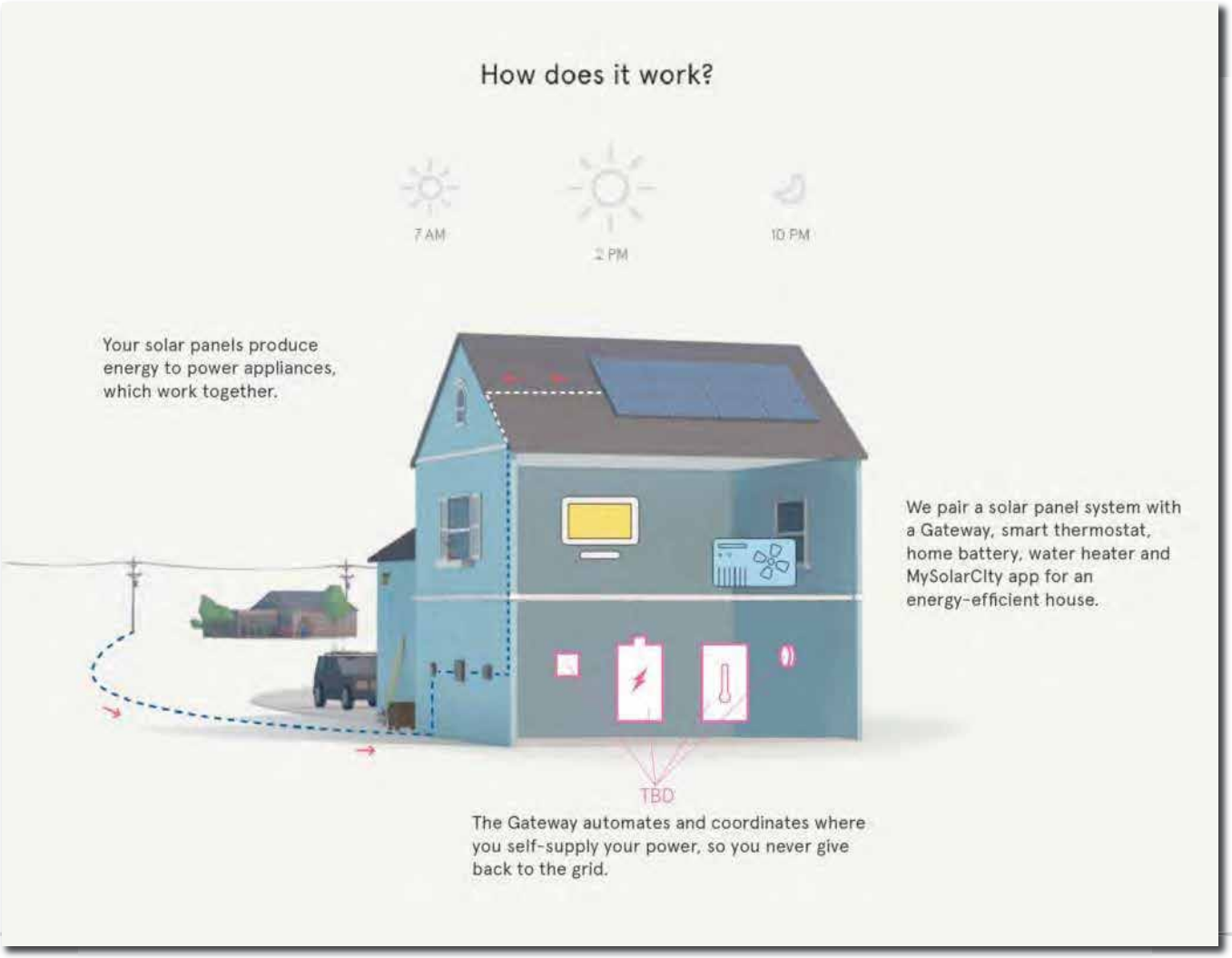
Smart Energy Home – How does it work?



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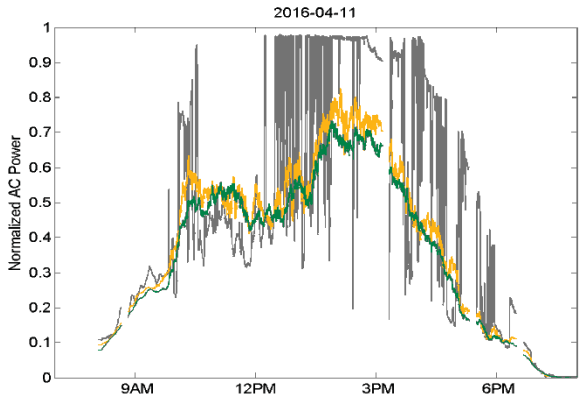
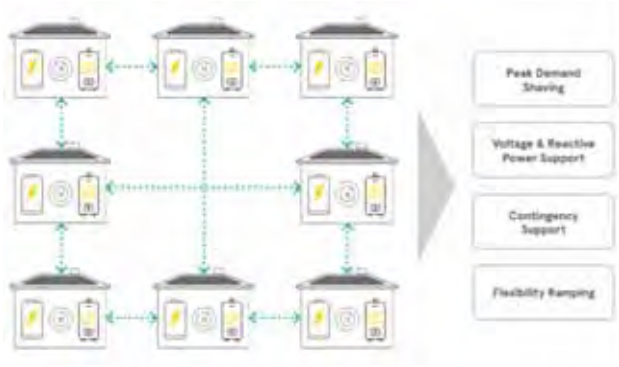
Pilot Projects

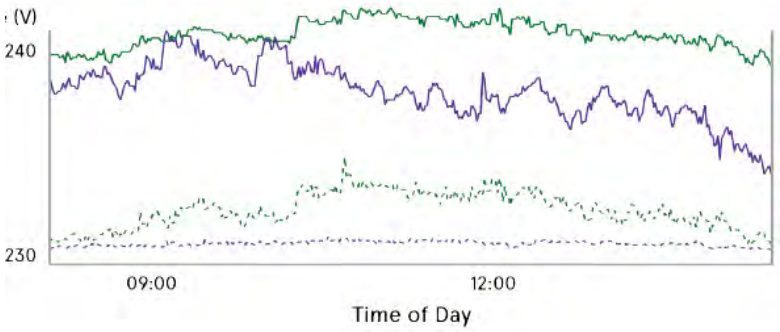
Geographic Smoothing



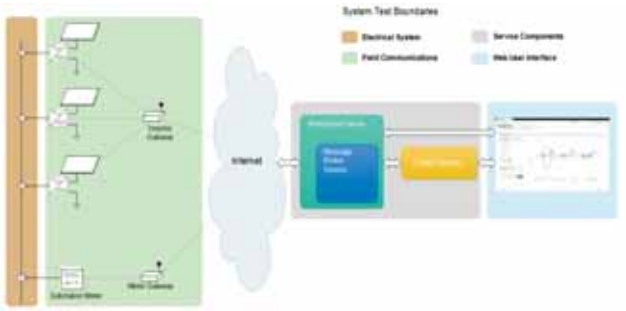
DER Aggregation for Grid Services



Smart Inverter Dynamic Control



Inverter Volt/VAR Optimization & Support



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Executive Summary

- Certain issues typically observed when installing conventional generation often times are overly conservative and/or estimated when screened with inverter-based generation
- Traditional mitigation approaches often reflect pre-advanced inverter based Distributed Energy Resource (DER) installations and should be evaluated to confirm whether it is appropriate to apply them to advanced inverter-based DERs
- Research and pilot projects demonstrate that today's grid can handle high penetration of DERs without affecting reliability and safety, and as the grid is modernized will be able to host even more

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Utility Scale Solutions – Hawaii and the Pacific

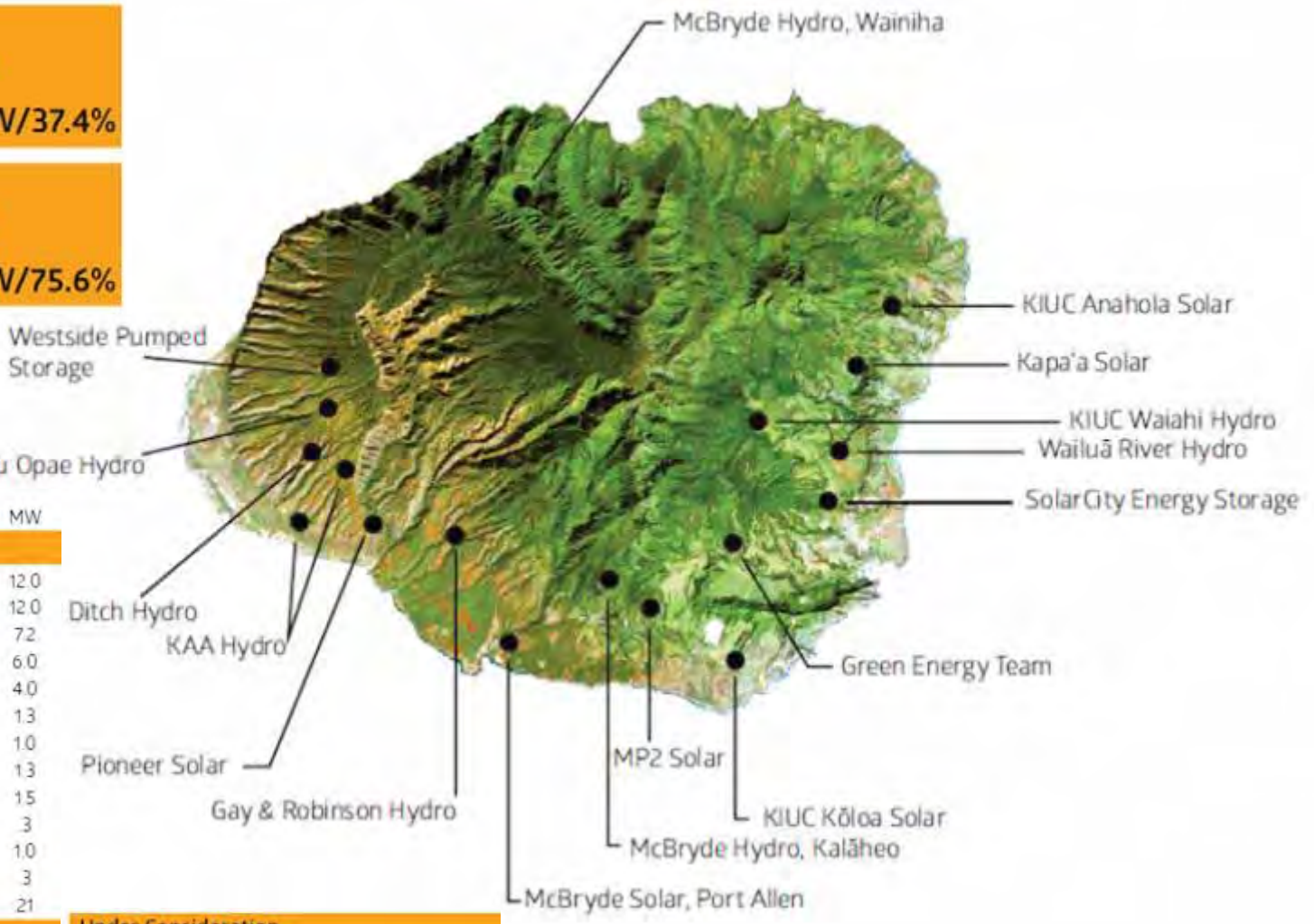
Kaua'I Renewable Energy Projects

Total Renewable Energy in Service 2015

68.9 MW/37.4%

Potential Renewable Energy in Service 2025

129.2 MW/75.6%



	Type	MW
Active In Use		
KIUC, Kōloa	Solar	12.0
KIUC, Anahola	Solar	12.0
Green Energy Team	Biomass	7.2
McBryde, Port Allen	Solar	6.0
McBryde, Wainiha	Hydro	4.0
KIUC, Waiahi	Hydro	1.3
McBryde, Kalāheo	Hydro	1.0
Gay & Robinson, Olokele	Hydro	1.3
KAA, Waimea/Kekaha	Hydro	1.5
Pioneer, Waimea	Solar	3
Kapa'a Solar	Solar	1.0
MP2, 'Ōma'o	Solar	3
Customer Solar	Solar	2.1
Under Construction/Permitting		
Gay & Robinson, Olokele	Hydro	6.0
SolarCity Energy Storage	Solar/Storage	1.3
Customer Solar	Solar	6.6

Under Consideration		
Pu'u Opae, Kekaha	Hydro	8.3
Menehune Ditch, Kekaha	Hydro	1.5
Wailuā River/Kalepa	Hydro	4.0
Westside Pumped Storage	Solar/Hydro	25.0

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Koloa PV Facility

12MWac PV Plant

Operational – September 2014

Owned and Operated by KIUC

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Kaua'i – Pursuit of higher %RE

- Hitting 90% RE during the day on multiple occasions
- Storage required to continue to increase RE%
- Has storage technology reached a price-point where it is economical to shift PV at Utility Scale?
- Short Answer – Qualified Yes.

- Video

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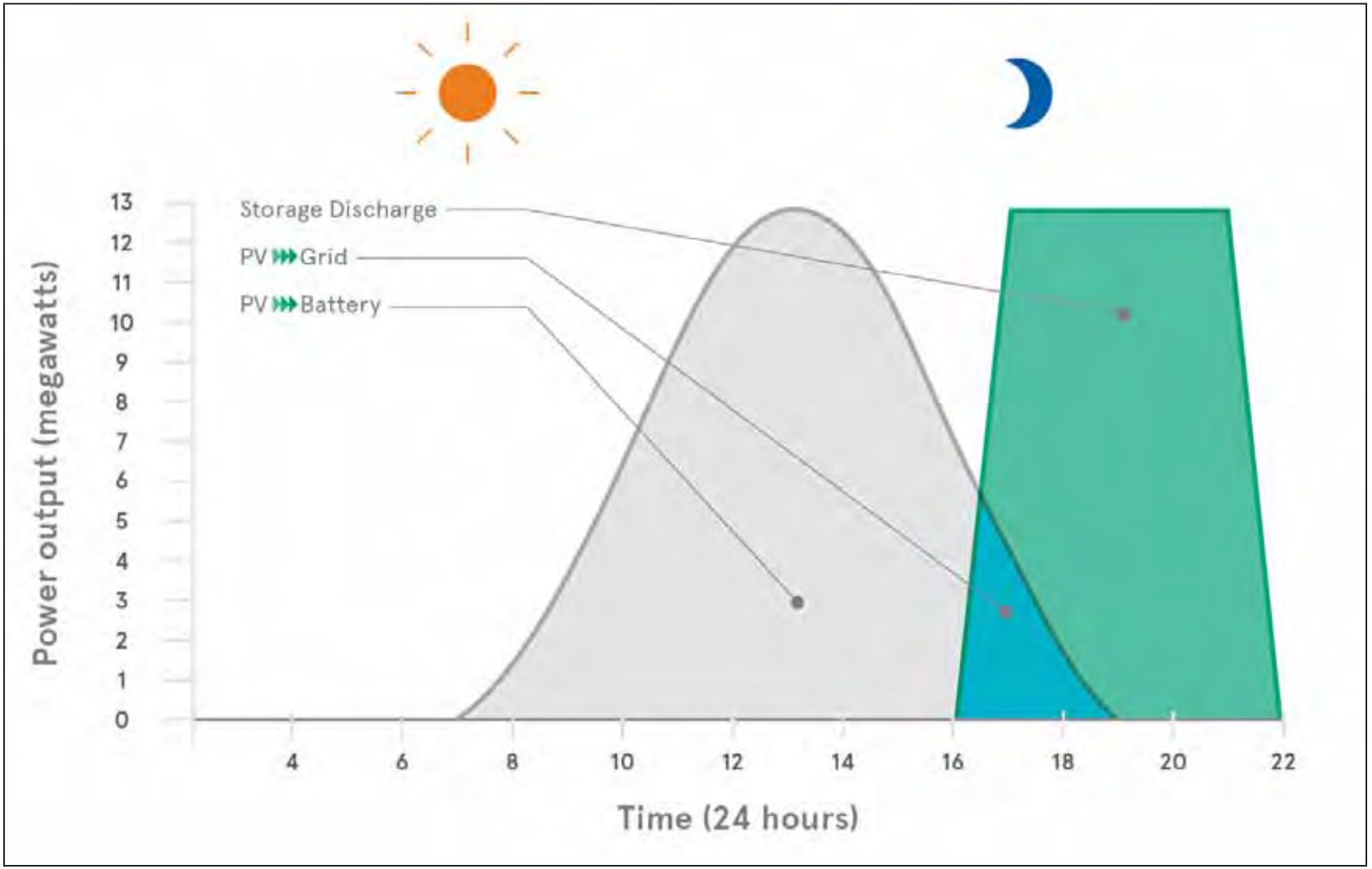
Kauai Island Utility Cooperative – Dispatchable PV



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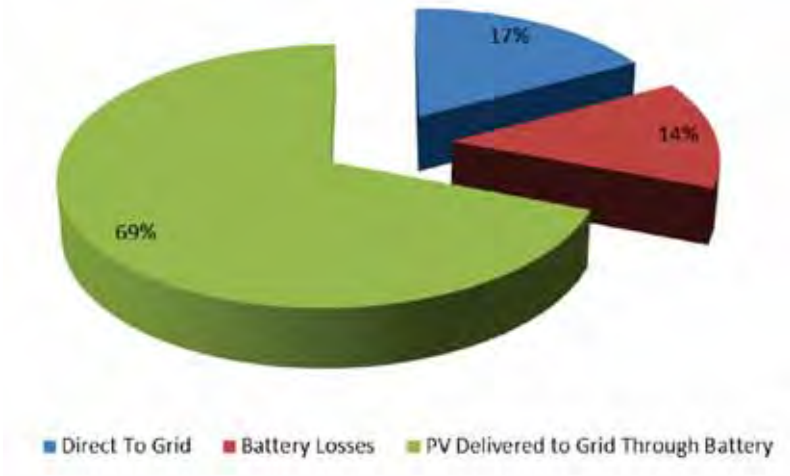
KIUC Project Details

- System Components
  - 13 MWac PV System
  - 13 MW / 52 MWh Battery Storage
- PPA Rate of $0.145 / kWh
  - Total Project Cost > $60M
  - Ongoing O&M of ~$300K / year
- Key Economic Variables
  - ITC & MACRS Depreciation
  - HI State Tax Credit
  - Investor Cost of Capital
- Key Technical Variables
  - PV & Battery System Costs
  - Battery Efficiency & Losses



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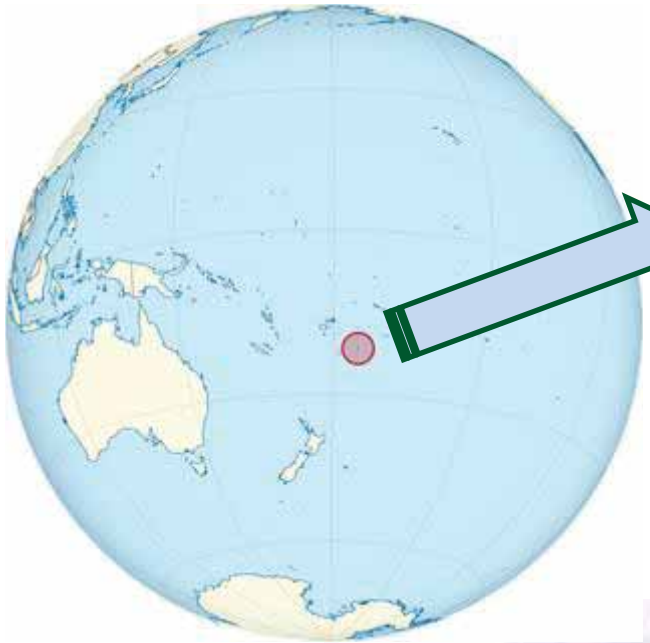
American Samoa – 80% Diesel Reduction on Island of Ta'u



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American Somoa Power Authority – Diesel Replacement

- ASPA provides power, water, etc.
  - Outer island of Ta'u powered 100% by antiquated diesel generators
- SolarCity under contract to install ~$6M project comprised of:
  - 1.4 MW ground mounted PV
  - 4.2 MWh battery storage
  - Replace diesel generators
- Microgrid system will be primary generation resource and controls system will manage grid (frequency, voltage, etc.)
- After project completion, island will be powered 80%+ by renewables with significant cost reduction

American Samoa Power Authority

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ASPA Ta'u Project Details

- Expedited Project Timeline
  - Q4 2015 = Executed Contract
  - Q1 2016 = Engineering / Mobilization
  - Q2 2016 = Construction & Testing
  - Q4 2016 = Commercial Operation
- Unique Project Considerations
  - Ta'u is ~75 miles from main island
  - Advanced controls technology
  - Land acquisition and permitting
- Key Takeaways
  - Technology capabilities exist today
  - Full shifting < diesel costs in very remote areas
  - Ability to deploy project in < 1 year

Site Audit Photo – November 2015

Drone Footage – January 2016

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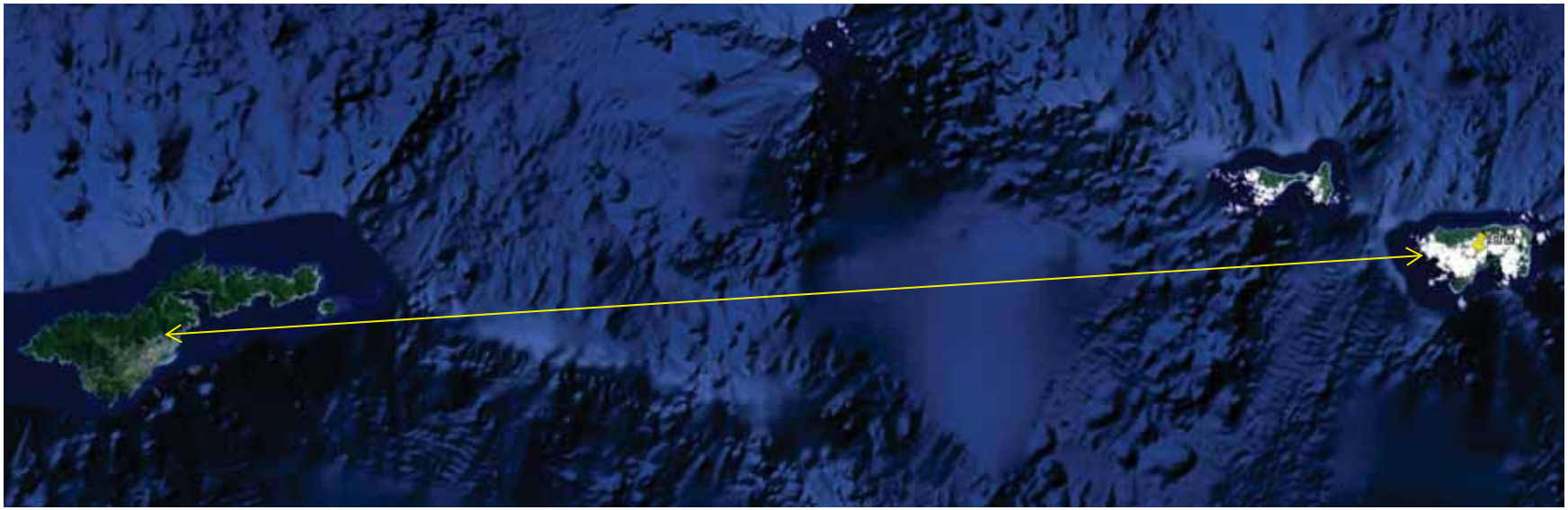
Shipping Logistics



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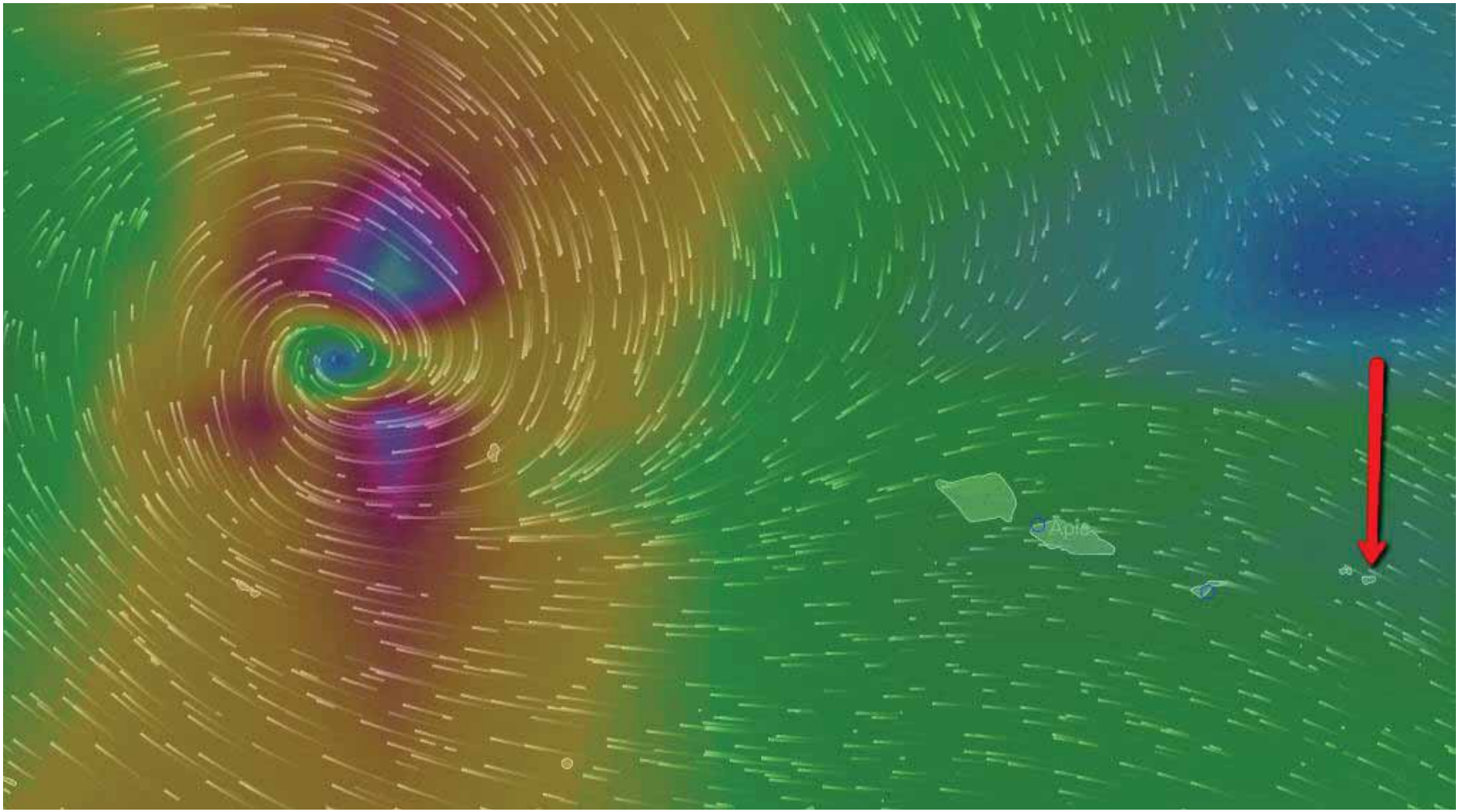
Cyclones



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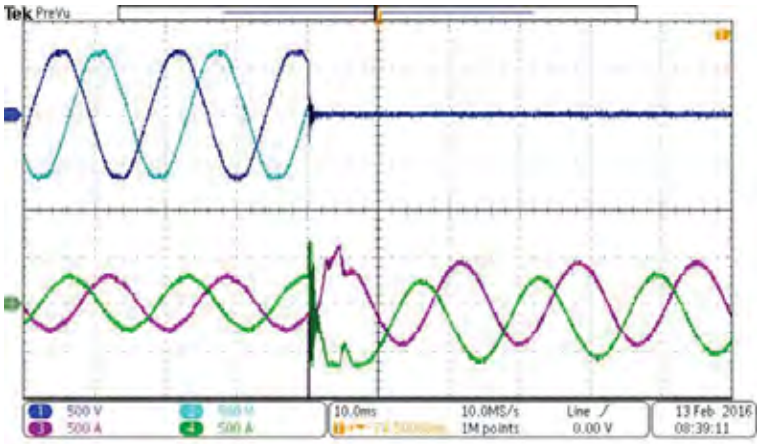
Integration Challenges

- Existing Switchgear & Generators
  - Replacement needed
- Electrical Distribution System
  - 3-phase at diesels
  - 1 or 2 phase distribution
  - Not balanced
- Protection Coordination
  - Island grid will be “formed” primarily by battery inverters - Power Electronics
  - Insufficient fault current to blow fused distribution system protection



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Training:

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Current Status

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Q&A

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Thank you.

Tristan Glenwright
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NYU Case Study Example

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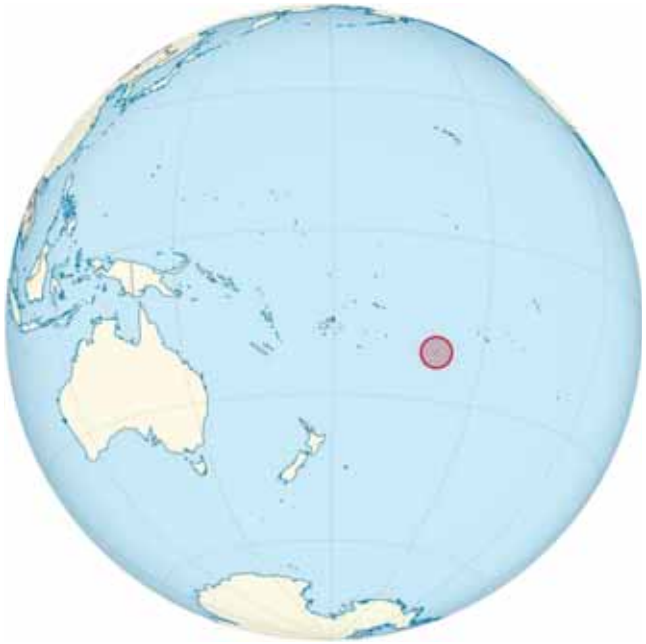
NYU Case Study Example:
Cook Islands - Aitutaki



Demographics

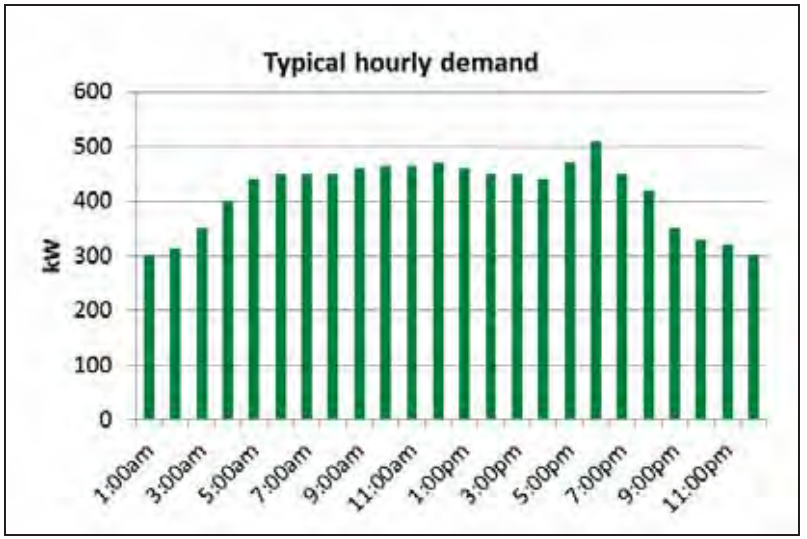
- Population: 2194
- Land area: 4448 acres (18 km^2)

Project Objectives

- National Strategy: 100% RE by 2020
- Focus on lowest cost with >50% renewable energy
- Review

Current Energy Systems

- **Consumption:** 3,642,002 kWh/yr
- **Fuel:** Diesel; 247,486 gal/yr
- **Peak load**: 580 kW
- **Residential tariff:** $0.43
- **Commercial tariff:** $0.33-$0.43
- **Fuel cost**: $3.97



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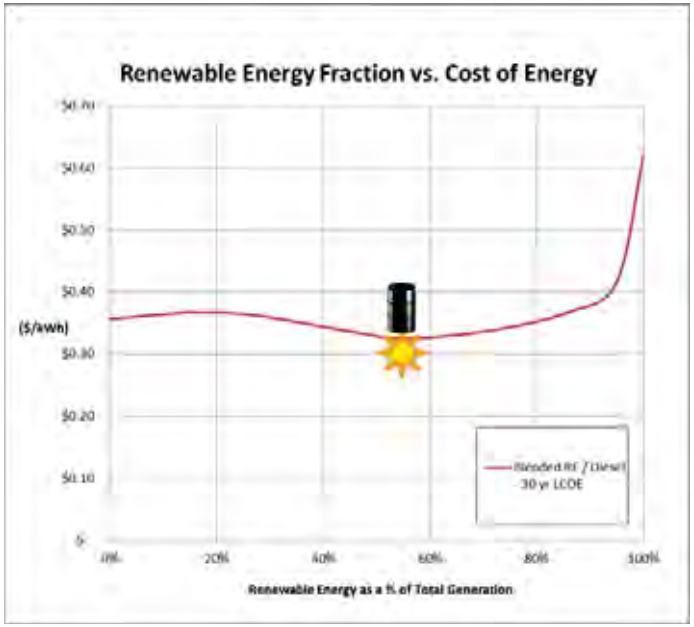
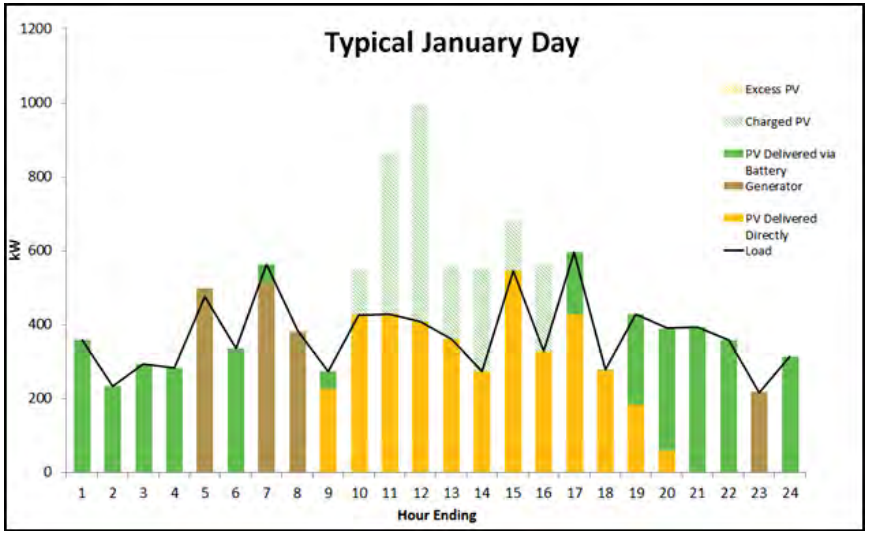
Technical Solution Optimization





PV capacity: 1,500 kW **Battery storage:** 4,400 kWh

RE proportion: 55% **Excess capacity:** 0.2%

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Economics vs. Diesel

SolarCity - Levelized Cost of Energy Calculator - Island Microgrids

Cook Islands "Te Aponga Uira"

Aitutaki, Cook Islands - Solar Only Scenario

Sensitivity Inputs are in Blue
Fixed / Calculated Values are in Black

Diesel Generation Configuration

Fuel Cost Breakdown		
Current Fuel Cost ($/gal)	$	3.97
Historical Fuel Consumption (gal/yr)		247,486
Transportation Adder ($/gal)		
Total Fuel Expense ($/yr)	**$**	**982,519**
Plant O&M & Replacement Cost Breakdown		
**Machine O&M & Labor Excluded.*		
Generator Replacement Year		15
Total Generator Size (kW)		1,000
Generator Replacement Cost ($/kW)	$	450
Total Load Met (kWh/yr)		3,624,000

Renewable Energy Microgrid Configuration

System Sizes		
Solar PV System Size (kW)		1,500
Energy Storage System (ESS) Size (kWh)		4,400
Wind System Size (kW)		0
System Costs & Specifications		
Solar PV System Cost ($/W)	$	2.40
Solar PV Inverter Replacement Cost ($/W)	$	0.10
Solar PV + Storage O&M Expense ($/kW)	$	5.00
ESS Costs ($/kWh)	$	780
Battery Replacement Cost ($/kWh)	$	200
Battery 1 Derate		60%
Battery 2 & 3 Derate		80%
Wind Capital Cost ($)	$	-
Wind O&M ($/kW/yr)	$	-
Additional Microgrid Costs ($)	$	150,000
Total Microgrid Capital Cost	**$**	**9,470,000**
Total Load Met with Renewables (kWh/yr)		1,993,200

Economic Assumptions and Results

Weighted Average Cost of Capital (WACC)	4.0%
Fuel Cost Escalator	6.0%
O&M Escalator	3.0%
Levelized Cost of Energy (LCOE) Term (years)	30

Diesel LCOE ($/kWh)	$	0.36
Renewable LCOE ($/kWh)	$	0.30

		Diesel Cost Escalator (%/year)				
		2%	4%	6%	8%	10%
Starting Diesel Cost ($/gal)	$ 2.00	$ 0.10	$ 0.13	$ 0.18	$ 0.25	$ 0.35
	$ 2.50	$ 0.13	$ 0.17	$ 0.23	$ 0.31	$ 0.44
	$ 3.00	$ 0.15	$ 0.20	$ 0.27	$ 0.37	$ 0.53
	$ 3.50	$ 0.17	$ 0.23	$ 0.32	$ 0.44	$ 0.62
	$ 4.00	$ 0.20	$ 0.26	$ 0.36	$ 0.50	$ 0.71
	$ 4.50	$ 0.22	$ 0.30	$ 0.40	$ 0.56	$ 0.79
	$ 5.00	$ 0.25	$ 0.33	$ 0.45	$ 0.62	$ 0.88

Diesel LCOE Sensitivity to Fuel Cost and Escalator

Note: Pricing is indicative

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Global Expansion

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Givepower

- 501(c) 3 Non-Profit Entity
  - 2013 Launch & 2014 Incorporation
- Two core functions:
  - International Development
  - Corporate Social Responsibility
- Three primary objectives:
  - Education
  - Health
  - Job Training

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Givepower Global Impact

SCHOOLS POWERED		
Countries	**2014**	**2015**
Kenya	304	426
Mali	56	33
Nicaragua	52	51
Nepal	31	246
Uganda	60	-
Nigeria	8	-
Haiti	-	27
Ghana	-	100
Malawi	-	50
Burkina Faso	-	20
TOTAL	**511**	**1003**
GRAND TOTAL:		**1514**

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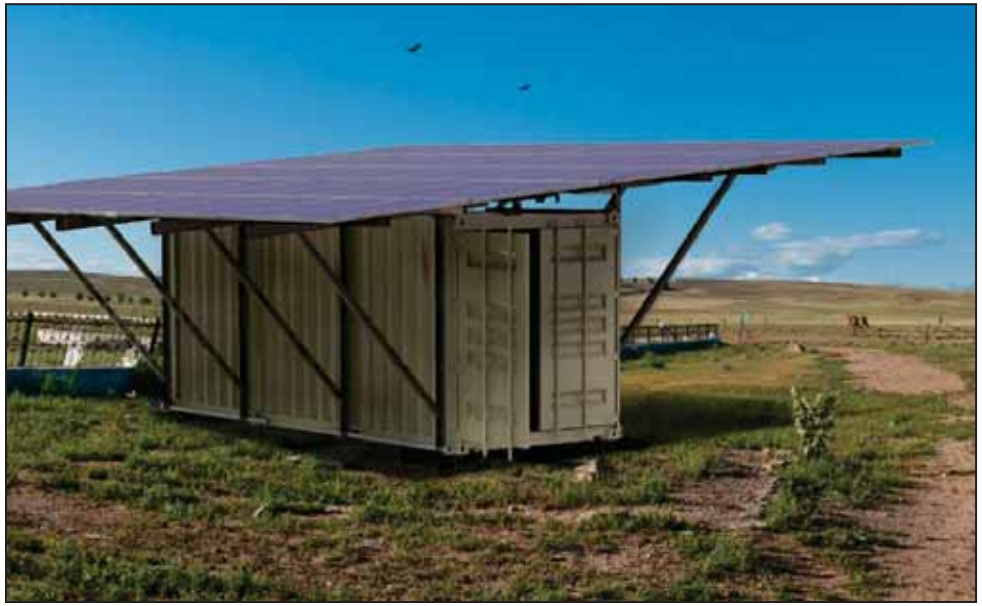
Energy Access

- “PowerHub”
  - Concept offering based on fully containerized energy + services
  - Value-engineered by SolarCity using our vertically integrated supply chain
  - Evaluating various opportunities to ensure product fits the market need
  - Seeking broadly applicable specification to allow for scale & cost reduction
  - Sourcing pilot projects deployed on cash grant basis in late 2016 / early 2017



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Global Expansion Strategy

- Project Based Expansion
  - Originate and develop $5M+ opportunities justifying market entry in itself
  - Identify large corporate / public offtakers with significant footprint
  - *Example: Utility scale PV + Storage; 2+ MW commercial portfolio*

- Rural Electrification / Energy Access
  - Focus area for 2016; pursue project specific opportunities with scale
  - Contract with NGOs, governments, multi-laterals, and other funding groups
  - *Example: $4M+ contract for 40+ sites within a single country*

- Scalable Market Identification / Entry
  - Segment market based on TAM in residential / commercial / utility / microgrid
  - Enter market through partnerships, acquisitions, or a JV like approach
  - *Example: Mexico Illios' acquisition*