Energy+Environmental Economics

PV Integrated Storage – Demonstrating Mutually Beneficial Utility Customer Business Partnerships

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Eric Cutter – E3

PV Integrated Storage

Evolution Or Revolution

Project Team

Energy+Environmental Economics

Cost / Benefit

ENERGY SOLUTIONS

Program Design

SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT

Utility Program Management

SUNVERGE

Solar Integrated Storage

SUNGEVITY
GENERATE POSITIVE™

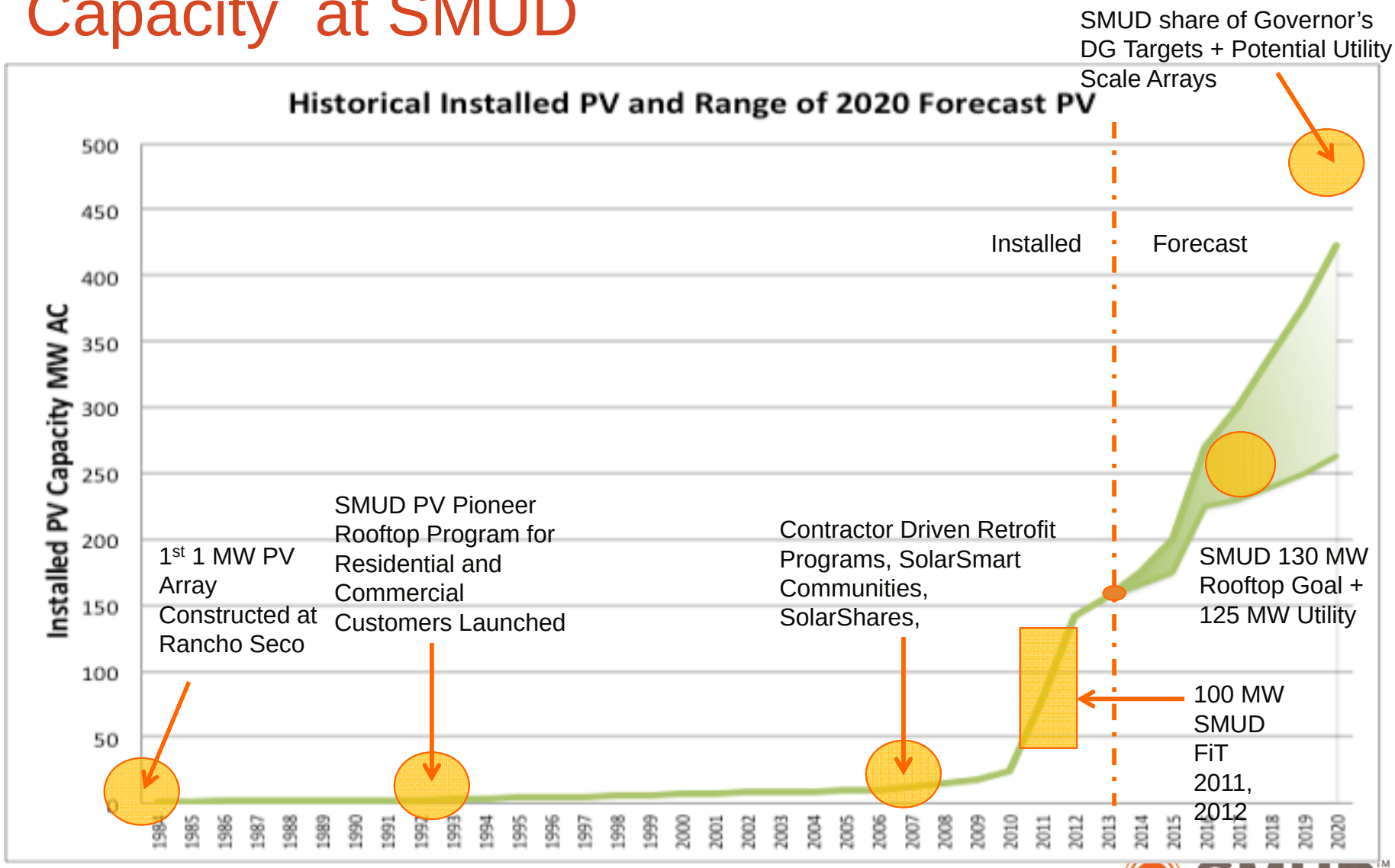
Distributed PV

ROCKY MOUNTAIN INSTITUTE®

Distribution Modeling

With Dr. Alexandra von Meier, CIEE & Dr. Duncan Callaway, UC Berkeley

Solar History and Range of Potential 2020 Capacity at SMUD



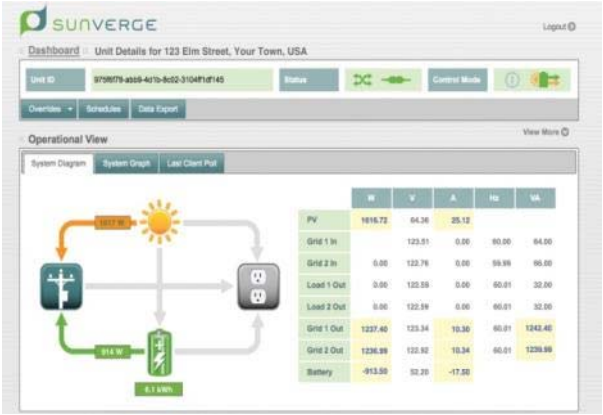
SMUD

Tasks

1. Develop interface utility Demand Response Management System
2. Demonstrate utility managed PV integration at existing Sunverge sites (2014)
3. Deploy Sunverge Systems at new customer sites (2015)
4. Develop avoided cost framework for quantifying local distribution system benefits
5. Design incentive program to enroll customer owned storage and loads for PV integration

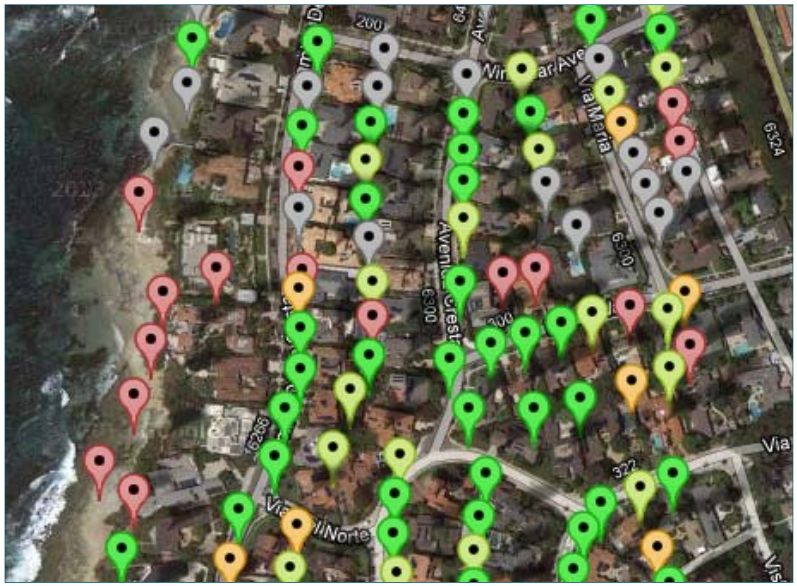
3. Demonstration

Residential Energy Smart Community Demonstration



- Thirty-four SMUD SolarSmart Homes with better than 25-40% efficiency over standard homes
- PV, smart thermostats and plug controls, HAN, lithium ion storage (4.5kW/10.7kWh)
- Partners Pacific Housing, Sunverge
- $450k SMUD grant funded by DOE Assistance Agreement DE-OE0000214
- Objectives
  - Reduce demand and TOU charges through demand response
  - UPS functionality
  - Minimize impact of PV variability, control ramp rates
  - Peak load shifting
  - Real-time visibility and analytics of aggregated load for the utility

4. Deployment



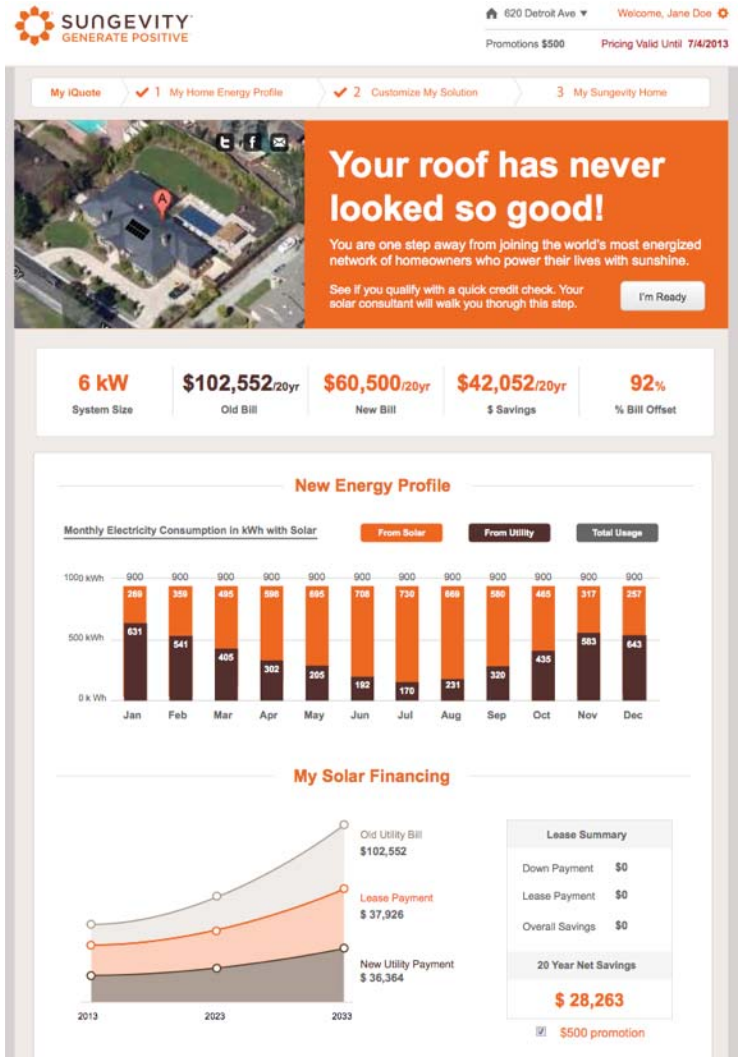
Solar Grid Planning/Customer Acquisition

- Filter available rooftops by insolation quality, generation capacity and profile
- Automatically identify large rooftops and good solar resource; good prospects with most to gain from switching to solar
- Automated system design for max production, aesthetics and customer economics
- Build PV fleet to meet utility specifications and growth forecasts

PV Generation Forecasting

- Seasonal and annual system production, economic/pricing data, degradation
- Developing NOAA and Cloud Vector modeling to forecast future production
- Provide 1-hour, 6-hour, 24-hour, 72-hour forecasts

TECHNOLOGY DRIVEN SALES AND FULFILLMENT



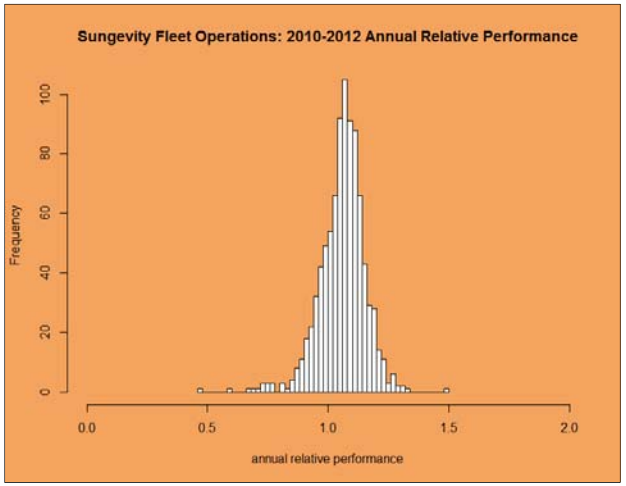
Efficient Project Fulfillment

- Remote Solar Design and iQuote gives firm price without home visit
- 100% sales closed and projects fulfilled through Sungevity call center
- Built in referral engine
- 30MW of operating assets designed remotely

FLEET MONITORING AND CUSTOMER SERVICE

Monitoring Platform

- Scalable monitoring platform for desktop and mobile
- Monitoring at individual, sub-system and system levels
- Product functionality:
  - Performance
  - Carbon Offset
  - Weather
  - Referral Center
- Monthly Performance:
  - 57% of all installed customers login monthly
  - 30% of active users login >4x per month

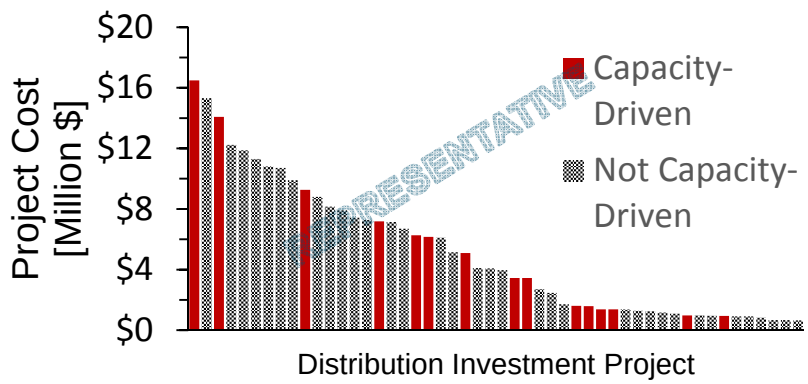


Customer Satisfaction

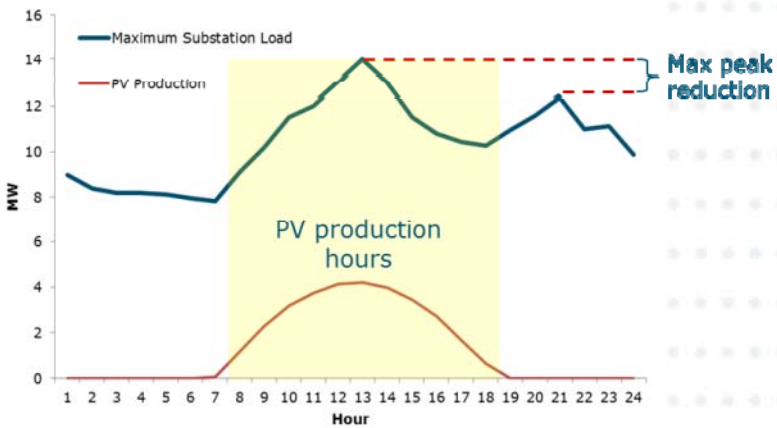
- High net promoter score of 81, comparable to leading global brands
- Intense customer engagement – 70% of solar customers proactively interact with Sungevity every month
- Sungevity customer service team proactively responds to all generation alerts

5. Local Benefits

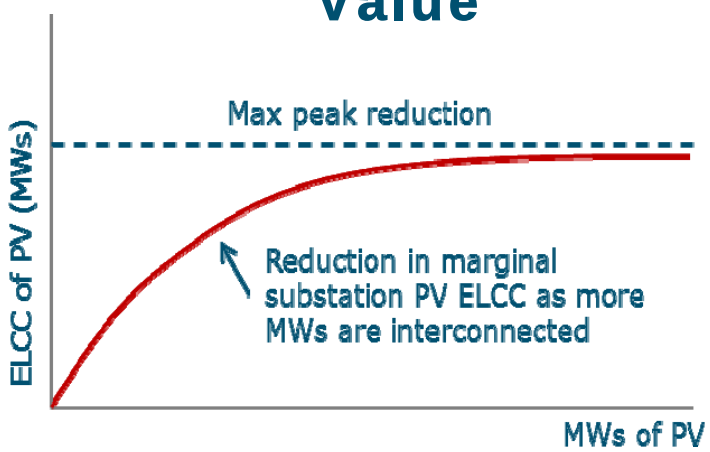
T&D Investments



PV Generation



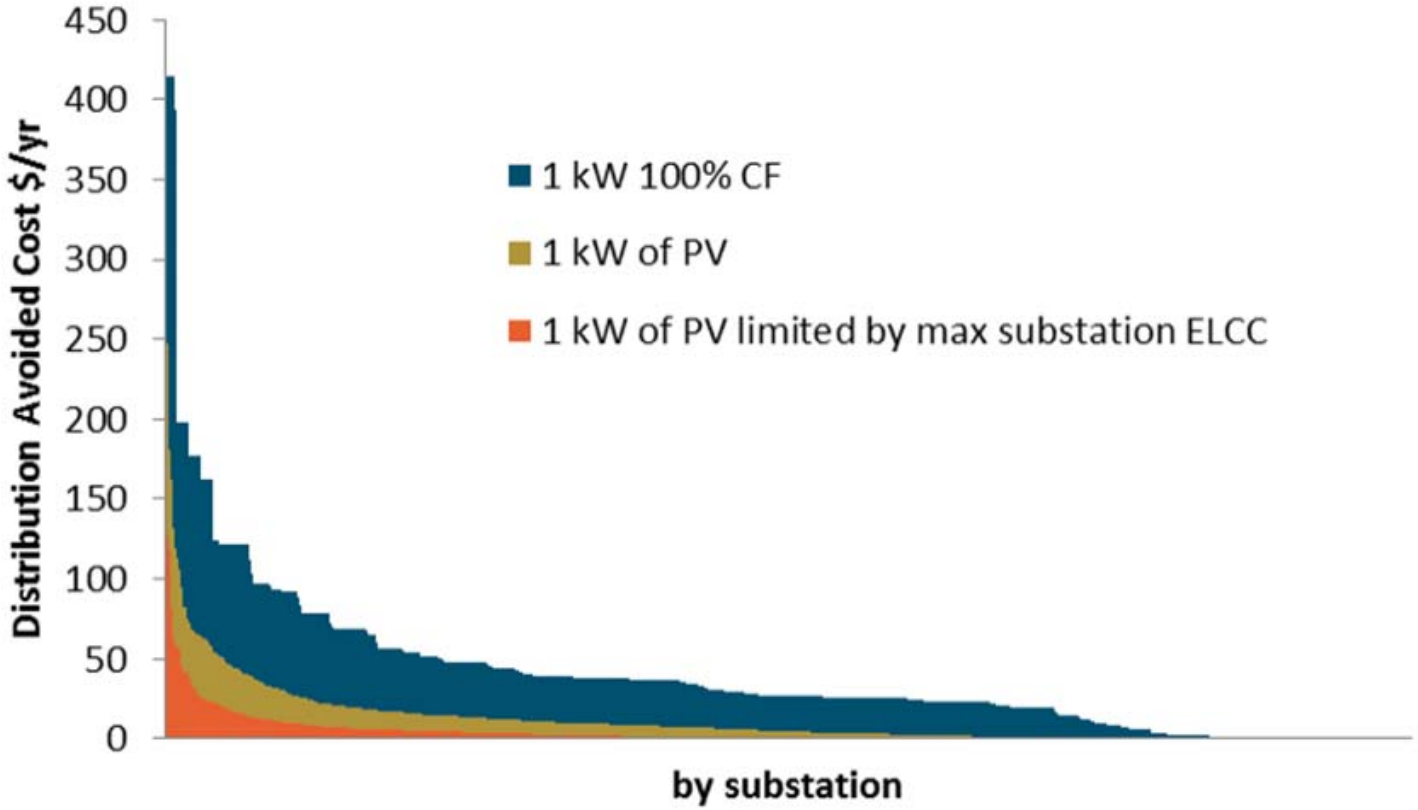
Diminishing Capacity Value



Increase Capacity Value

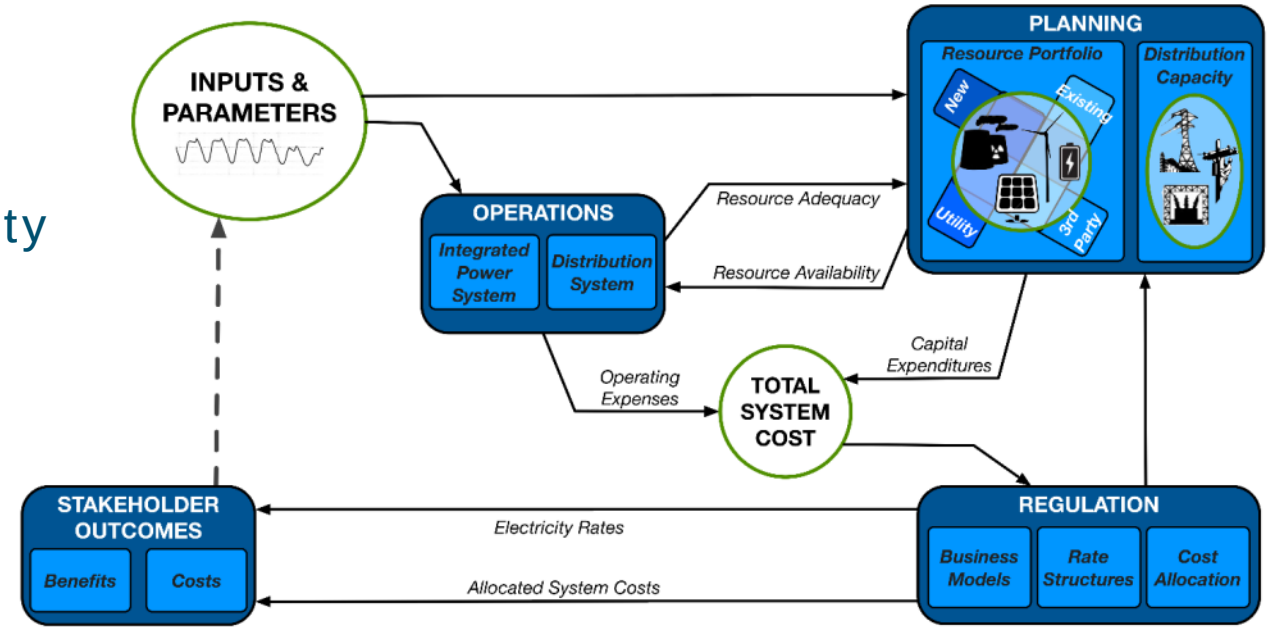
with Storage

w/o Storage



Beyond Capacity Value

- **EPRI's OpenDSS and RMI's EDGE model**
- **Use actual and test feeders**
- **Calculate $ benefits**
- **Indicators assessed :**
  - Equipment operations
  - Power quality
  - Investment deferral



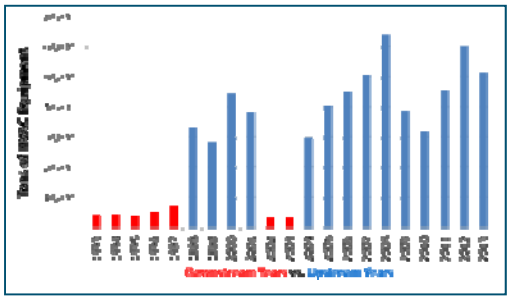
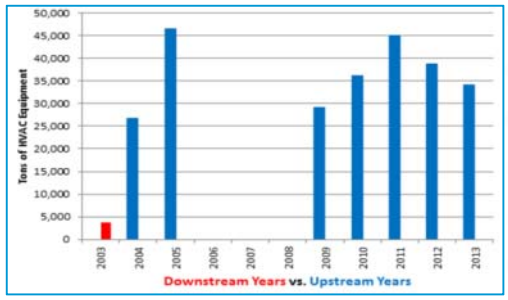
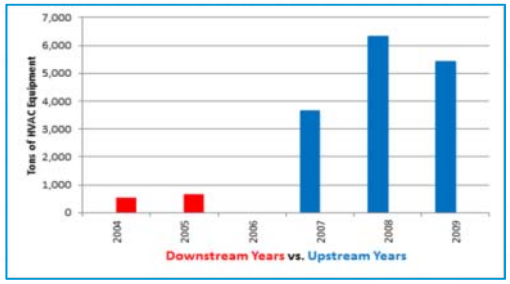
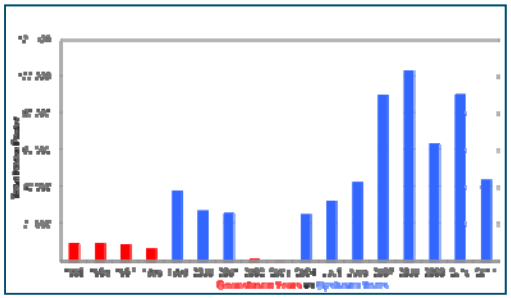
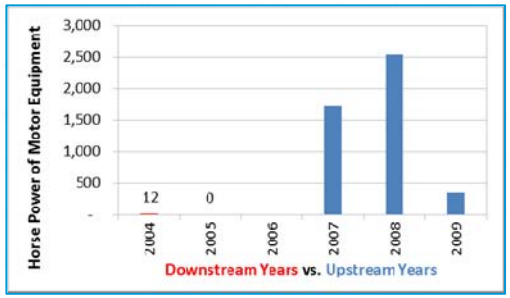
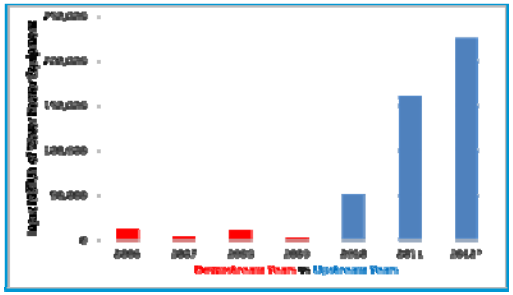
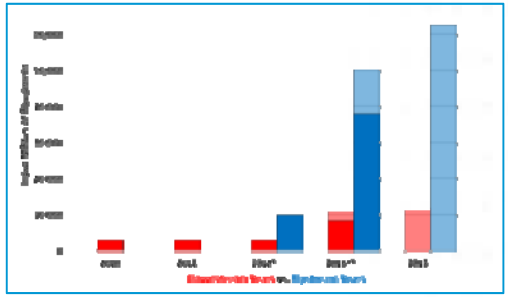
- RMI's Electricity Distribution Grid Evaluator (EDGE) model

6. Program Design

Innovative Design

Traditional Incentive Program	Proposed Program Design
Based on theoretical performance	Based on performance data of pilot projects
Eligibility criteria inflexible and based on theory	Eligibility based on pilot performance and lessons learned from other incentive programs
Focused on upfront or performance-based technology incentives	Integration of technology incentives and innovative tariff design
Restricts participation in multiple programs	Considers all potential revenue streams while avoiding double-dipping
No strong marketing & outreach component	Integrate marketing, education and outreach strategies directly

Results Oriented

	PG&E	SCE / SCG	NV Energy
HVAC			
Motors			
Water Heating			

Energy Solutions' Program Performance

Previous Program Designs

In Conclusion

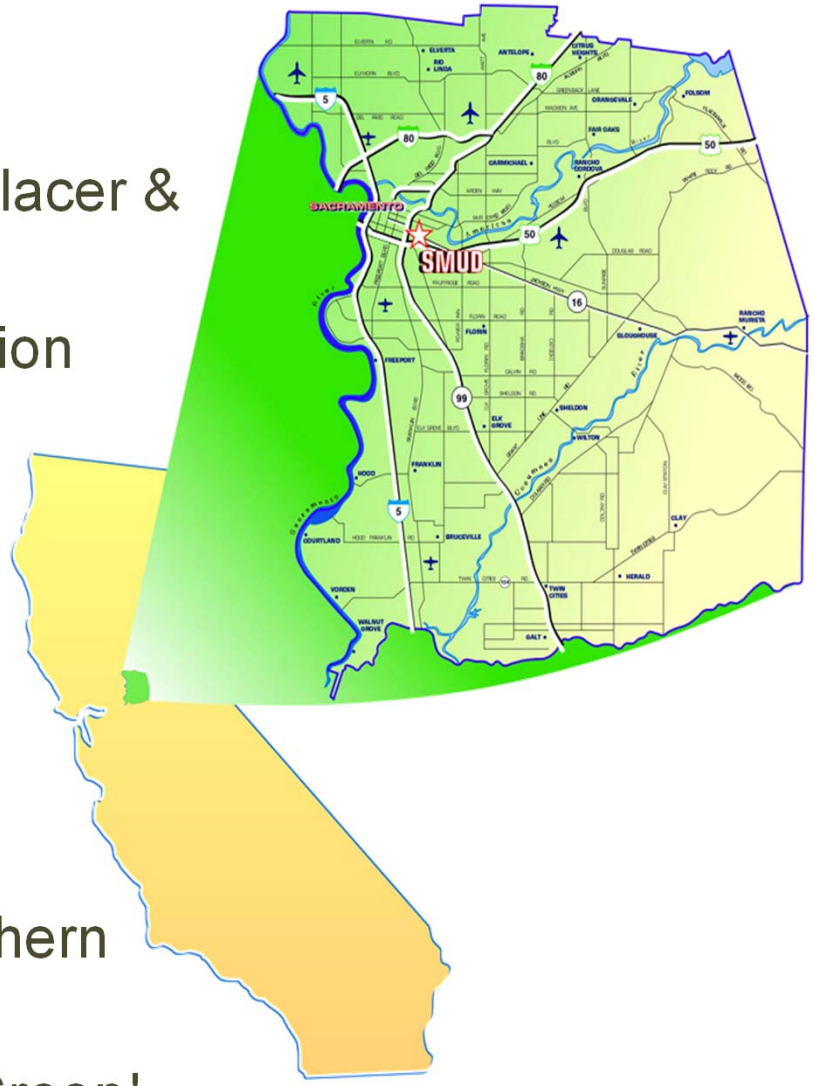
- **Will distributed PV work for or against utility grid?**
- **Beyond Net Energy Metering – Demonstrating grid benefits:**
  - Quantifying local operating and capital deferral benefits
  - Combining customer and utility benefits
  - Fast, visible and automated response
- **Continuous customer engagement with innovative programs**
- **Implementing at scale**

Energy+Environmental Economics

APPENDIX

SMUD – Owned By Customers

- Not for Profit, Publicly Owned Utility
- Began (1946)
- Sacramento County (small part of Placer & Yolo Counties)
- Almost 600,000 Customers; 1.4 Million Population
- Peak Load: 3,299 MW (July 2006)
- 6th Largest POU in U.S.
- 7 Member Board of Directors
- Elected by Customer Owners
- Not a Part of City or County
- Manage Balancing Authority of Northern California (BANC)
- Low Rates, Reliable, Innovative & Green!



SMUD™

Goals

- Translate demonstration of high penetration distributed PV integration into tangible policy and planning recommendations
- Demonstrate improved performance and value of distributed PV generation with truly integrated energy storage
- Demonstrate technology, tariff and alternative incentive programs that embrace dynamic pricing, zero-net energy homes and high-penetration PV
- Develop robust avoided cost estimates for local distribution system impacts, supported by OpenDSS modeling using test feeders
- Develop concrete program design and customer outreach strategies

Performance Objectives

- Collect one year of 4 second AC and DC metered performance and reliability data for PV generation, energy storage and customer loads at 44 customer sites.
- Reduce net feeder load by 90% of combined nameplate rating of all SIS installed on feeder.
- Maintain effective load carrying capacity (ELCC) of 70% or greater even with increasing penetrations of solar generation.
- Quantify at least $225 per kW-Yr./$1.50 per watt of utility system benefits and at least $360 per kW-yr./$2.20 per watt of customer benefits for PV integrated energy storage.

2500 R St. Future Plans (CY 2014 and beyond)

- Smart thermostat procurement and installation by 6/30/14
- Customer portal development and activation by 6/30/14
  - Provides solar generation, battery storage status, HVAC consumption, whole-house load, and power delivered to/from grid
- Implementation of DR events June-September 2014
- M&V completion by December 2014
  - Placement of monitoring equipment, measurement period, evaluation dates
  - Includes whole-house and appliance level monitoring for 3 homes; 5 homes for HVAC-only monitoring
- Plan for more advanced DR business rules for 2015
  - Potentially pricing as well
  - Address TOU-CPP + PV net metering rate harmonization