SILICON VALLEY
CLEAN ENERGY

"Watts For Lunch"

September 20th, 2018

Hosted By

Google

Why 'Watts for Lunch'?

- Quarterly C&I Forum focused on advancing the economic use of carbon-free electricity:
  - Learning, idea sharing, best practices
  - New technologies and services
  - Programs and incentives
- Interactive SVCE updates
  - Understand customer priorities and guide SVCE program investments
- Local peer networking

Behind-the-meter Energy Storage

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Today’s Agenda

10:30	SVCE Intro And Host Welcome
10:35 am	Attendee Introductions
10:40 am	Lead in to Energy Storage
10:50 am	“Watt Do You Think?” Interactive Polling
11:00 am	Behind-the-meter Customer-sited Energy Storage – Nick Tumilowics
11:20 am	Commercial and Industrial Storage Overview with Case Studies – Jacob Monroe
11:40 am	Lunch and Networking
12:10 pm	Self Generation Incentive Program – Brian Bishop
12:25 pm	Campus-wide Thermal Storage, a Case Study – Joe Stagner
12:45 pm	“Watt Do You Think?” Interactive Polling
12:50 pm	Panel Discussion and Q&A with Speakers
1:15 pm	SVCE Update for Fall 2018 – Don Bray
1:25 pm	Wrap-up and Forthcoming Event Announcement

Get To Know Your Peers

Attendee Introductions

John Supp

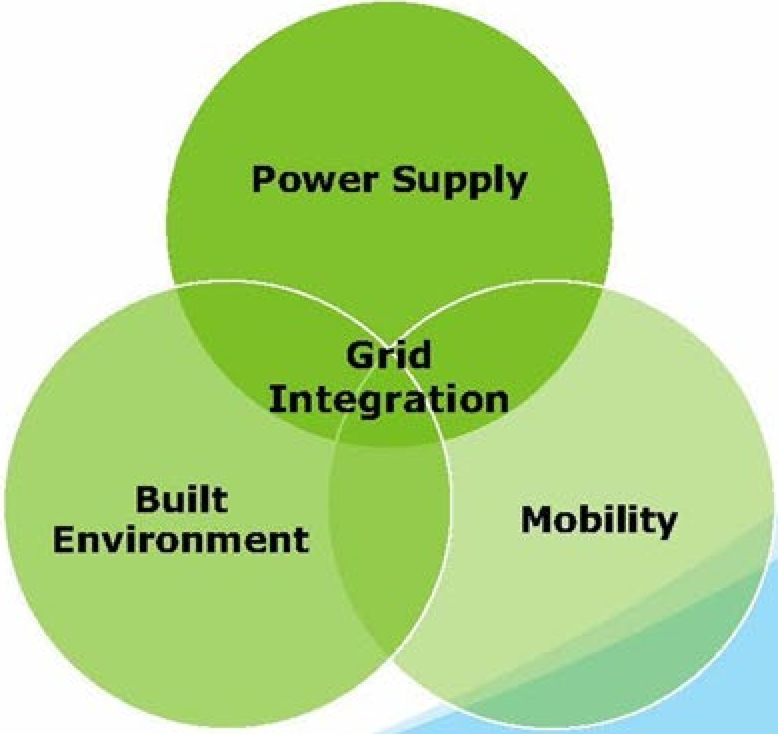
Account Services Manager

Storage Lead-in

Bend the Carbon Curve-

The Future is Electric

SVCE must procure & maintain a decarbonized power supply while electrifying everything and ensuring successful grid integration.



Power Supply

Grid Integration

Built Environment

Mobility

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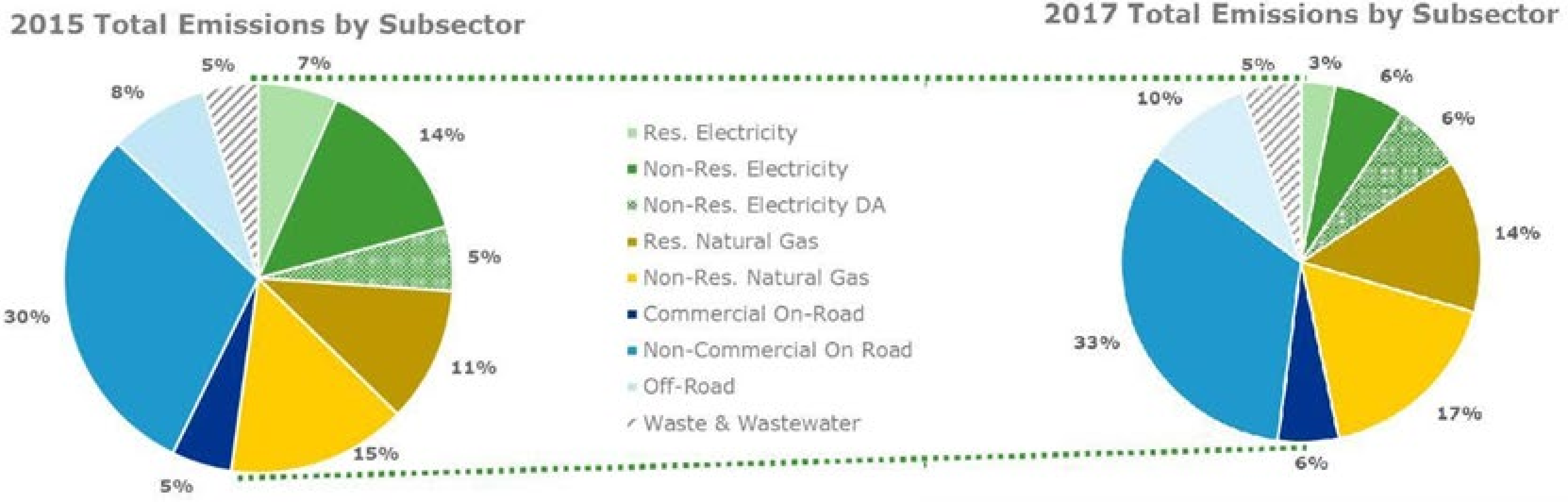
Emissions Reduction ‘15-’17



Emissions from Res/Non-Res Electricity declined from 21% to 9%

- Waste & Wastewater emissions not calculated and not included in the baseline. Estimated using typical per capita data for illustrative purposes.

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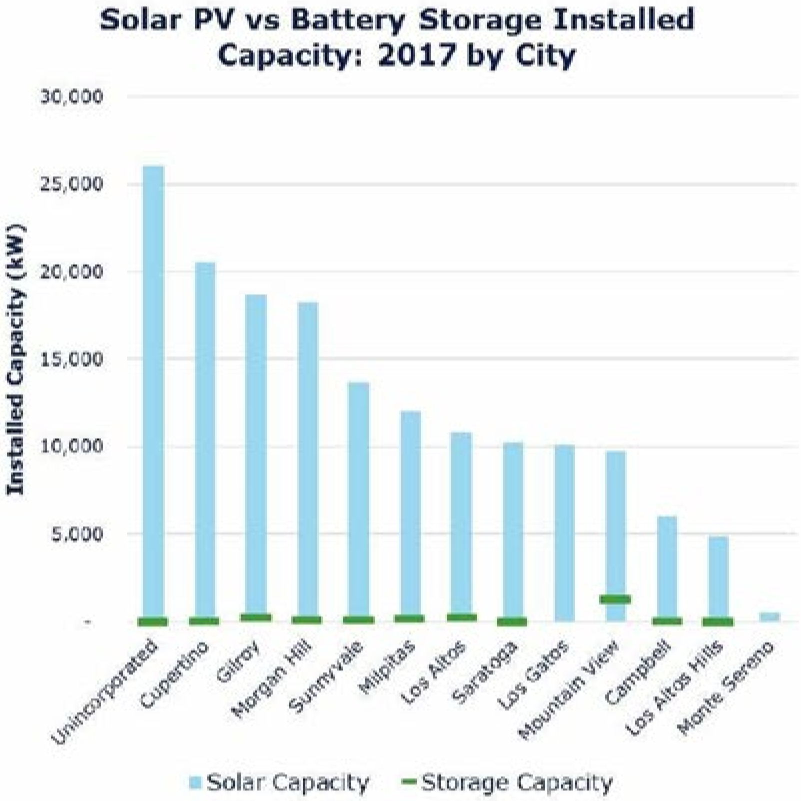
Baseline-

Storage and PV in SVCE Territory

- Installed PV (net-metered only) = 160 MW
- Installed Battery Storage = 8 MWh

For all storage to provide 4-hour capacity, Total Storage would need to be closer to 640 MWh.



Solar PV vs Battery Storage Installed Capacity: 2017 by City

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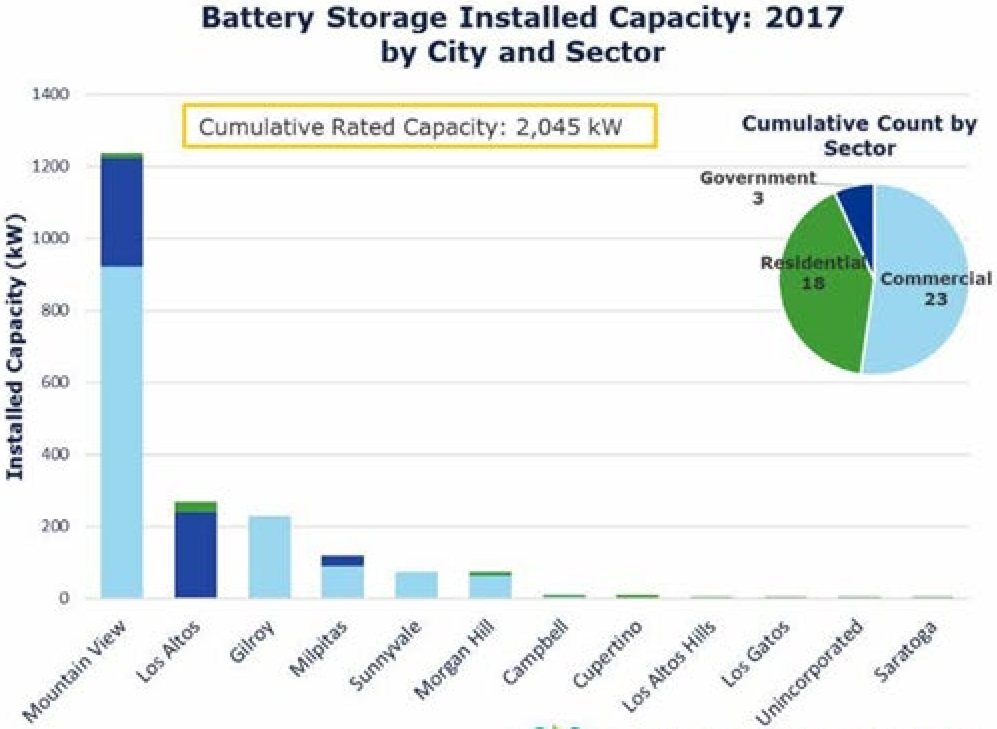
Where Is the Storage?

SVCE Territory

- Distribution of grid-tied energy storage.
- This represents installed and approved storage.
- **We expect the installations to be substantially higher in the 2018 GHG Elements report.**



Nick Tumilowicz

Principal Manager, Grid Integration of DERs

Electric Power Research Institute (EPRI)

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ELECTRIC POWER RESEARCH INSTITUTE

Behind-the-Meter Customer-Sited Energy Storage Overview

Nicholas Tumilowicz
Principal Manager

Evan Giarta
Systems Integration Engineer

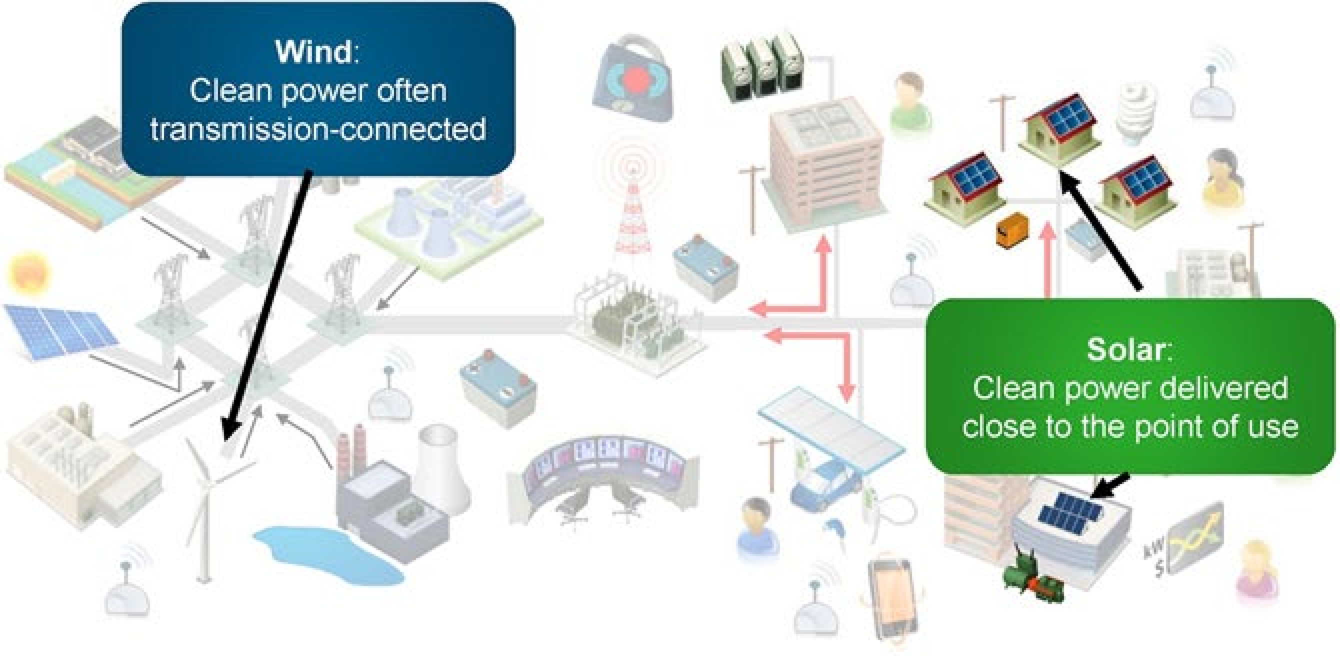
SVCE Meeting: Watts for Lunch
2018-09-20

Together…Shaping the Future of Electricity

EPRI's Mission

Advancing ***safe***, ***reliable***, ***affordable*** and ***environmentally responsible*** electricity for society through global collaboration, thought leadership and science & technology innovation

Transformation of the Power System

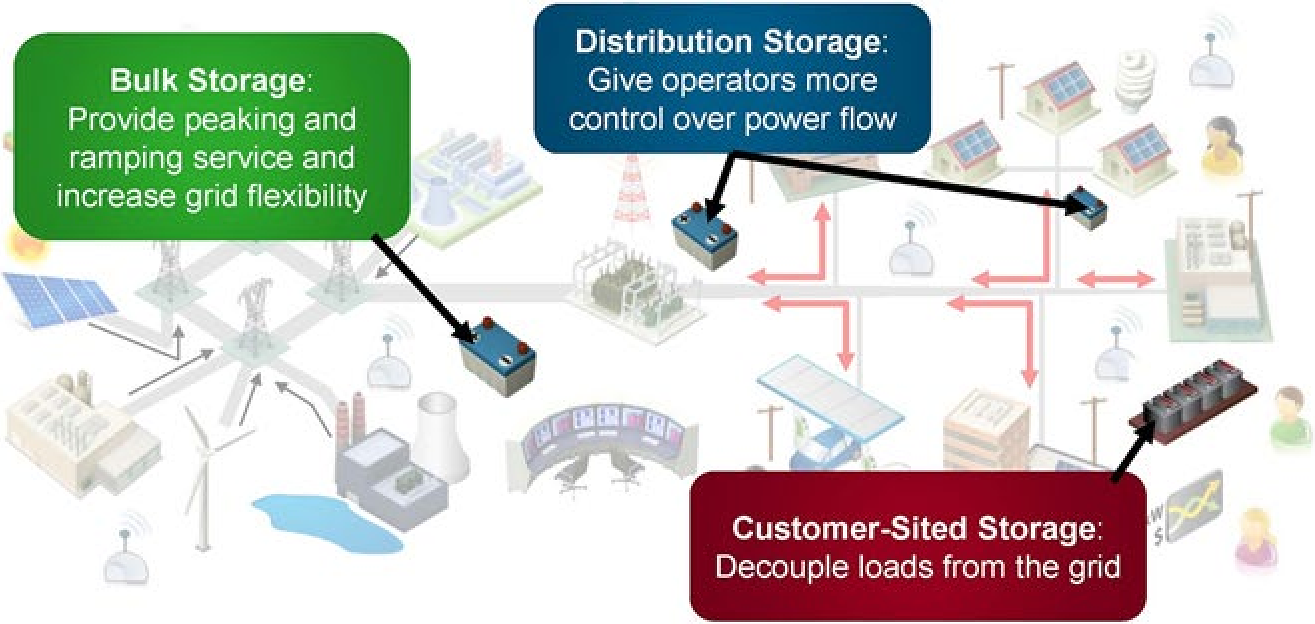


Wind:
Clean power often
transmission-connected

Solar:
Clean power delivered
close to the point of use

Renewables and EV's are Transforming the Power Grid

Transformation of the Power System



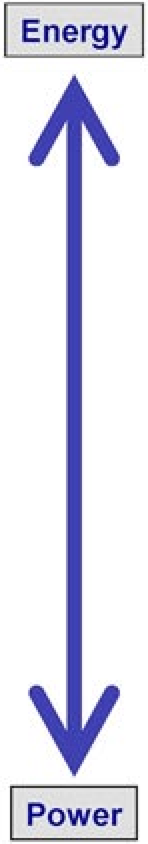
Bulk Storage: Provide peaking and ramping service and increase grid flexibility

Distribution Storage: Give operators more control over power flow

Customer-Sited Storage: Decouple loads from the grid

Energy Storage is Playing Key Roles Across the Grid

Energy Storage Technologies



Energy

Power

- Thermal
- Pumped Hydro
- Compressed Air Energy Storage (CAES)
- Batteries
  - Sodium Sulfur (NaS)
  - Flow Batteries
  - Lead Acid
  - Advanced Lead Carbon
  - Lithium Ion
- Flywheels
- Ultracapacitors

Pumped Hydro
(Taum Sauk)
400 MW
3520 MWh

Sodium Sulfur
Battery
4 MW
24 MWh

Flywheels
20 MW
5 MWh

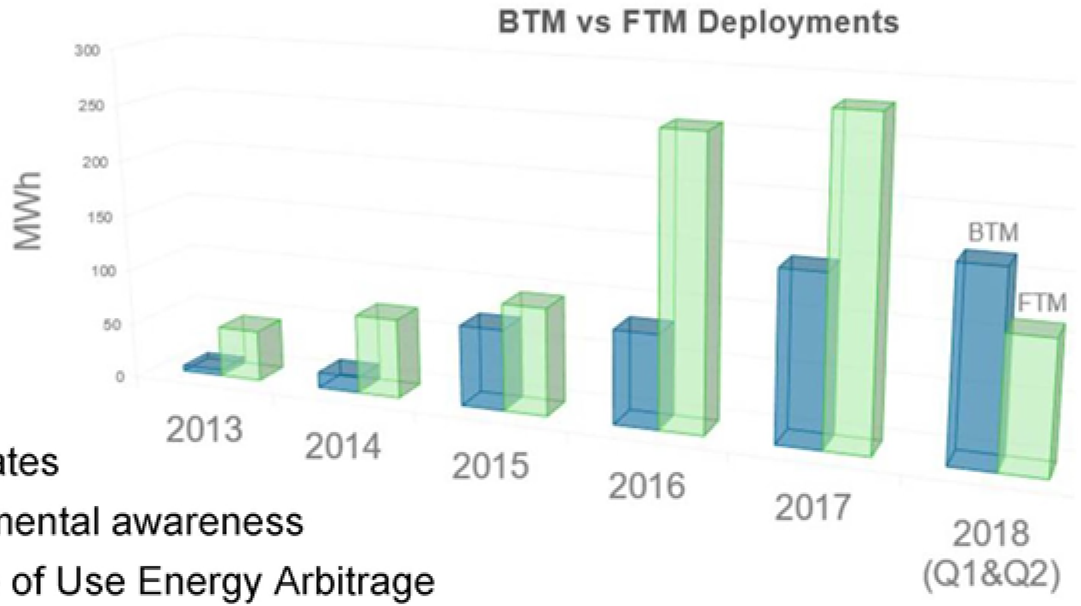
Customer-Sited Technologies

- **Lithium Ion chemistries - 94% market**
  - Iron Phosphate (LFP)
  - Nickel Manganese Cobalt (NMC)
- **Product harmonization in progress**
  - Inverter (AC-DC)
  - Battery and Management System
  - Energy Management System
- **Service providers developing offers**
  - $15/month adder for clean, quiet backup power
  - Demand Response programs connecting grid services

Market Update: Customer-Sited Energy Storage

- **Global Deployment Update – Systems in Operation**

☐ Germany:	100,000 units
☐ Japan:	60,000 units
☐ Australia:	21,000 units
☐ US:	12,000 units



- **Adoption Drivers**
  - ☐ Federal & State Incentives/Mandates
  - ☐ Reliability and increased environmental awareness
  - ☐ Demand Charge Reduction, Time of Use Energy Arbitrage
  - ☐ CA SB-100 : 100% clean energy supply by 2045, 60% by 2030
  - ☐ CA SB-700 : SGIP amendment, addition $800M over 6 years (pending)

Behind-the-Meter Business Models

Model #1: Customer-Owned

- **Value Application**
  - Load shifting for avoided costs
  - Demand response participation for grid services
- **Process**
  - Policy incentives (CA SGIP, ITC for solar)
  - Bill savings (TOU + Demand charges)
  - Additional aggregation programs
- *Examples: Sunrun, Tesla, Swell*

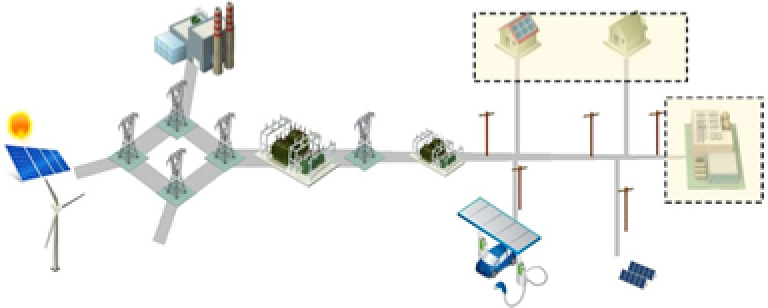
Model #2: Developer-Owned

- **Value Application**
  - Customer bill savings
  - Supports aggregation for grid services
- **Process**
  - Developer collects incentives
  - Customer payment (shared savings)
- *Examples: Stem, ENGIE Storage*

Model #3: Utility-Owned

- **Value Application**
  - Load shifting for avoided costs
  - Backup to certain customers
- **Process**
  - Customer monthly payment
  - Partial rate recovery related to ratepayer benefits
- *Example: Green Mountain Power*

Drivers: Customer policy incentives, self-consumption of solar PV without net metering, retail TOU rates with significant on-off peak spreads, demand charges, utility program participation



Grid Benefits of Energy Storage Adoption

- **Capacity Resource**: Peaker replacement or non-wires alternative
- **Flexibility Resource**: System ramping, renewable variability and uncertainty
- **Reliability / Resiliency Resource:** Electricity inventory for reserves
- **Voltage / Power Quality Resource:** Power conditioning system capabilities

Behind-the-Meter Energy Storage: Programs and Projects

- **State and Utility Programs**
  - Sacramento Utility District (early mover of customer research and adoption)
  - Southern California Edison (programs under development)
  - Pacific Gas & Electric (under existing DR Programs)
  - Hawaiian Electric Company
  - AZ, MA, NY

- **BTM Energy Storage Projects**
  - Fontana Zero Net Energy Residential Community
    - Nine new constructed homes with solar + storage
  - Sonoma Valley Unified School District
    - 250 kW, 500 kWh BTM Rule 21 interconnection on school property
  - Energy Savings to Refrigeration at Community Food Banks
    - Cold Thermal Energy Storage contributes to reduction in cooling costs while maintaining food quality

Maturation of Programs and Virtual Power Plants

Together…Shaping the Future of Electricity

Jacob Monroe

Vice President of Business Development

Advanced Microgrid Solutions (AMS)

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Advanced Microgrid Solutions

C&I Overview

September 2018

Advanced Microgrid Solutions

Leader in Optimizing Distributed Energy Resources

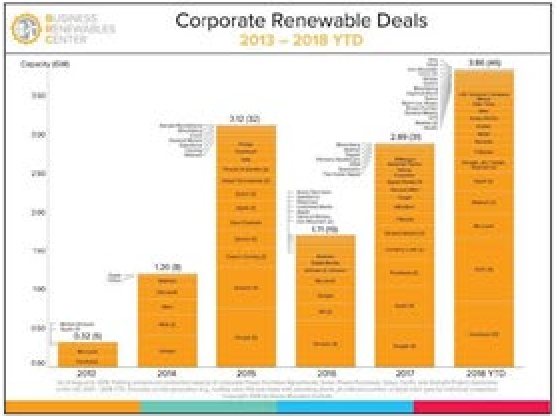
AMS controls, optimizes, and monetizes load control like energy storage systems via its industry-leading transactive energy management platform

- Scalable model delivers **guaranteed client savings with zero upfront cost**
- Developer of dispatchable, aggregated **Hybrid Electric Buildings®**
- Best-in-class partnerships with **Lockheed Martin, Tesla, and PowerSecure**
- AMS platform and optimization engine harnesses maximum value
- **Industry's first debt-financed project fund** with $200m commitment from **Macquarie Capital**

MORE OPTIONS FOR ENERGY PROCUREMENT

Customers are driving to 100% renewable to meet sustainability goals…

…and deploying Distributed Energy Resources



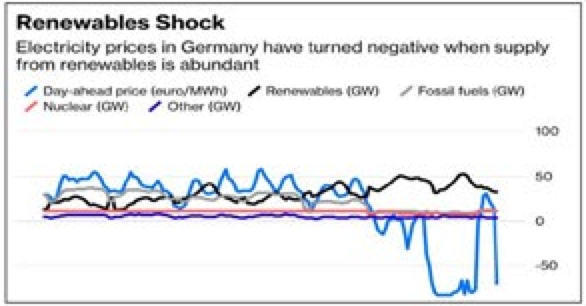
Corporate PPA's result in greater exposure to real-time wholesale prices

Customers need software and load control to optimize these assets and enable participation in energy markets

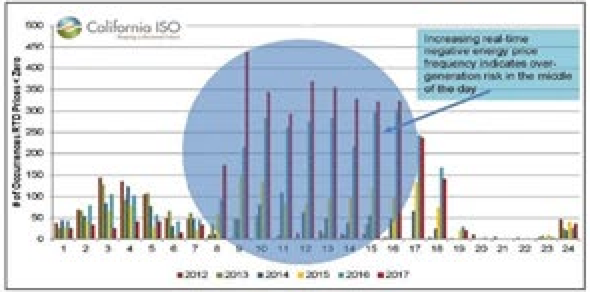
Source: Business Renewables Center, BRC Deal Tracker, as of August 6, 2018.

RENEWABLES ARE CAUSING VOLATILITY

Over-Generation & Negative Prices


Renewables Shock

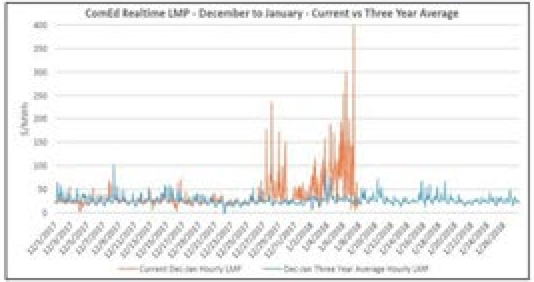
Electricity prices in Germany have turned negative when supply from renewables is abundant



Increasing real-time negative energy price frequency indicates over-generation risk in the middle of the day

Extreme Price Volatility


Extreme prices EU-28


ComEd Realtime LMP - December to January - Current vs Three Year Average

ENERGY STORAGE CHANGES EVERYTHING

Generators

Generators are using storage, including behind-the-meter assets, to firm renewable generation and increase returns on those assets.

Retailers / Utilities

Utilities are using storage to more efficiently match supply and demand at the distribution level

C&I Customers

Customers are installed storage to control costs and participate directly in wholesale markets

Southern California Edison LCR

2.2GW

Nuclear production shuttered by Southern California Edison in 2013

250MW

Energy storage procured by SCE, in place of expensive peaker power plants

50MW

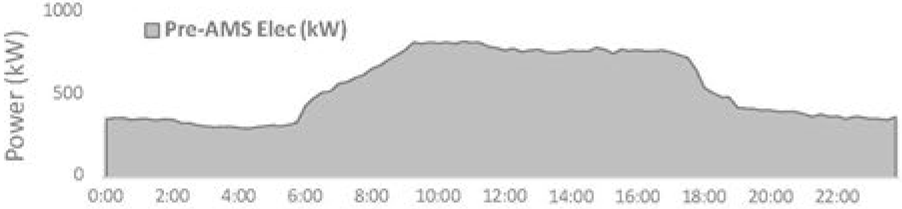
Dispatchable capacity provided by behind-the-meter AMS energy storage deployments

~120

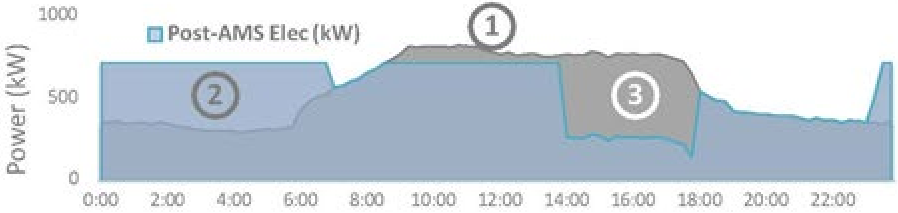
The total number of projects AMS will and manager in order to deliver these key grid services to SCE

AMS CO-OPTIMIZATION MODEL

Typical Building Load



Building Load with Energy Storage System

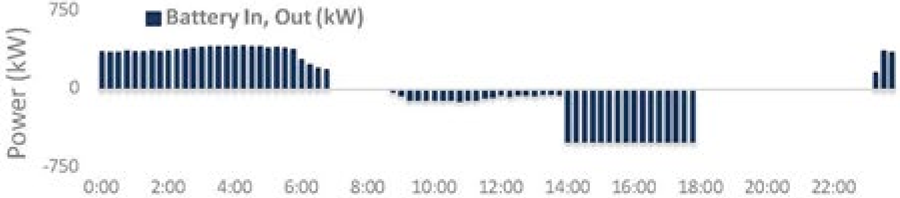


① Demand Charge Reduction

② Time of use Rate Arbitrage

③ Potential Utility Service

Energy Storage System Dynamics



GRID DISPATCH

Battery fleets have the ability to drop load in congested areas

Multiple batteries discharge simultaneously during a utility dispatch

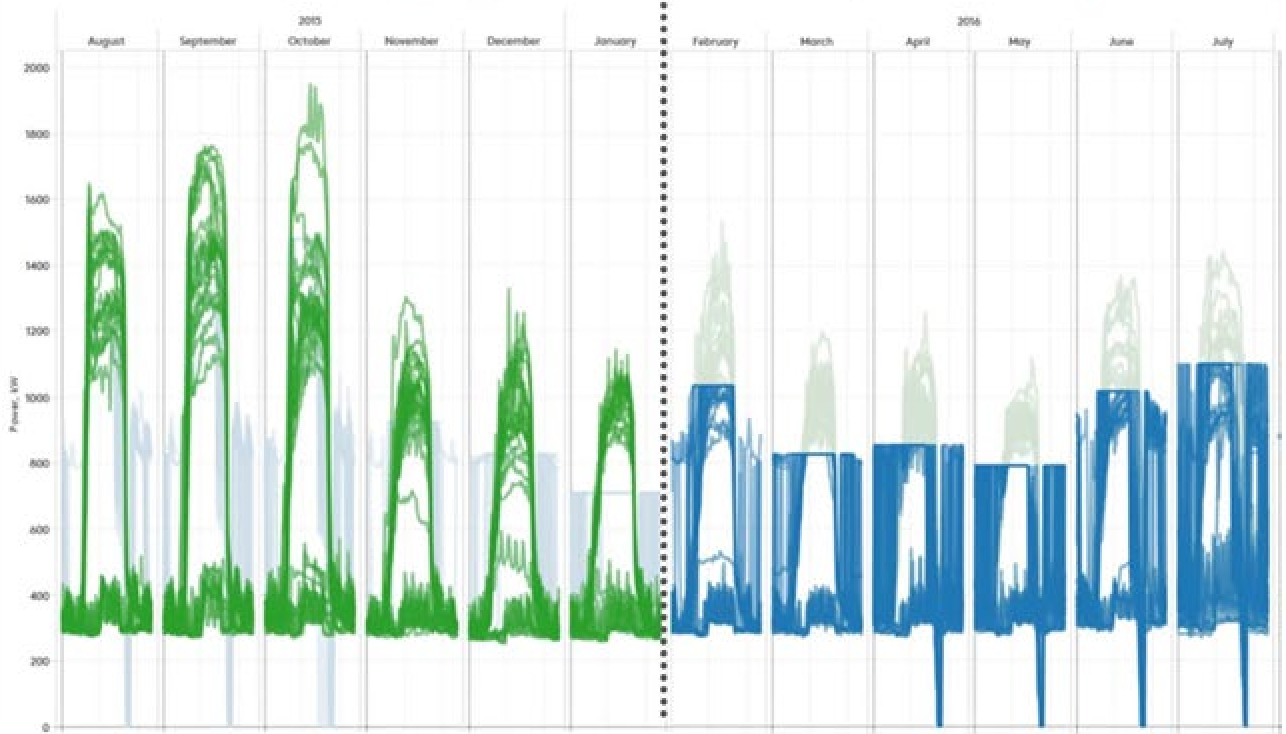
Co-optimization: one battery stops serving dispatch (blue) based energy needs at that individual site, and another increases discharge (red) to maintain overall portfolio dispatch level

Battery charging and discharging can be controlled and when a fleet is aggregated into a singular dispatchable resource to the utility, it creates the distributed equivalent of a new power plant

CONTROLLED LOAD VISUALIZATION

BEFORE:
Unmanaged Building Energy Use

AFTER:
AMS Hybrid Electric Building™



ECONOMIC MODEL

- **Guaranteed savings & no upfront cos**
- **Systems funded** with project finance
- **Turnkey installation,** executed by experienced developers
- **Technology agnostic**, with large- scale battery storage supply agreements
- **AMS operates the system** from a full-
  Network Operations Center (NOC)

Energy Savings

Host Customer

Services Fee

Advanced Battery System

Intelligently Manage and Control

AMS

Grid Services

Utility

Utility Contract

CASE STUDY
IRVINE COMPANY

- 26 commercial office buildings
- 10 MW of firm, disptachable capacity to the utility
- 25% peak demand reduction
- $1,000,000 reduction in annual electricity costs

IRVINE COMPANY
Since 1864

CASE STUDY
CALIFORNIA STATE UNIVERSITY

- Chancellor's Office & CSU Long Beach
- 2.75 MW contracted capacity across three systems
- $500,000 reduction in annual electricity costs

CSU The California State University

CASE STUDY **INLAND EMPIRE UTILITIES AGENCY**

- Six water recycling & pumping facilities
- 3.75MW of energy storage maximizing value of the grid and onsite resources:
  - 3.5 MW solar
  - 1 MW wind
  - 2.8 MW fuel cell
- $550,000 reduction in annual electricity costs

Inland Empire Utilities Agency
A MUNICIPAL WATER DISTRICT

Advanced Microgrid Solutions

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Brian Bishop

Product Expert and SGIP Program Manager

Pacific Gas and Electric (PG&E)

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Self Generation Incentive Program (SGIP)

Brian Bishop
PG&E

SVCE
September 20, 2018

Background and Key Facts

- Statewide CPUC program; PG&E, SCE, SoCalGas, CSE (SDG&E).
- Initiated in 2001; provides Generation and/or Storage incentives.
- *First home of PV incentives* until CSI in 2006. Great History!

Program Goals:

1. Grid; peak load reduction, improve efficiency, reliability of the T&D system, and lower infrastructure costs.
2. Environmental; GHG reduction, criteria air pollutant reduction.
3. Market Transformation; incubator. Support technologies that have the potential to thrive in future years without rebates.

Status Update

Approved to collect thru 2019, administer thru 2020.

Decision 16.06.055 (06/2016) modified program rules and structure:

- ➢ 75% storage, 25% generation; CSI-style incentive steps.

Decision 17.04.017 doubled budget (all to AES); now ~85% storage.

SB700 extends the program through 2024. Just needs a signature!

Right Now:

- Energy storage is ***emitting*** GHGs; per Itron's impact analyses.
- CPUC's Staff Proposal – relying on *GHG Signal Working Group* – recommends operational changes to reduce GHG impacts.
- New rules being debated and should be settled by Q2, 2019.

SGIP Technologies

Internal Combustion

Fuel Cell Electric

Wind

SGIP used to be all about *Generation*

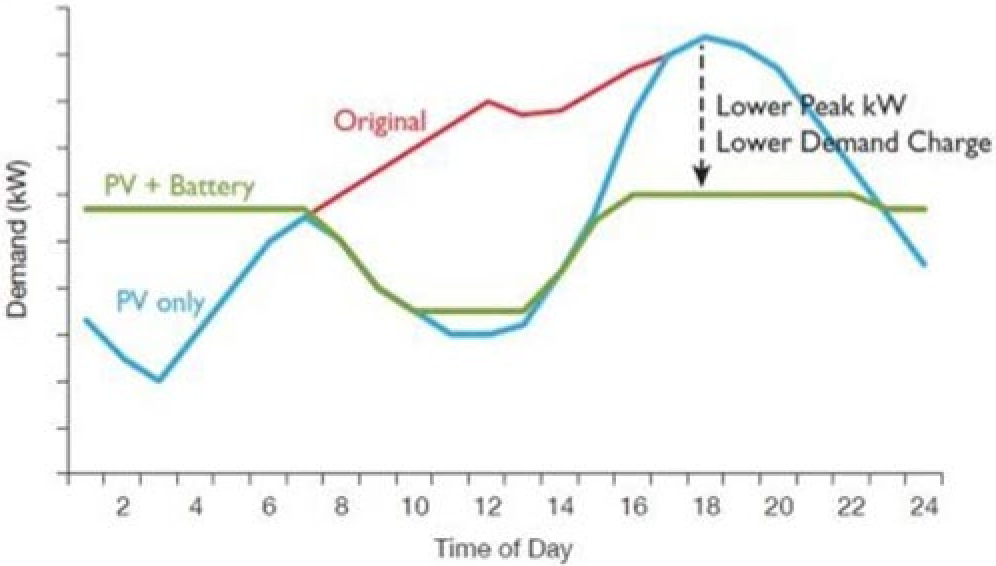
Now it's about all about *Energy Storage*

←Batteries

Shift Load and Optimize Renewables

- Storage can shift energy use & cost to different times.
- "Dispatch-ability" can lower bills, support the grid.
- Storage can also optimize renewable generation.

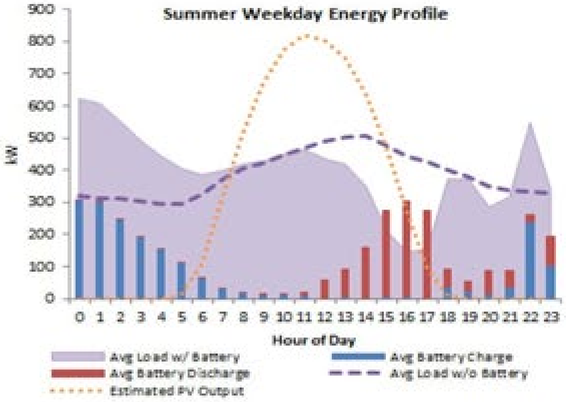
Effects of PV + Storage on Customer Load Profile

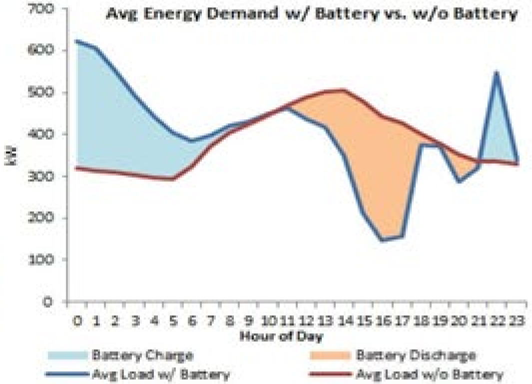


Energy Storage; Case Studies

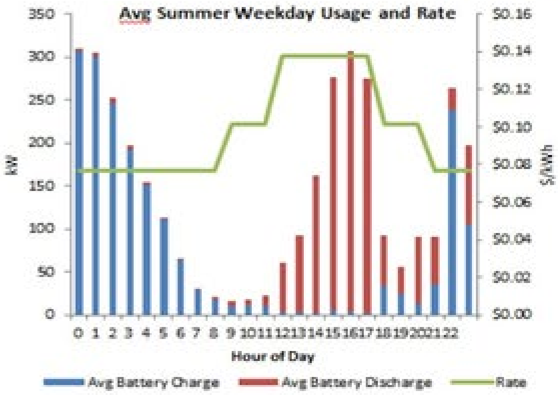
PG&E analysis of charge & discharge, rates, economic / environmental impacts of AES.

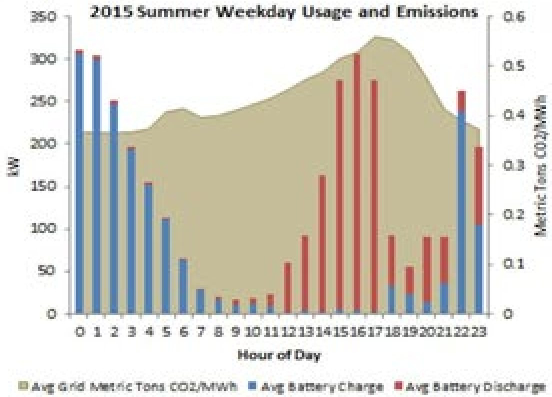
Summer Weekday Battery Usage



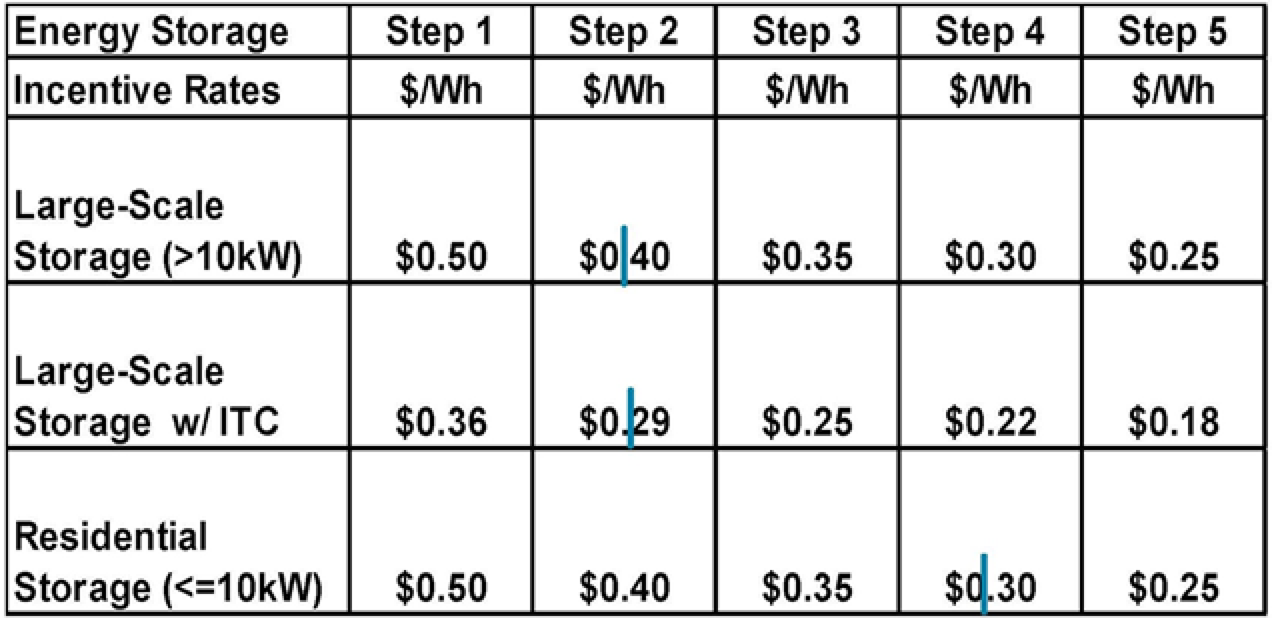


Results of Battery Usage



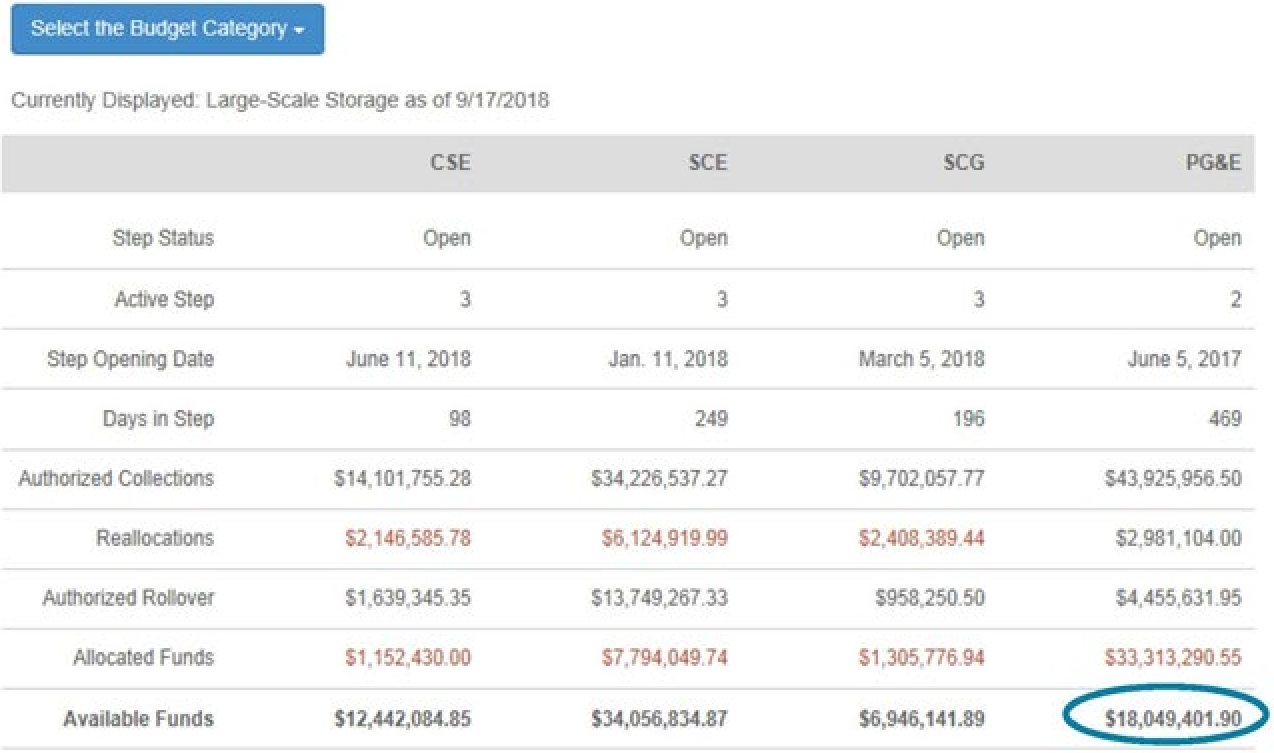


SGIP Storage Incentives



Energy Storage	Step 1	Step 2	Step 3	Step 4	Step 5
Incentive Rates	$/Wh	$/Wh	$/Wh	$/Wh	$/Wh
Large-Scale Storage (>10kW)	$0.50	$0.40	$0.35	$0.30	$0.25
Large-Scale Storage w/ ITC	$0.36	$0.29	$0.25	$0.22	$0.18
Residential Storage (<=10kW)	$0.50	$0.40	$0.35	$0.30	$0.25

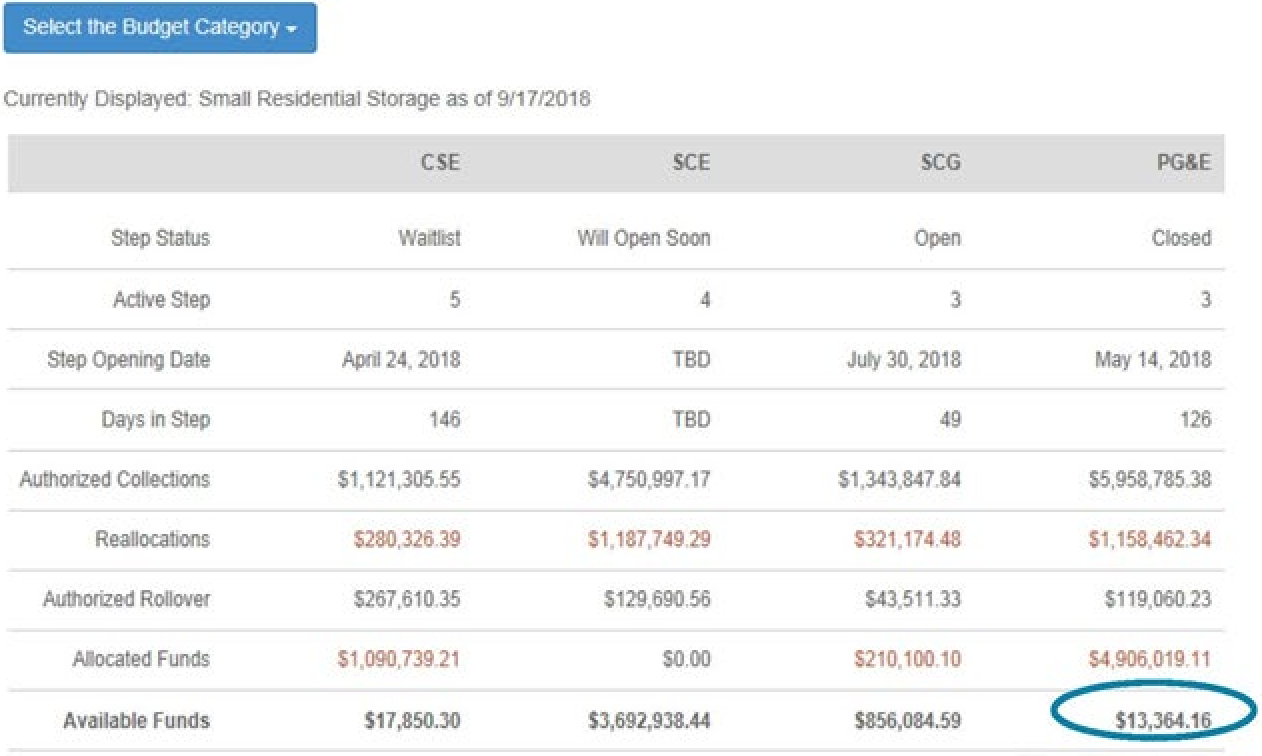
From the SGIP Metrics Page; Large Storage



Currently Displayed: Large-Scale Storage as of 9/17/2018

	CSE	SCE	SCG	PG&E
Step Status	Open	Open	Open	Open
Active Step	3	3	3	2
Step Opening Date	June 11, 2018	Jan. 11, 2018	March 5, 2018	June 5, 2017
Days in Step	98	249	196	469
Authorized Collections	$14,101,755.28	$34,226,537.27	$9,702,057.77	$43,925,956.50
Reallocations	$2,146,585.78	$6,124,919.99	$2,408,389.44	$2,981,104.00
Authorized Rollover	$1,639,345.35	$13,749,267.33	$958,250.50	$4,455,631.95
Allocated Funds	$1,152,430.00	$7,794,049.74	$1,305,776.94	$33,313,290.55
Available Funds	**$12,442,084.85**	**$34,056,834.87**	**$6,946,141.89**	**$18,049,401.90**

From the SGIP Metrics Page; Small Storage



Currently Displayed: Small Residential Storage as of 9/17/2018

	CSE	SCE	SCG	PG&E
Step Status	Waitlist	Will Open Soon	Open	Closed
Active Step	5	4	3	3
Step Opening Date	April 24, 2018	TBD	July 30, 2018	May 14, 2018
Days in Step	146	TBD	49	126
Authorized Collections	$1,121,305.55	$4,750,997.17	$1,343,847.84	$5,958,785.38
Reallocations	$280,326.39	$1,187,749.29	$321,174.48	$1,158,462.34
Authorized Rollover	$267,610.35	$129,690.56	$43,511.33	$119,060.23
Allocated Funds	$1,090,739.21	$0.00	$210,100.10	$4,906,019.11
Available Funds	**$17,850.30**	**$3,692,938.44**	**$856,084.59**	**$13,364.16**

Closed, moving to Step 4

SB700

- Passed by State Legislature; just needs Governor's signature.
- Extends SGIP for five years at current funding levels; approximately $166M per year statewide. [PG&E = 44%, roughly $73M/yr].
- Prohibits generation technologies using nonrenewable fuels from incentive eligibility beginning in January 2020.

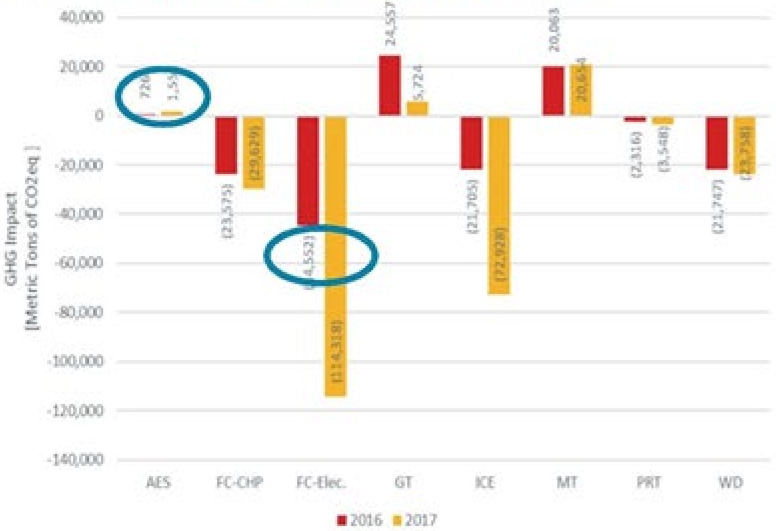
Questions:

- How will GHG Signal WG recommendations effect future program?
- Will CPUC approve full funding of Leg-approved budget, trim back the budget, or reduce/increase incentive levels?
- How will SGIP PAs or PG&E address investor risk-aversion and the stalled commercial market?

Trends and Other Info

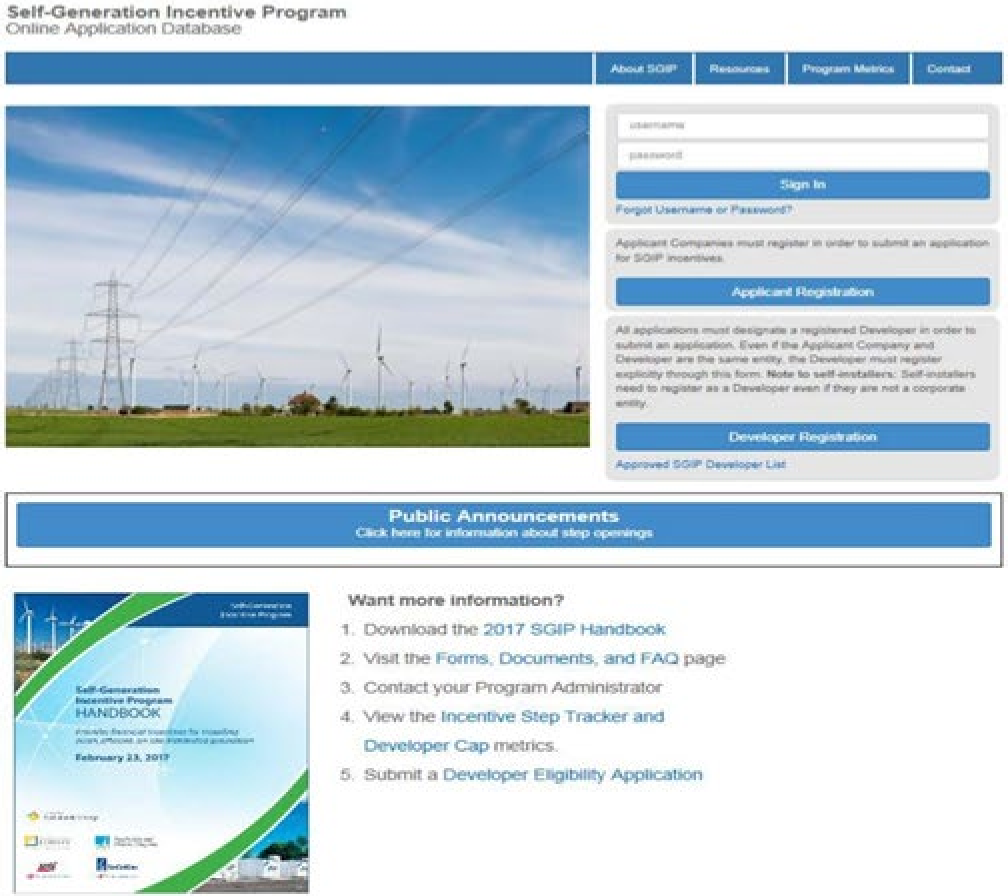
- Ironically, natural gas fuel cells reduce the most GHGs in SGIP; new rules and funding restriction discourage participation.
- Timing of AES charge & discharge relative to grid marginal emissions rate remains most important factor for GHG reductions.

FIGURE 6-1: GREENHOUSE GAS IMPACTS BY TECHNOLOGY TYPE AND CALENDAR YEAR



- Monthly and TOU demand reduction, rate arbitrage are primary drivers.
- Non-residential systems deliver customer on-bill savings, grid support.
- Non-res systems that participate in DR provide real demand reduction, and reduce GHGs and system costs.
- Residential systems are primarily used as backup, also increase GHGs.

SGIP Homepage: https://www.selfgenca.com/



Self-Generation Incentive Program
Online Application Database

Applicant Companies must register in order to submit an application for SGIP incentives.

All applications must designate a registered Developer in order to submit an application. Even if the Applicant Company and Developer are the same entity, the Developer must register explicitly through this form. **Note to self-installers:** Self-installers need to register as a Developer even if they are not a corporate entity.

Want more information?

1. Download the 2017 SGIP Handbook
2. Visit the Forms, Documents, and FAQ page
3. Contact your Program Administrator
4. View the Incentive Step Tracker and Developer Cap metrics.
5. Submit a Developer Eligibility Application

Appendix

NEM Questions

NEM 2 Rule 21 Governs <=10kW & >10kW Systems:

Installing new solar + storage together:

NEM 2 Rule 21 rules apply. $145 charge for interconnection.

- If storage 10kW or less, $145 for interconnection as long as PV is sized @ 1MW or less.
- If storage is >10kW, storage must be sized w/in 150% of the PV CEC AC rating, and PV cannot be sized >1MW. If storage is sized >150%, must participate in NEM MT; app fee $800.

Installing storage to pre-existing solar: 2 Options

1. To qualify for “NEM Paired Storage”, with PV and inverter both under 10kW, customer pays $145 for interconnection.

2. For larger systems, customer pays $800 and all fees associated with a non-NEM Rule 21 generator.

Other Useful Resources

- Public Announcements: https://www.selfgenca.com/home/about/
- Program Metrics: https://www.selfgenca.com/home/program_metrics/
- General FAQ: https://www.selfgenca.com/home/resources/
- Residential FAQ: http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442452260
- Contact Page: https://www.selfgenca.com/home/contact/
  - Mailing address for all PAs
- Panel Notes in the application form

SGIP Resources

Program Manager: Brian Bishop

Email: BTBD@pge.com

Phone: 415.973.0720

- **www.pge.com/sgip**
  - *Program Handbook*
  - *Program Documents*
- **SGIP Phone: 415.973.6436**
- **SGIP Email: selfgen@pge.com**

Joe Stagner

Executive Director, Sustainability and Energy Management

Stanford University

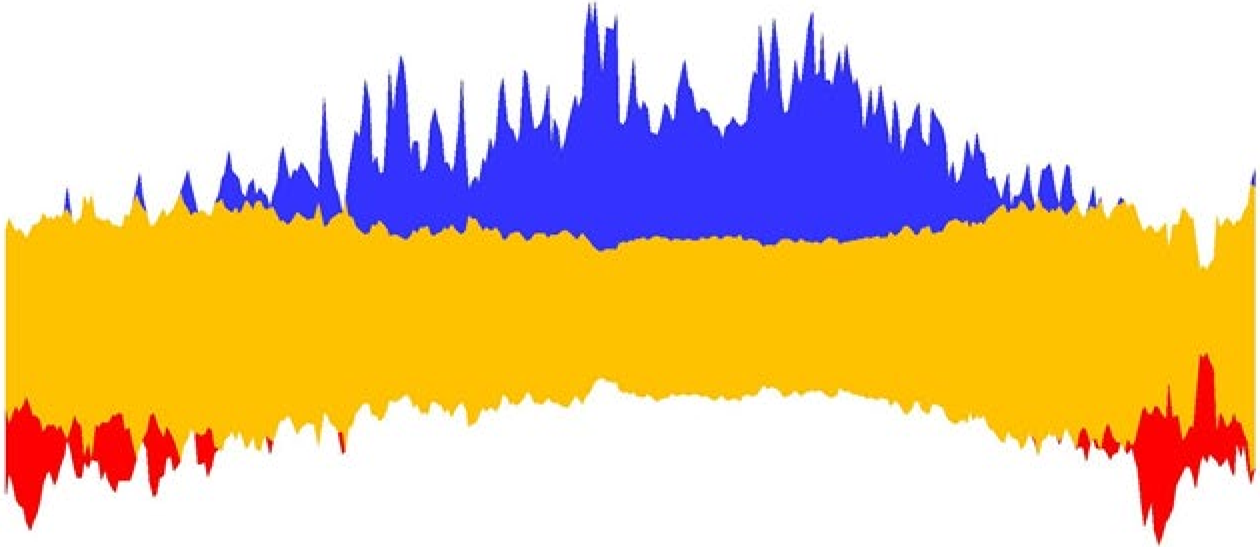
SILICON VALLEY
CLEAN ENERGY

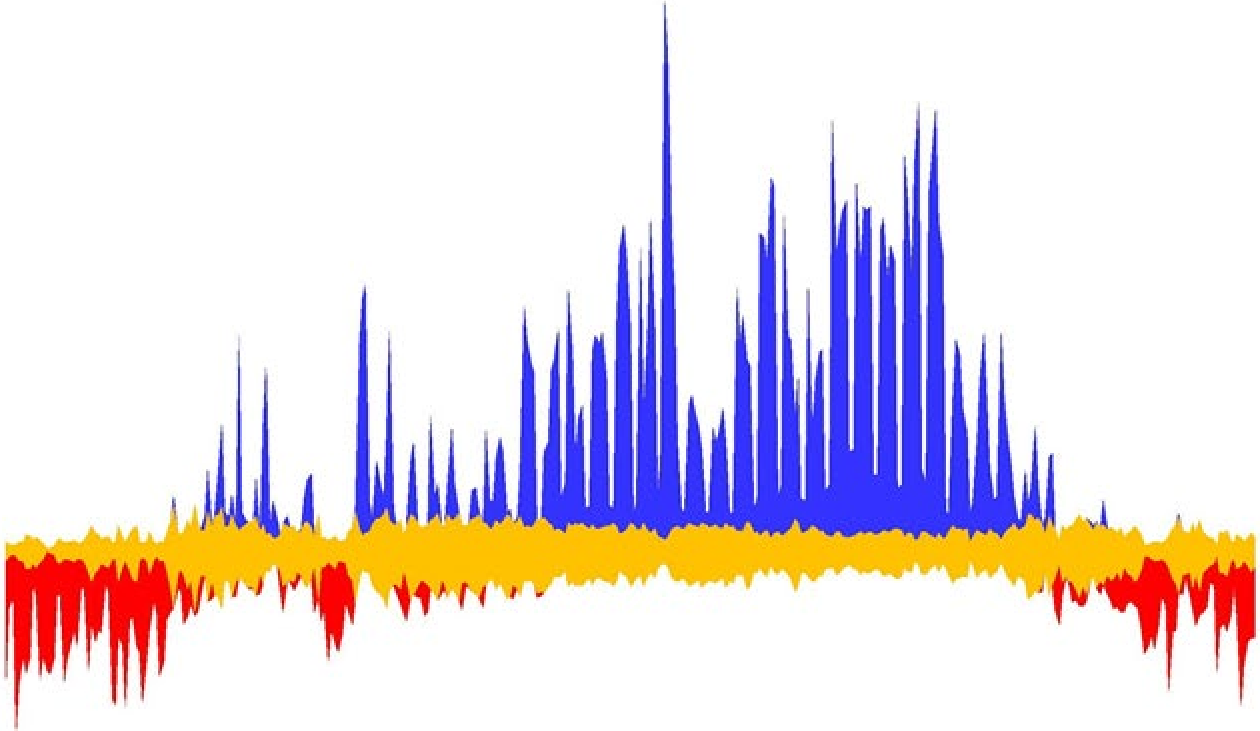
Stanford
ENERGY SYSTEM
INNOVATIONS

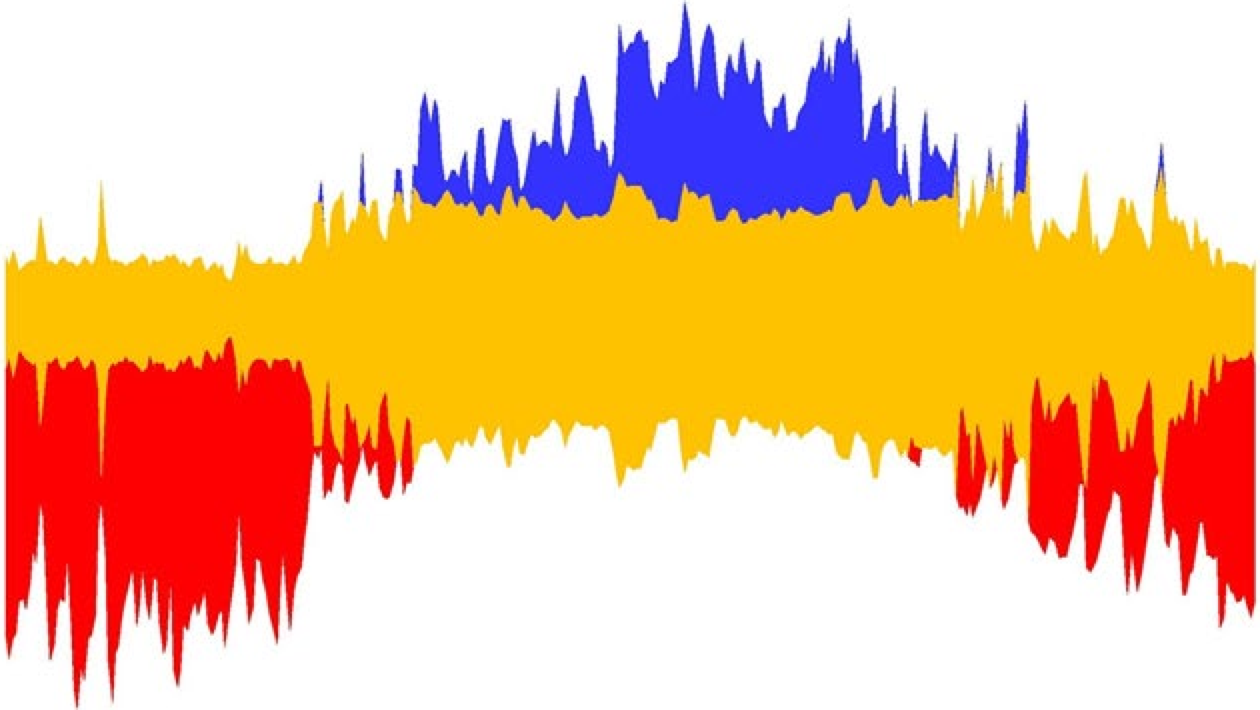
SILICON VALLEY
CLEAN ENERGY

Joseph Stagner, P.E.
Executive Director
Dept. of Sustainability & Energy Management
Stanford University

Energy Rorschach Test

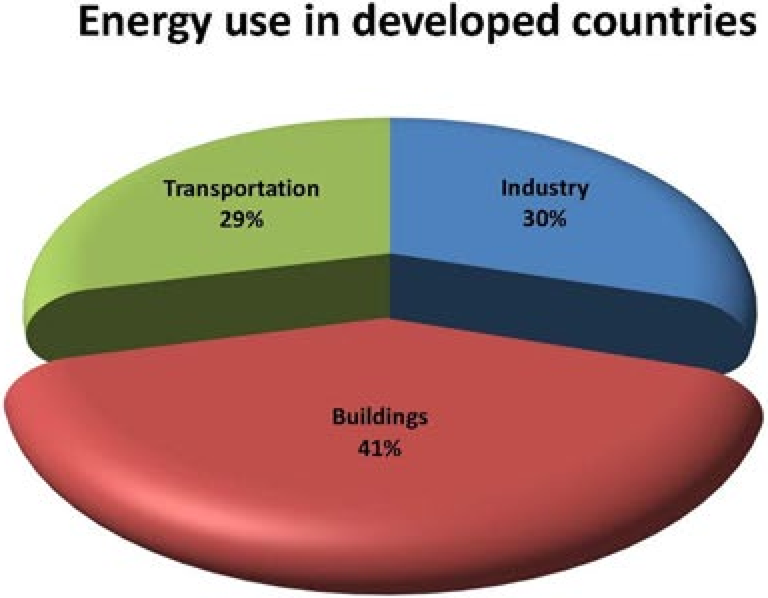






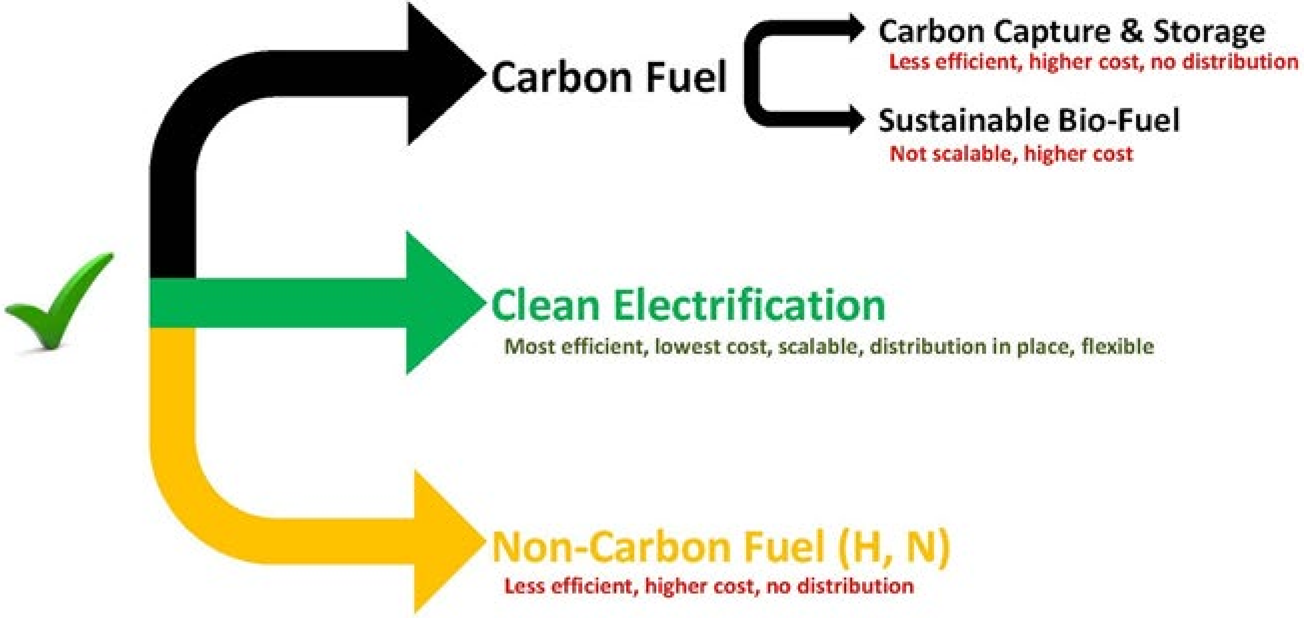
The Need and Case for Clean Electrification

Building Energy- Scale



- Electricity, Heating, and Cooling of structures
- 40% of GHG emissions

Pathways for *Sustainable* Building Energy



Carbon Fuel

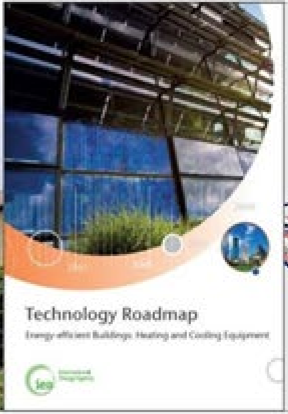
- **Carbon Capture & Storage**
  Less efficient, higher cost, no distribution
- **Sustainable Bio-Fuel**
  Not scalable, higher cost

✓ **Clean Electrification**
Most efficient, lowest cost, scalable, distribution in place, flexible

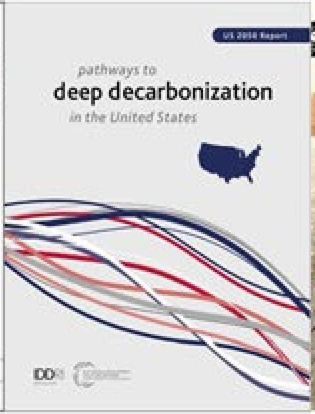
Non-Carbon Fuel (H, N)
Less efficient, higher cost, no distribution

Stanford, IEA, National Labs, UN, SCE, and others agree about the clean electrification pathway:

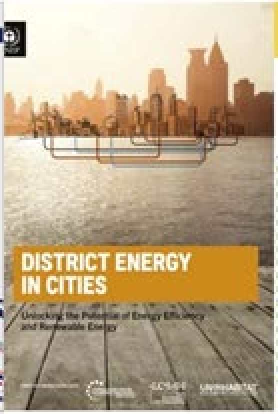
2009



2011



2014



2015

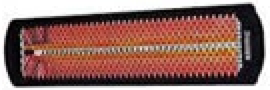
2017

Building Electrification: Basics

Heating & Hot Water:

Key to Clean Electrification of Building Energy

- Building Power & Cooling (typically) are already electric
- Heating & Hot Water are typically natural gas fueled
  - How do we electrify these efficiently & economically?
  - Heat Pumps!

	**Electric Resistive Heating**	**7** units of fuel	**6,816 btu** of gas = 1 KWH = **3,413 btu** of heat (via 50% efficient gas power plant)
	**Gas Heating**	**4** units of fuel	**4,000 btu** of gas = **3,413 btu** of heat (via 85% efficient heater)
	**Electric Heat Pump**	**1-2** units of fuel	**1,133 to 2,040 btu** of gas =.17 (120F) to .3 (160F) KWH = **3,413 btu** of heat (via 50% efficient gas power plant)

Heat Pump Examples

Residential Scale

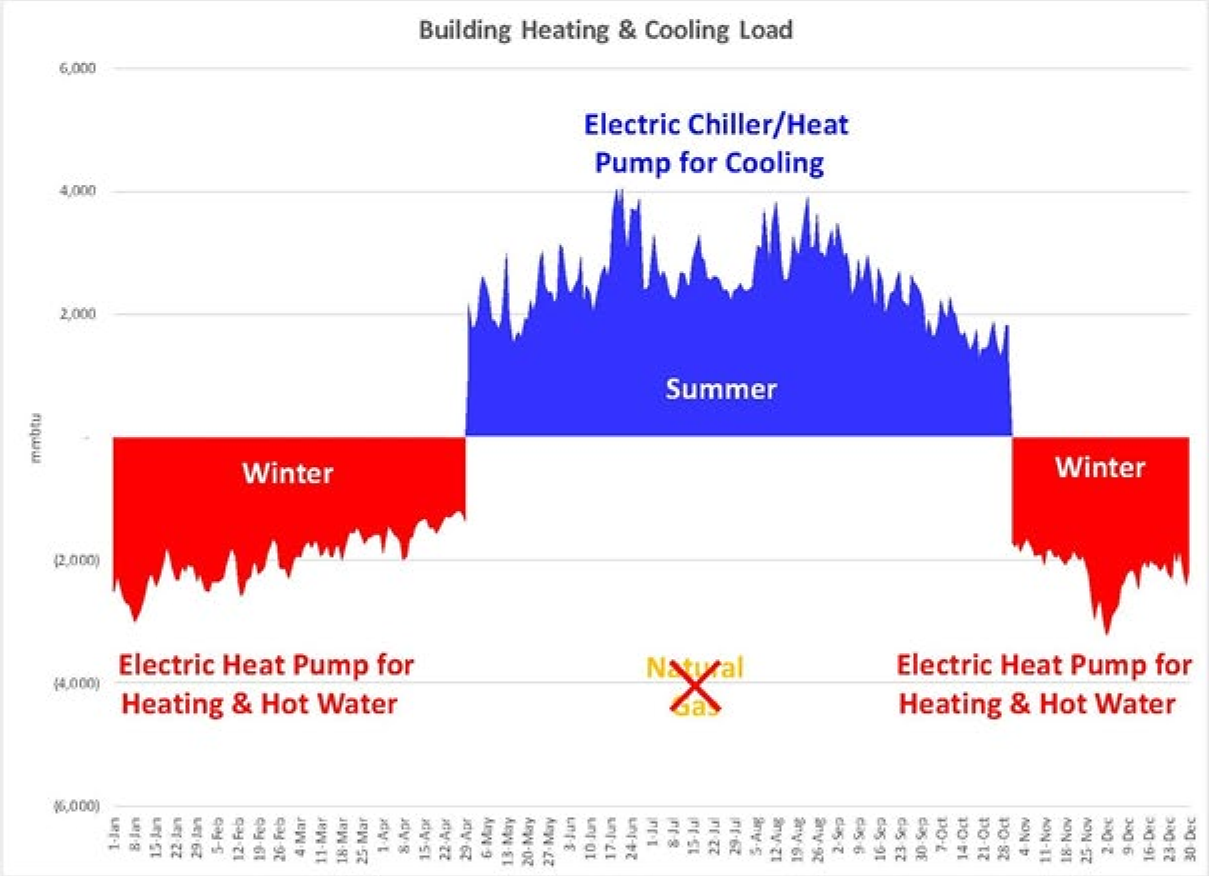
XV20i Variable Speed

Building Scale

YORK® VRF Low Ambient Heat Pump (HP) Outdoor Unit 208/230V

District Energy Scale

Basic 'Two Pipe' Heating & Cooling System



Electric Chiller/Heat Pump for Cooling

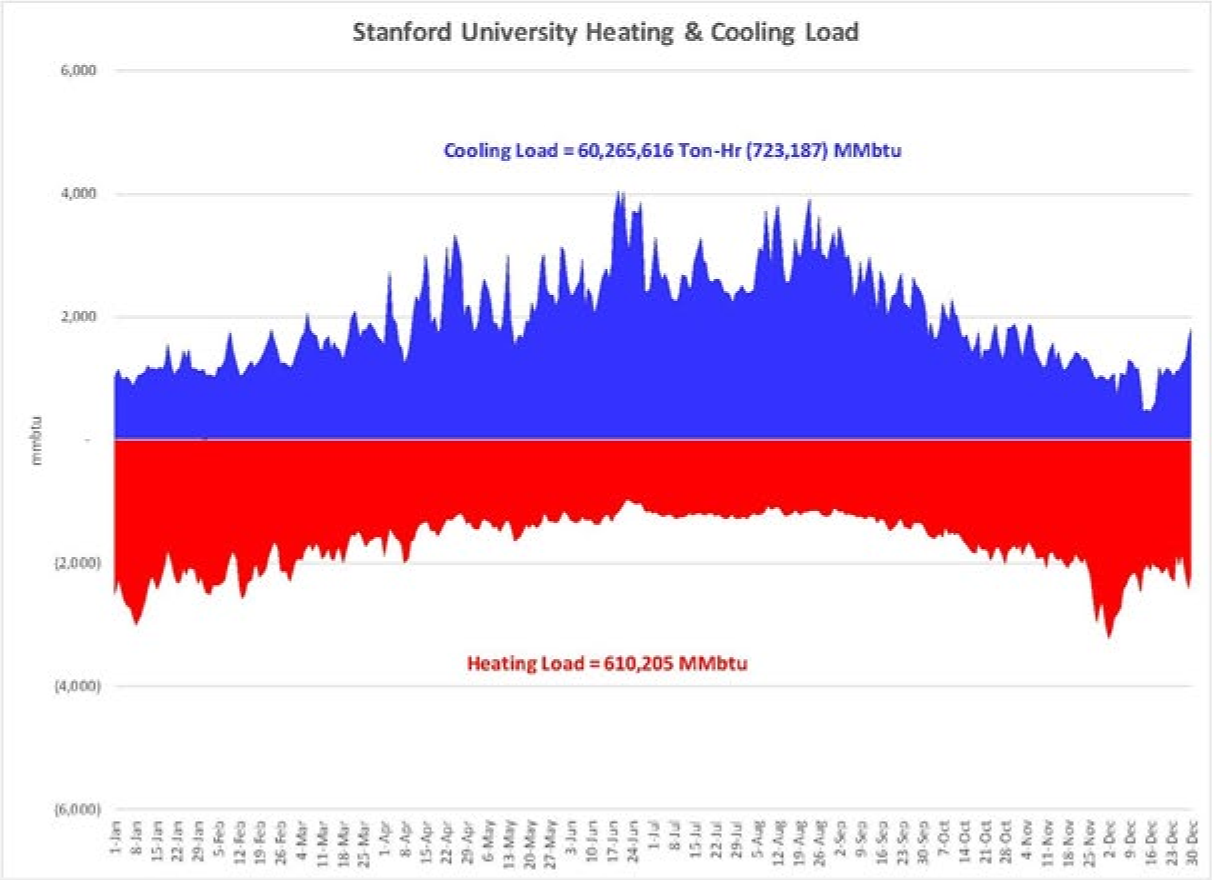
Electric Heat Pump for Heating & Hot Water

~~Natural Gas~~

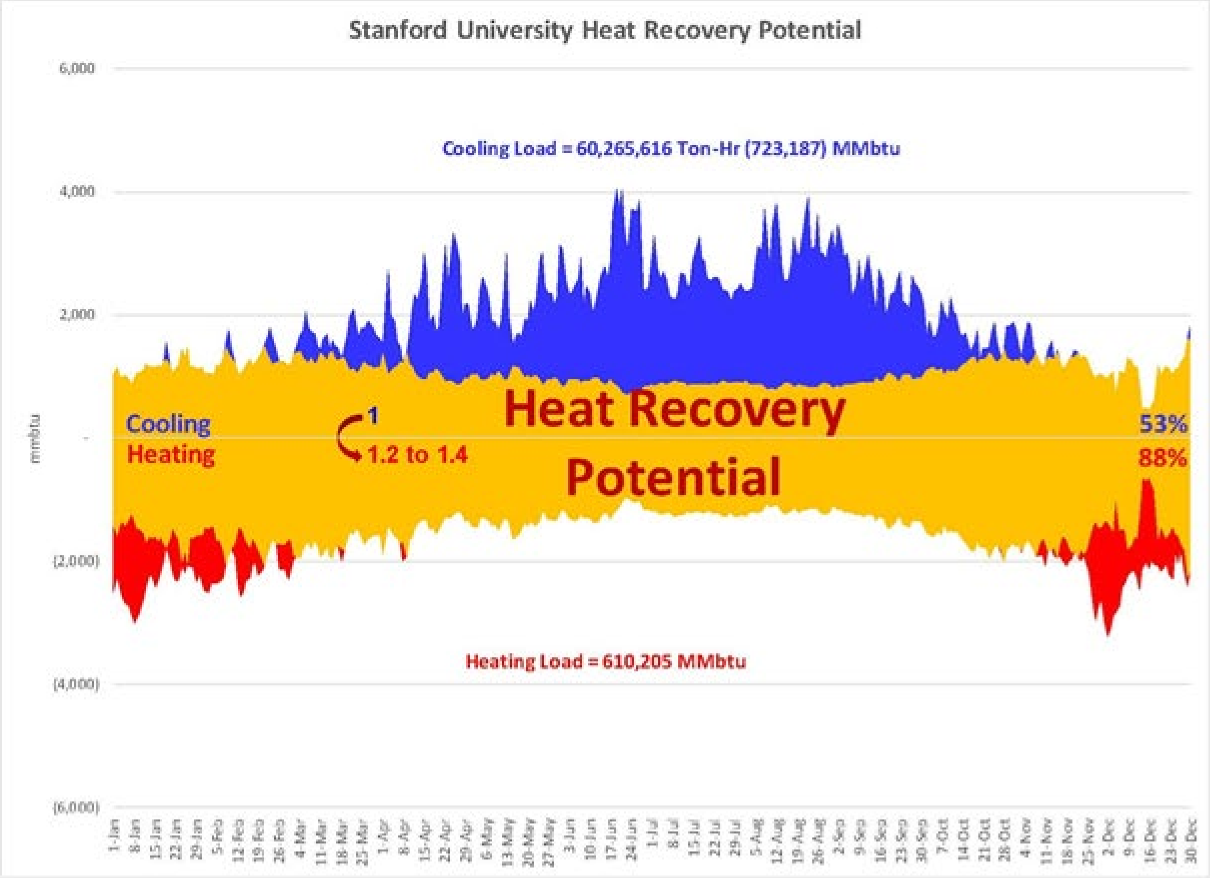
Electric Heat Pump for Heating & Hot Water

Advancement 1:
Heat Recovery

Both Heating & Cooling in same day or even week?

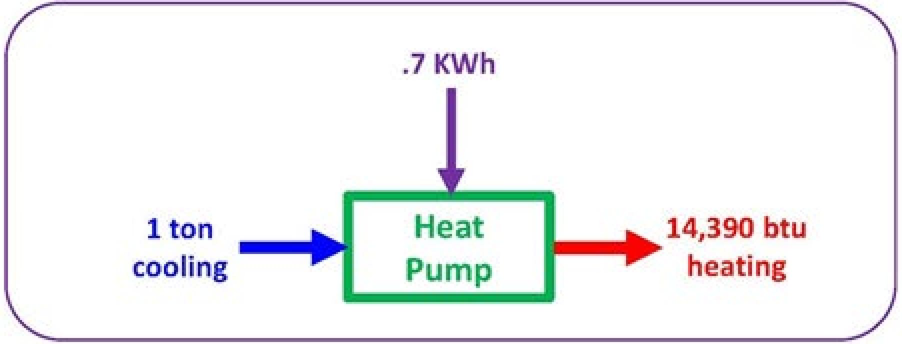


Use Heat Pump first for Heat Recovery, then Separate Heating & Cooling as needed



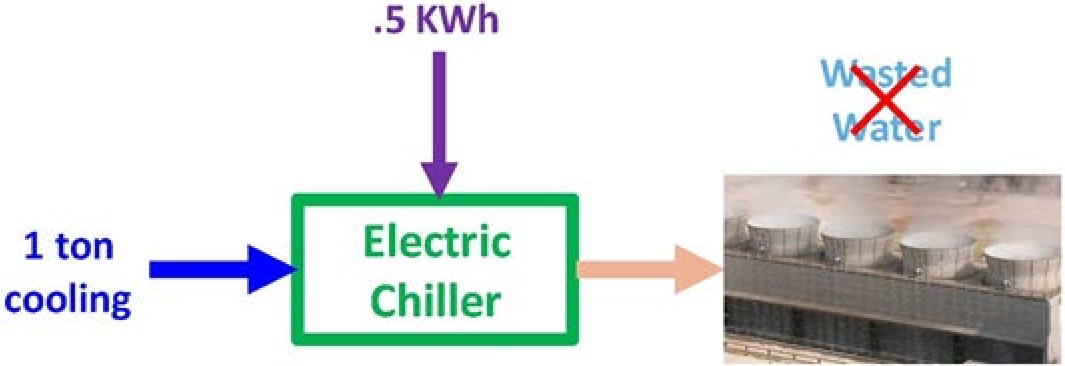
Why do Heat Recovery?

- Simultaneous heating & cooling by one machine is more efficient:



Saves water where evaporative cooling is used

- Waste heat from cooling is captured & reused instead of discharged out evaporative cooling tower



.5 KWh

1 ton cooling

Electric Chiller

~~Wasted Water~~

Advancement 2:
Thermal Energy Storage

Benefits of Thermal Energy Storage

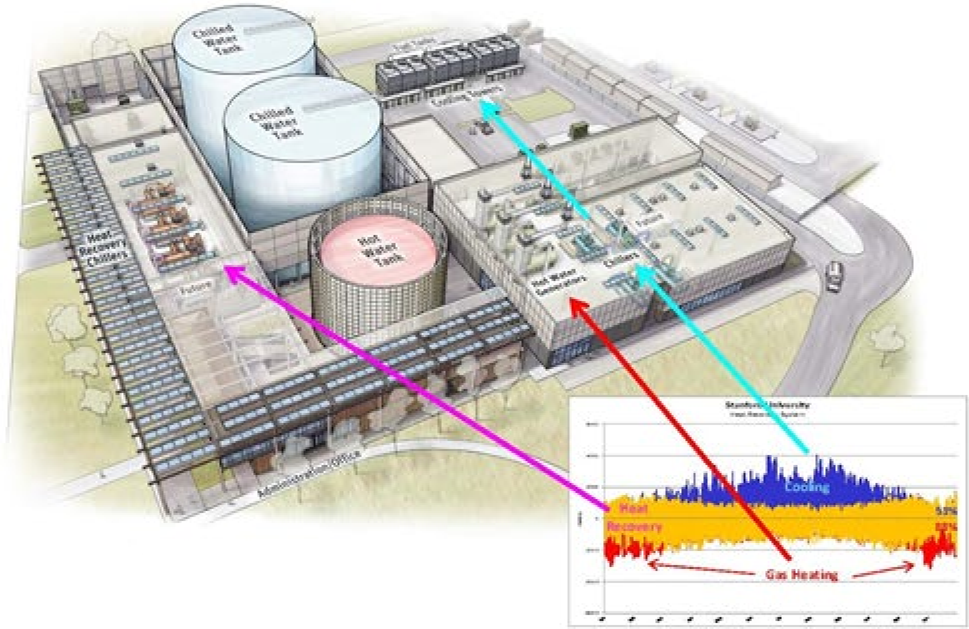
- Lower capital cost (water tank cheaper than more machines)
- Lower O&M cost (water tank easier to maintain than machines)
- Shifts machine work from higher to lower electricity cost hours
- Increased machine efficiency (allows evaporative cooling to be shifted to cooler temperature hours)

- …and in the case of Heat Recovery, allows waste heat to be saved for later use

Advancement 3:
Model Predictive Control

Heat Recovery System has 5 basic components:

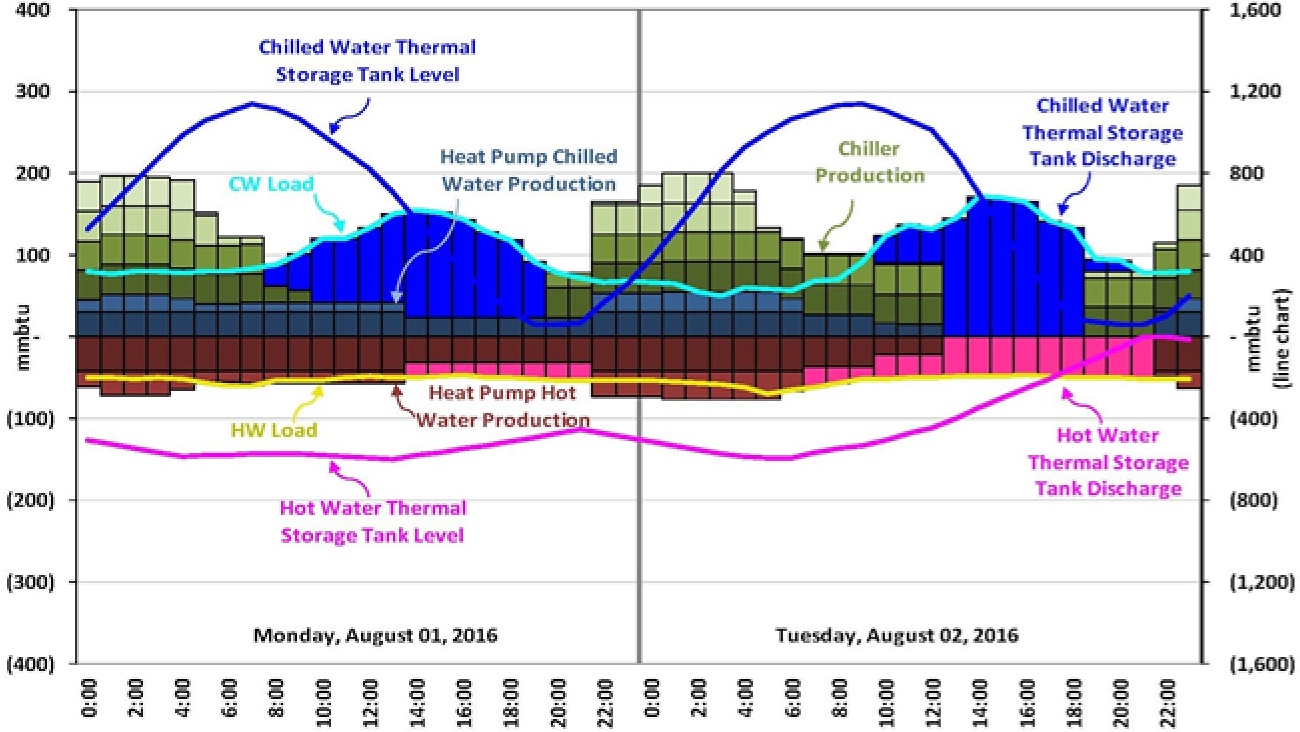
1. **Heat Pump (simultaneous heating & cooling)**
2. **Chiller (for excess unusable summertime waste heat)**
3. **Heater (for winter heating load not supplied by heat recovery and to back up electric heat pumps)**
4. **Cold thermal energy storage**
5. **Hot thermal energy storage**



How to design & operate such a system?

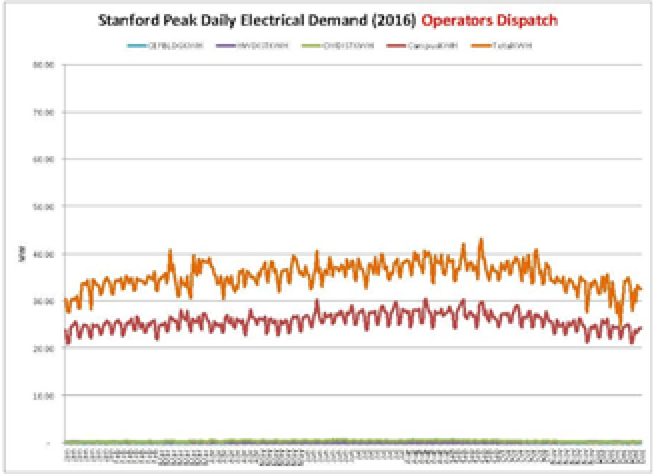
Model Predictive Control Software

Increases system efficiency, reduces electricity peak demand and total cost

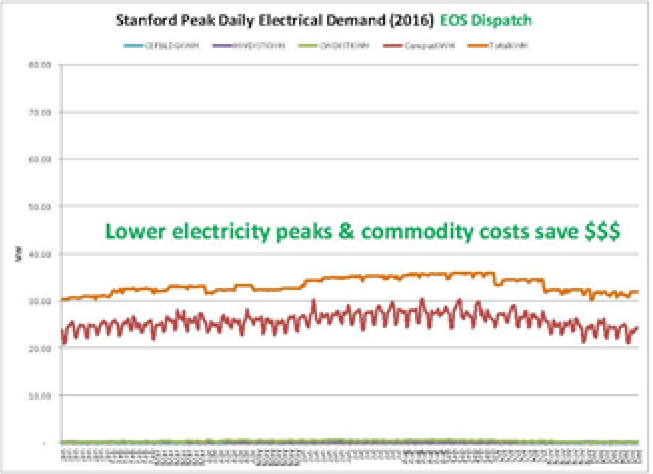


Benefits of Model Predictive Control

Manual Operation



Computer Operation

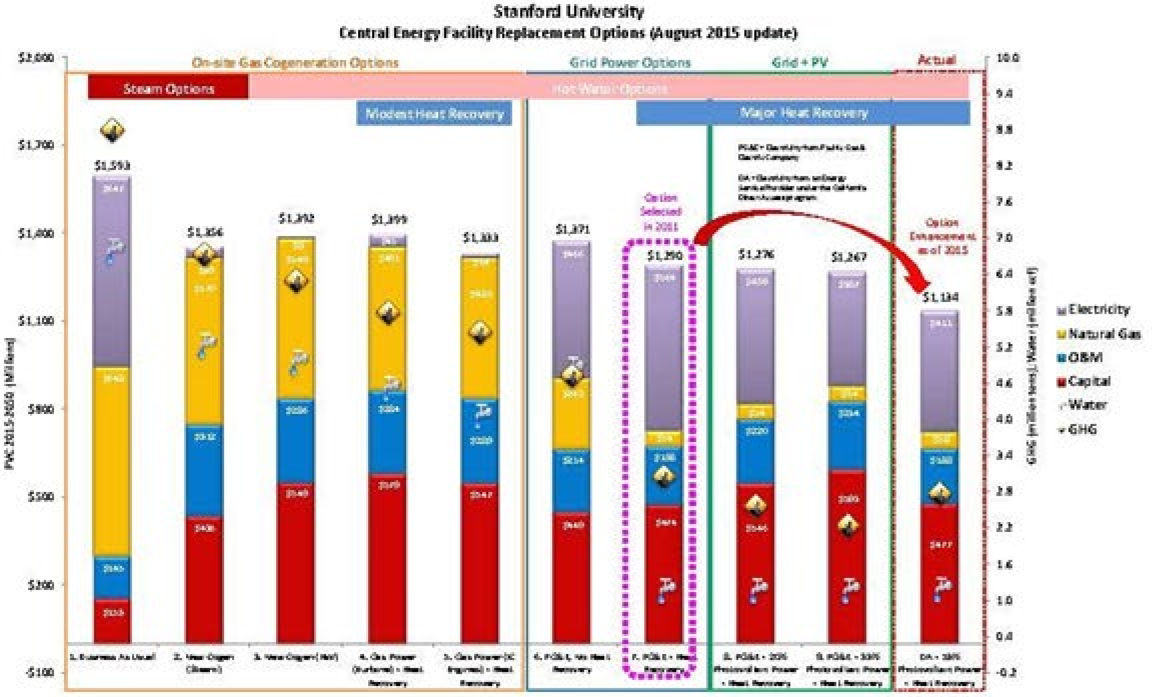


Lower electricity peaks & commodity costs save $$$

- 2016 full year Operators vs. Computer simulation conducted
- Benefits of computer optimization:
  - Reduces peak demand on grid by 7.3 MW (35.9 MW vs 43.2MW)(17%)
  - Saves $500,000 per year (10%) in CEF electricity cost
  - Functions as ‘autopilot’ to run CEF

Stanford Example

ENERGY OPTIONS CONSIDERED IN 2011
PRESENT VALUE COST



THE BIG PICTURE

Support Academic Mission

Maintain Economic Viability

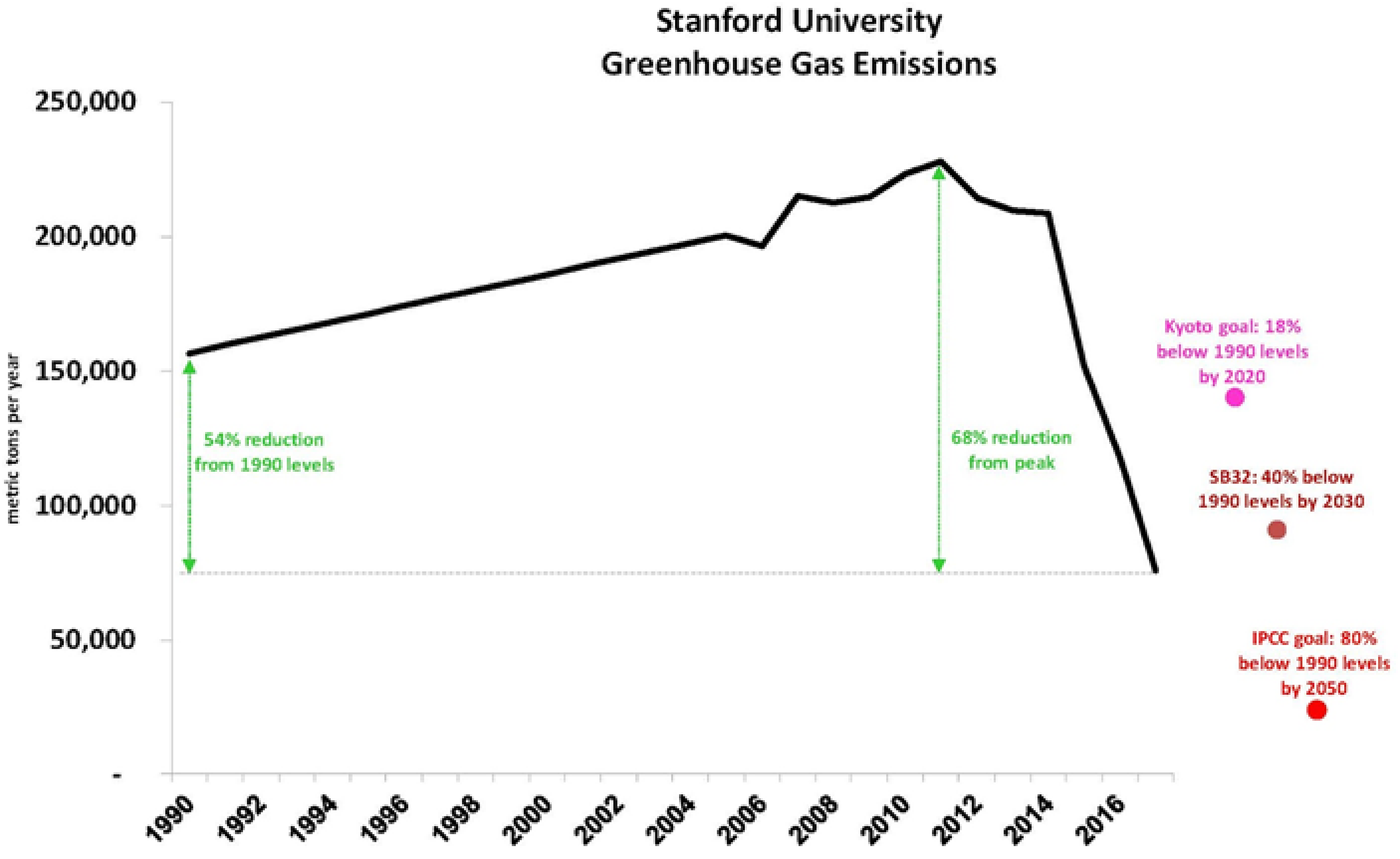
Lead Sustainability by Example

68% reduction in campus greenhouse gas emissions by 2017, >80% by 2025

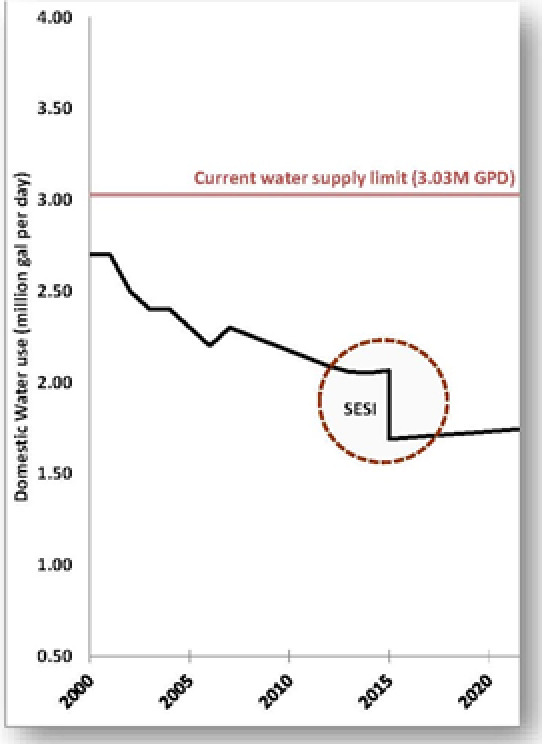
15% reduction in campus drinking water use by 2015, >18% by 2025

$420 million saved over next 35 years

GHG reduction way ahead of the curve



Stanford Potable Water Savings since 2000



History of Conservation

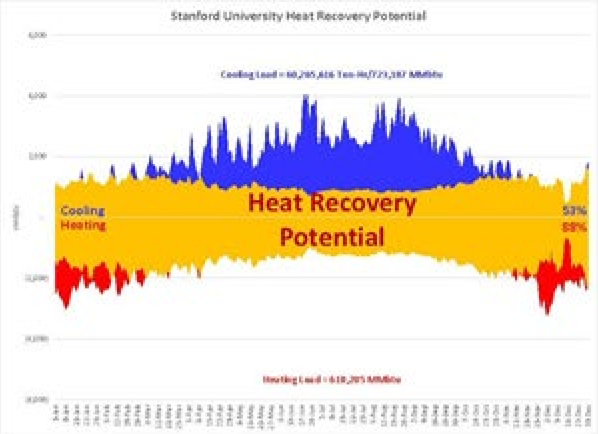
Since 2000, Stanford reduced its potable water consumption by 21% through building retrofits and conservation efforts.

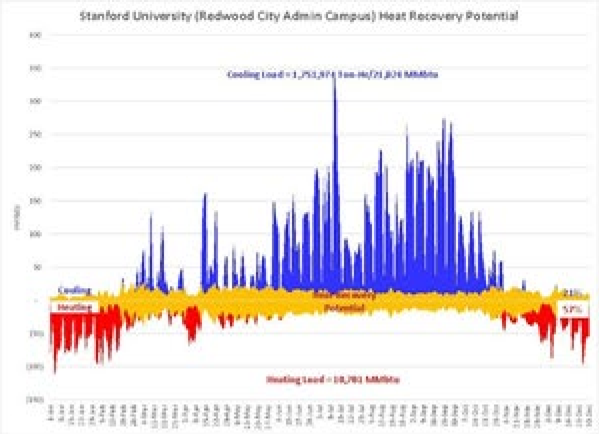
With SESI, Stanford saves an additional 18%.

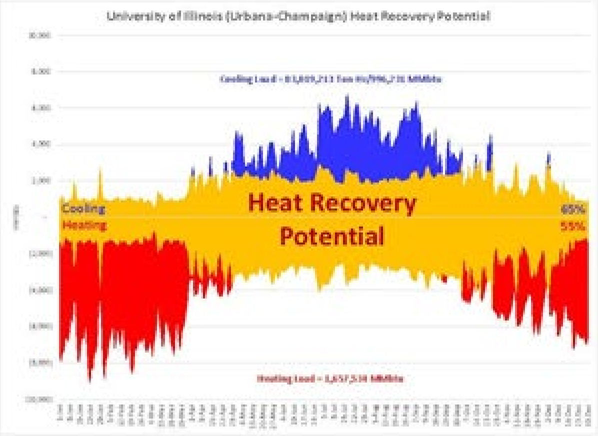
Stanford reduced its water consumption by 39% in just 15 years.

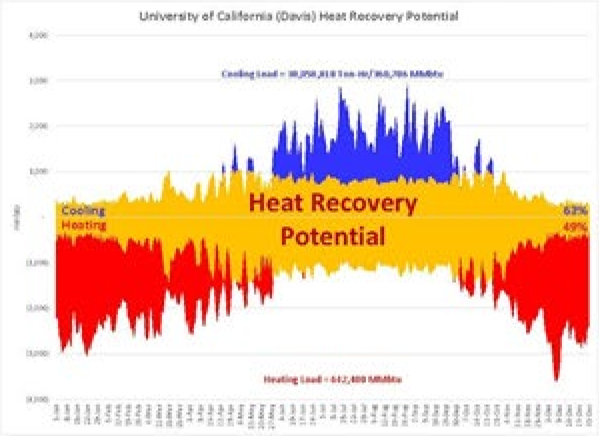
Transferability

Electrification & heat recovery makes sense in *all* climates

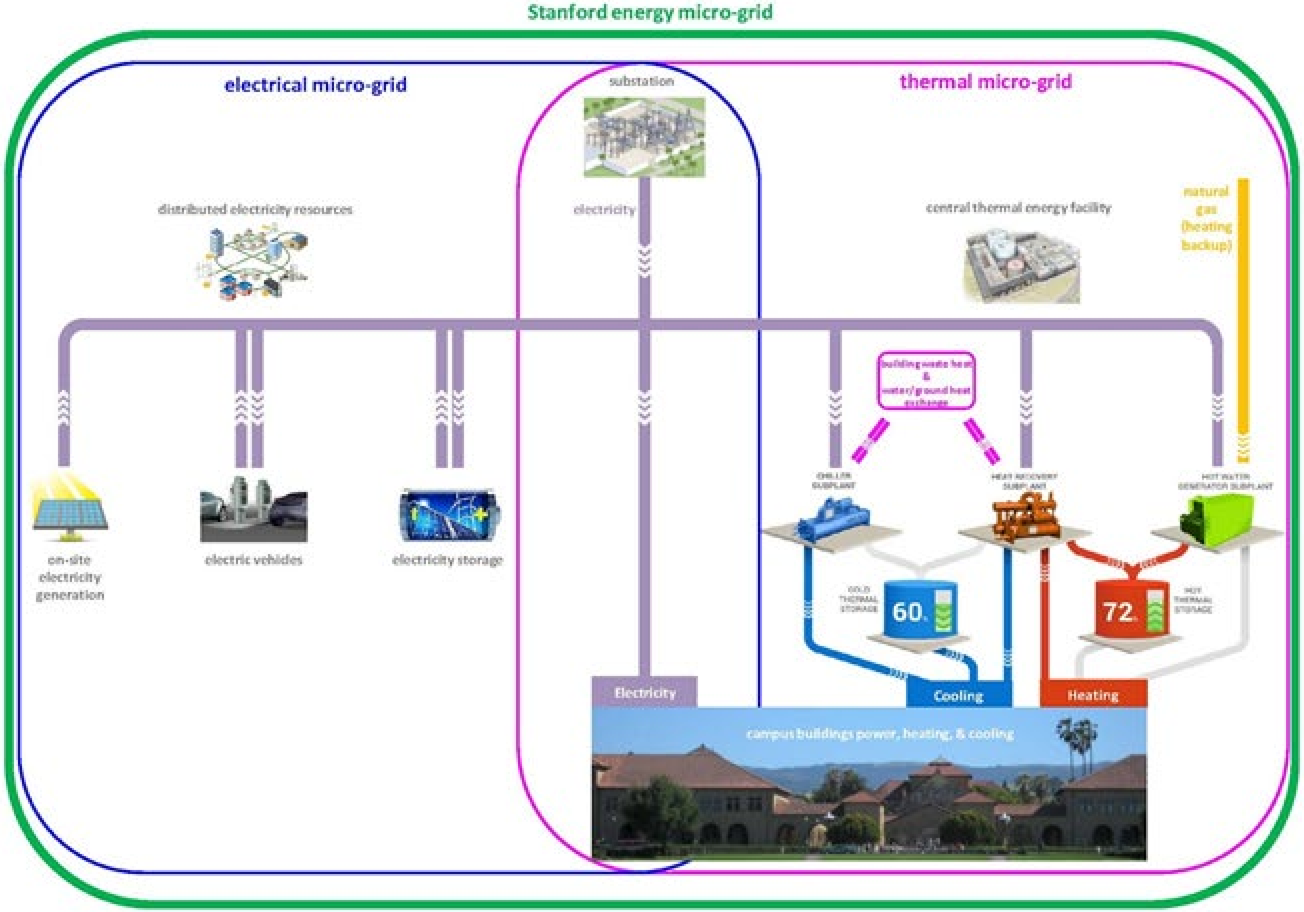




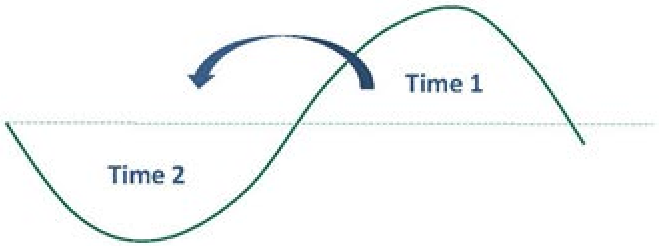




Total Energy Micro-grid…thermal before electric



Energy Storage- Electricity v Thermal



Goal: Transfer Grid Electricity Load from Time 1 to Time 2

Thermal Energy Storage Option

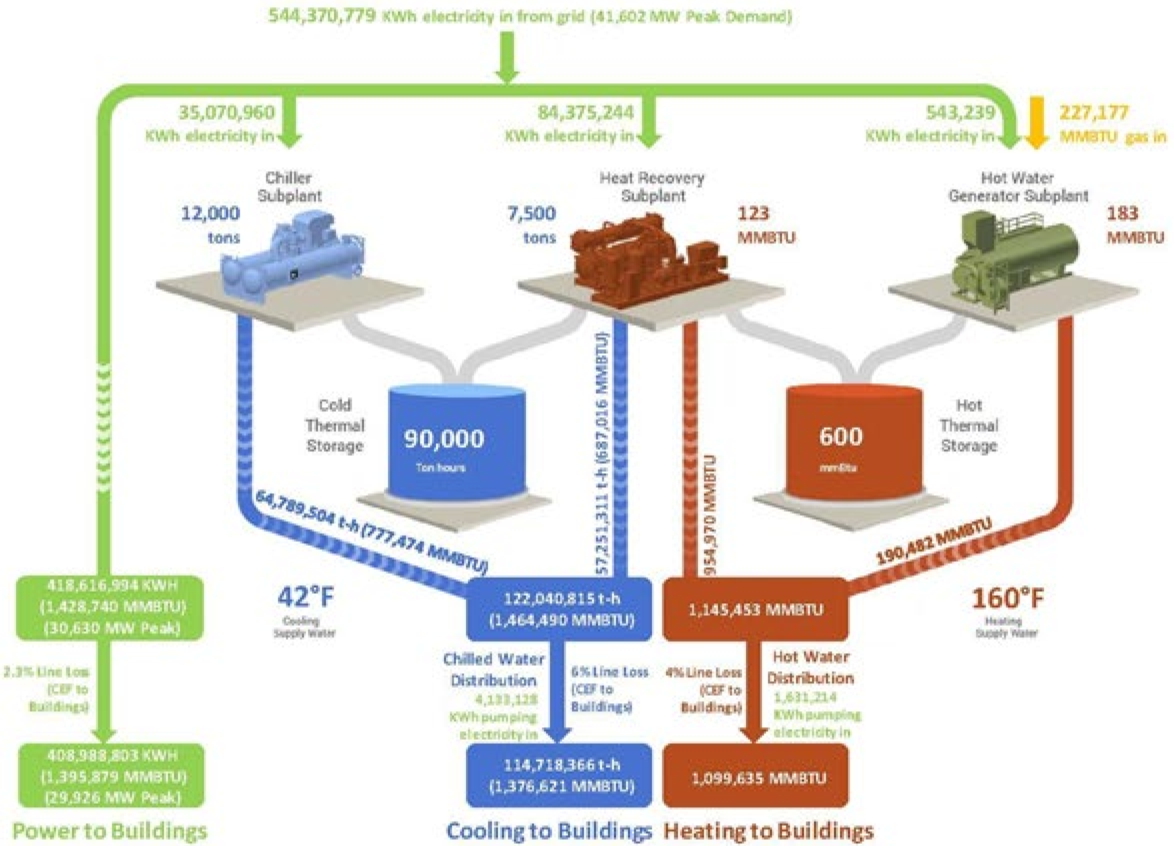
1. Consume grid electricity for operating heating & cooling equipment in Time 2
2. Store heating & cooling energy until Time 1
3. Consume heating and cooling energy in Time 1

Electricity Storage Option

1. Consume grid electricity for electricity storage in Time 2
2. Store electrical energy until Time 1
3. Consume electrical energy for operating heating & cooling equipment in Time 1

Appendix

SESI Actual Performance (2016 & 2017): 92% Efficiency[1]



1: If electricity from 44% efficient (HHV) gas generator (California fleet average; nominal for on-site fuel cell or IC genset)

SESI Energy Efficiency Calculations- 2016 + 2017 Actual Performance

$$\mathrm{COP}_{\text{Heating+Cooling}} = \frac{(\text{useful heating \& cooling work out MMBTU})}{(\text{energy input MMBTU})} = \frac{(1{,}464{,}490 + 1{,}145{,}453)}{(409{,}524 + 227{,}177)} = 4.1$$

Total electricity consumed for heating & cooling production = 35,070,960 + 84,375,244 + 543,239 = 119,989,443 KWh * .003413 MMBTU/KWh = 409,524 MMBTU

$$\text{Trigeneration Efficiency- Plant} = \frac{(\text{useful work out MMBTU})}{(\text{energy input MMBTU})} = \frac{(1{,}428{,}740 + 1{,}464{,}490 + 1{,}145{,}453)}{(4{,}177{,}873 + 227{,}177)} = 92\%$$

Trigeneration efficiency, central energy facility production only, as measured at plant headwall, excludes distribution pumping energy from the central energy facility to the buildings served

Useful Work Out: See diagram for useful work out as measured at plant headwall

Energy Input: Total electricity consumed to supply building power, heating & cooling work out at plant headwall, excluding hot water and cold water distribution pumping energy = 418,616,994 + 35,070,960 + 84,375,244 + 543,239 = 538,606,437 KWh * .003413 MMBTU/KWh = 1,838,264 MMBTU = 4,177,873 MMBTU natural gas[1] for electricity supply + 227,177 direct natural gas use at the plant for auxiliary heat production

$$\text{Trigeneration Efficiency- System} = \frac{(\text{useful work out MMBTU})}{(\text{energy input MMBTU})} = \frac{(1{,}395{,}879 + 1{,}376{,}621 + 1{,}099{,}635)}{(4{,}222{,}584 + 227{,}177)} = 87\%$$

Trigeneration efficiency, total system, as measured at building interface to district energy system, including distribution line loss and hot water and cold water distribution pumping energy from the central energy facility to the buildings served

Useful Work Out: See diagram for useful work out as measured at the building interface to the district energy system

Energy Input: Total electricity consumed to supply building power, heating & cooling, including hot water and cold water distribution pumping energy = 408,988,803 + 35,070,960 + 84,375,244 + 543,239 + 4,133,128 + 1,631,214 = 544,370,779 KWh * .003413 MMBTU/KWh = 1,857,937 MMBTU = 4,222,584 MMBTU natural gas[1] for electricity supply + 227,177 direct natural gas use at the plant for auxiliary heat production

1. Conversion of imported electricity to natural gas HHV fuel input is based on a heat rate of 7,750 btu/KWh (44% efficiency), which is the average for California grid gas generation as reported in *__Thermal Efficiency of Natural Gas-Fired Generation in California, August 2017 Update, California Energy Commision.__*

Let’s Discuss…

… as we pick the brains of our expert panel.

SILICON VALLEY
CLEAN ENERGY

Don Bray

Director of Account Services and Community Relations

SVCE Update

SVCE Update

Mission

- Clean, carbon-free electricity at competitive prices
- Programs to support ongoing emissions reduction via electrification of transportation and the built environment

SVCE Member Agencies

City of Campbell

City of Cupertino

City of Gilroy

City of Los Altos

Town of Los Altos Hills

Town of Los Gatos

City of Milpitas

City of Monte Sereno

City of Morgan Hill

City of Mountain View

City of Saratoga

City of Sunnyvale

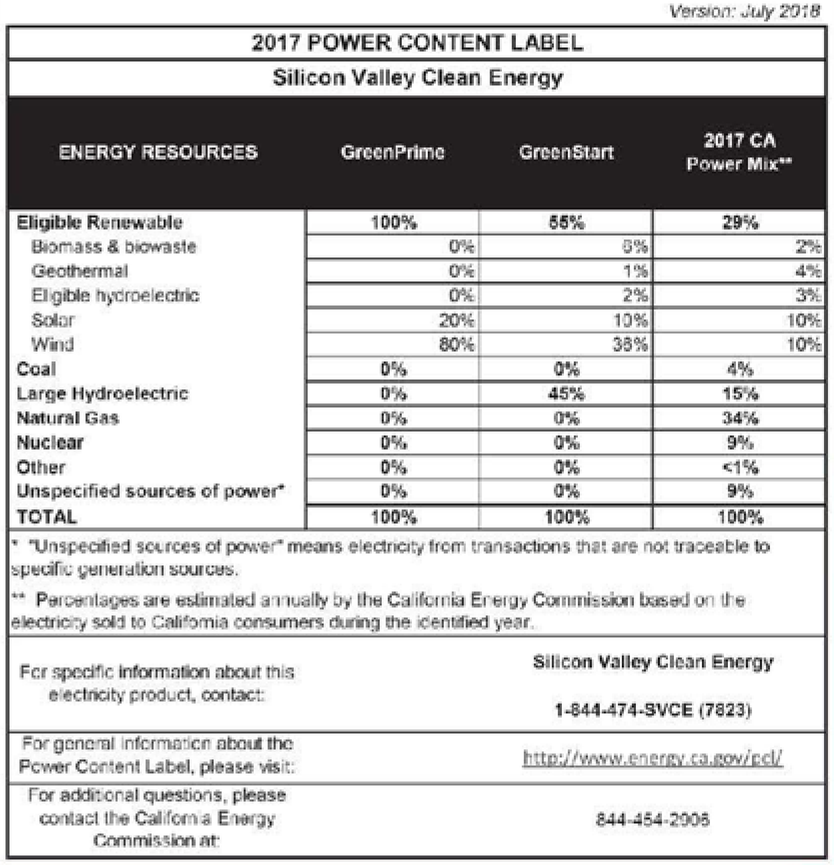
Santa Clara County

SILICON VALLEY
CLEAN ENERGY

Power Content

- GreenStart
  - 55% renewable
  - 45% hydro
  - 0.25lbs CO2/MWh

- GreenPrime
  - 100% renewable
  - 0.00 lbs CO2/MWh
  - Green-e Certified



Version: July 2018

2017 POWER CONTENT LABEL

Silicon Valley Clean Energy

ENERGY RESOURCES	GreenPrime	GreenStart	2017 CA Power Mix**
Eligible Renewable	100%	55%	29%
Biomass & biowaste	0%	6%	2%
Geothermal	0%	1%	4%
Eligible hydroelectric	0%	2%	3%
Solar	20%	10%	10%
Wind	80%	38%	10%
Coal	0%	0%	4%
Large Hydroelectric	0%	45%	15%
Natural Gas	0%	0%	34%
Nuclear	0%	0%	9%
Other	0%	0%	<1%
Unspecified sources of power*	0%	0%	9%
TOTAL	100%	100%	100%

* "Unspecified sources of power" means electricity from transactions that are not traceable to specific generation sources.

** Percentages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the identified year.

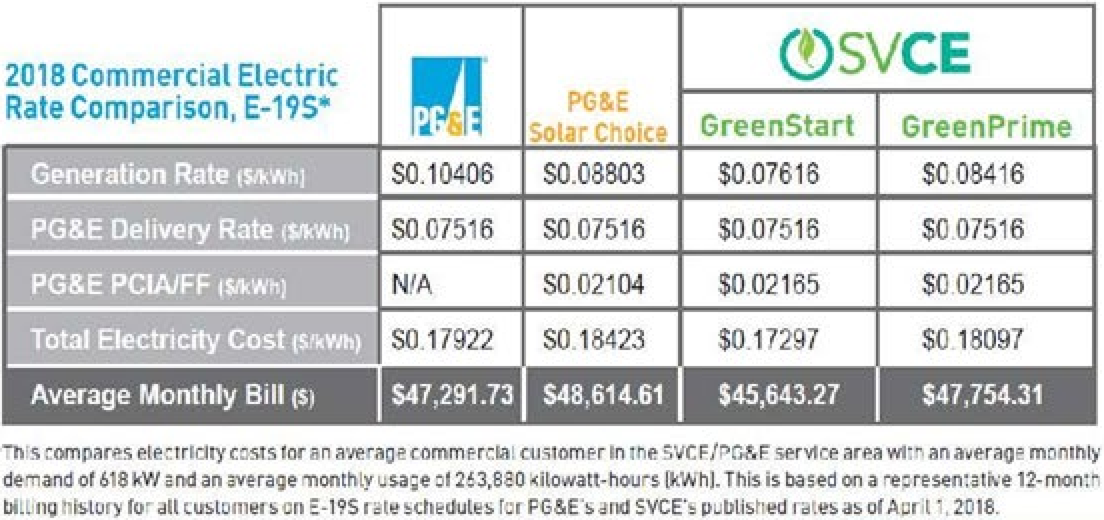
For specific information about this electricity product, contact:	**Silicon Valley Clean Energy** **1-844-474-SVCE (7823)**
For general information about the Power Content Label, please visit:	http://www.energy.ca.gov/pcl/
For additional questions, please contact the California Energy Commission at:	844-454-2906

SILICON VALLEY
CLEAN ENERGY

Pricing

- GreenStart
  - 6% savings with SVCE generation in 2018
  - ~3.4% savings in total

- GreenPrime
  - $0.008/kWh premium to GreenStart
  - ~1% premium in total to PG&E



2018 Commercial Electric Rate Comparison, E-19S*	PG&E	PG&E Solar Choice	SVCE	
			GreenStart	GreenPrime
Generation Rate ($/kWh)	$0.10406	$0.08803	$0.07616	$0.08416
PG&E Delivery Rate ($/kWh)	$0.07516	$0.07516	$0.07516	$0.07516
PG&E PCIA/FF ($/kWh)	N/A	$0.02104	$0.02165	$0.02165
Total Electricity Cost ($/kWh)	$0.17922	$0.18423	$0.17297	$0.18097
Average Monthly Bill ($)	**$47,291.73**	**$48,614.61**	**$45,643.27**	**$47,754.31**

*This compares electricity costs for an average commercial customer in the SVCE/PG&E service area with an average monthly demand of 618 kW and an average monthly usage of 263,880 kilowatt-hours (kWh). This is based on a representative 12-month billing history for all customers on E-19S rate schedules for PG&E's and SVCE's published rates as of April 1, 2018.

SILICON VALLEY CLEAN ENERGY

2018 Community Benefits Summary

3.6 Billion kWh

Carbon-free energy delivered

266,500

Residential and business customers, a 97% participation rate

1.1 Billion Pounds

Carbon emissions avoided by providing clean energy

$16.5 Million

On-bill dollar savings for SVCE customers

$159,000

Cash payments to customers for generating extra solar energy

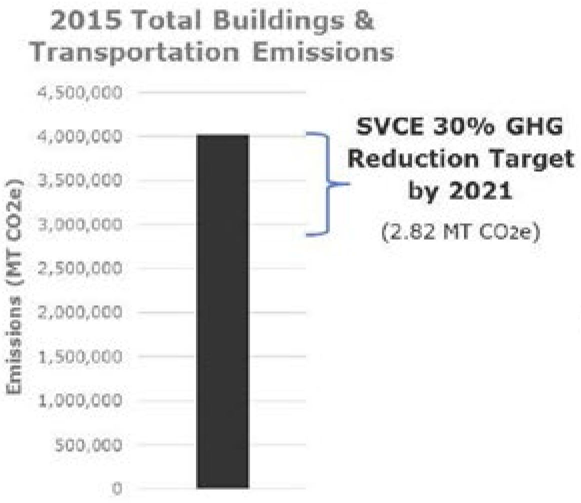
16.6%

Community-wide emissions reduction from 2015 baseline

SILICON VALLEY
CLEAN ENERGY

Annual Results October 2017 – September 2018

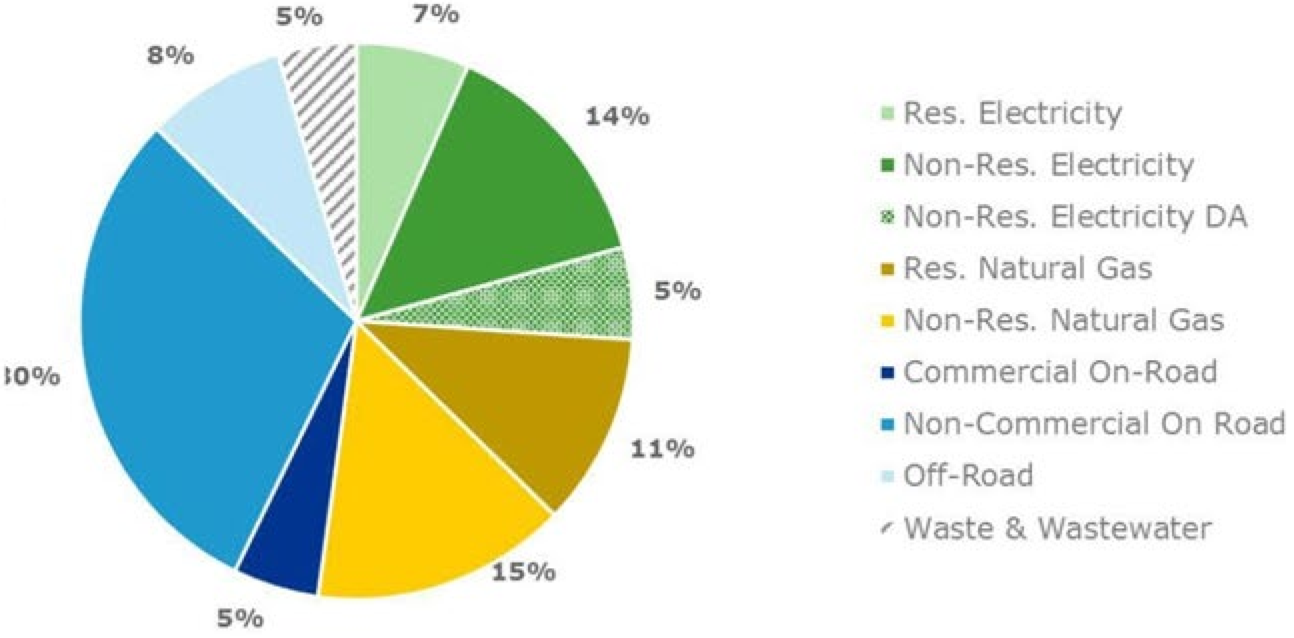
Emissions Baseline - 2015



2015 Total Buildings & Transportation Emissions

SVCE 30% GHG Reduction Target by 2021

(2.82 MT CO₂e)



2015 Total Emissions by Subsector

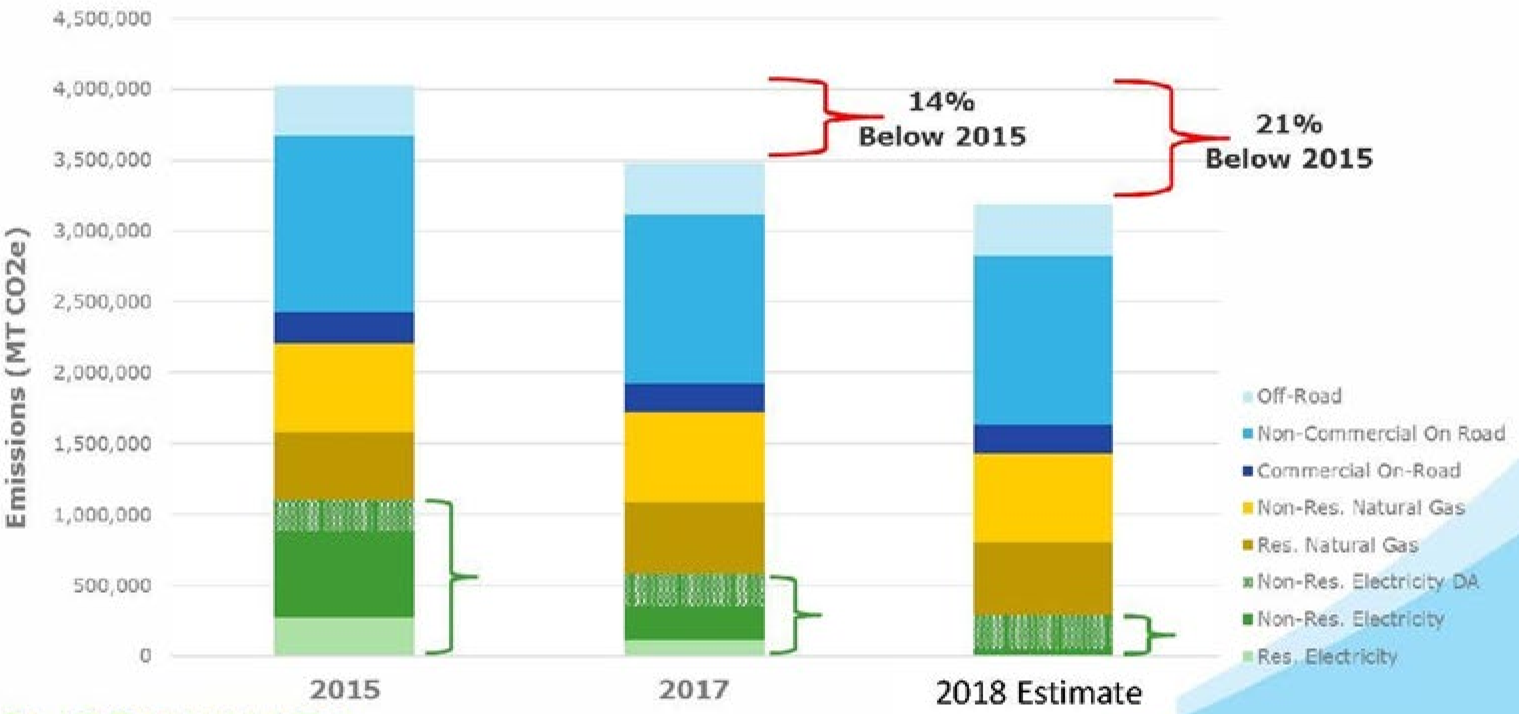
- Waste & Wastewater emissions not calculated and not included in the baseline. Estimated using typical per capita data for illustrative purposes.

2017 Emissions Update

14% Reduction Transportation & Buildings Sectors Emissions

SILICON VALLEY CLEAN ENERGY

2018 Emissions - Estimated

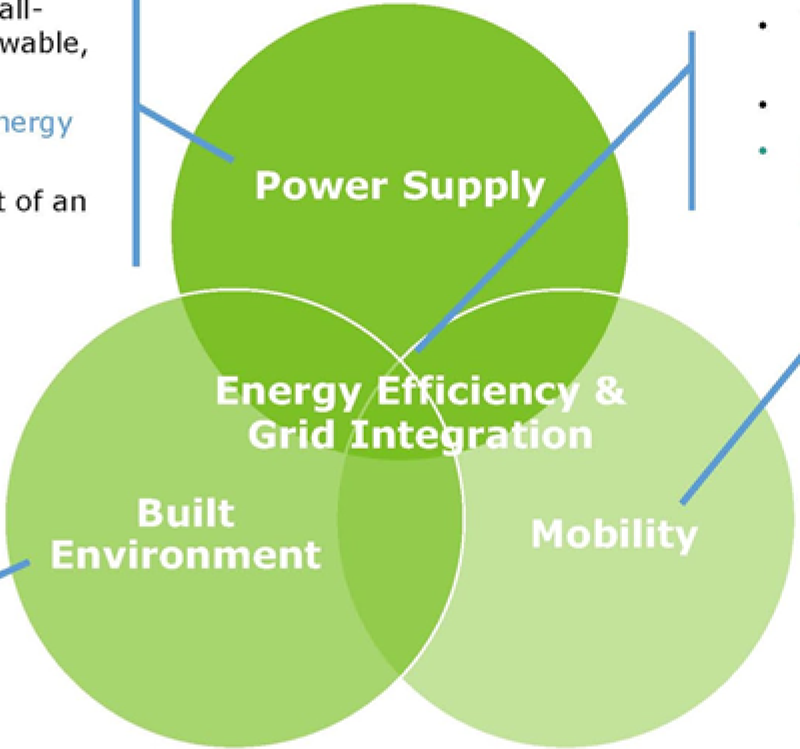


14% Below 2015

21% Below 2015

SILICON VALLEY CLEAN ENERGY

Program Activity Areas (Draft)



- Develop new rate products, e.g. all-electric, C&I load-following renewable, dedicated supply
- Issue RFP for local, distributed energy resources
- Community input in development of an integrated resource plan

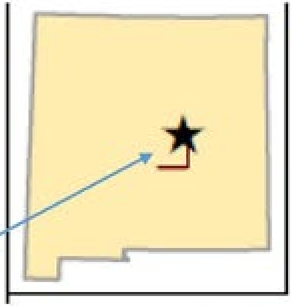
- Review and remove barriers to electrification in existing municipal policies
- Develop model specifications for all-electric residential, commercial, mixed-used
- Develop model all-electric building standards, reach code(s) and related policies
- All-electric development incentives, showcase projects
- Launch heat pump water heater retrofit program
- Expand state policies for building decarbonization

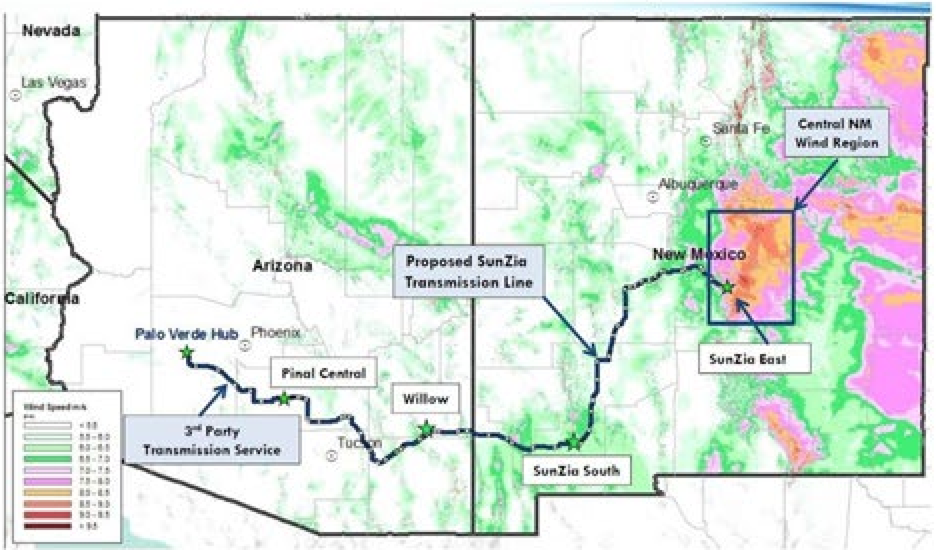
- "Peak Day Pricing" program for C&I (existing program)
- Managed EV charging incentives
- Develop online resource center for customer education on electrification, efficiency and available programs

- Carry out community-wide EV readiness and infrastructure plan
- Address market gaps in multi-family and mixed use commercial EV charging
- Work with member agencies to electrify their vehicle fleets

Supply Update: Corona Wind

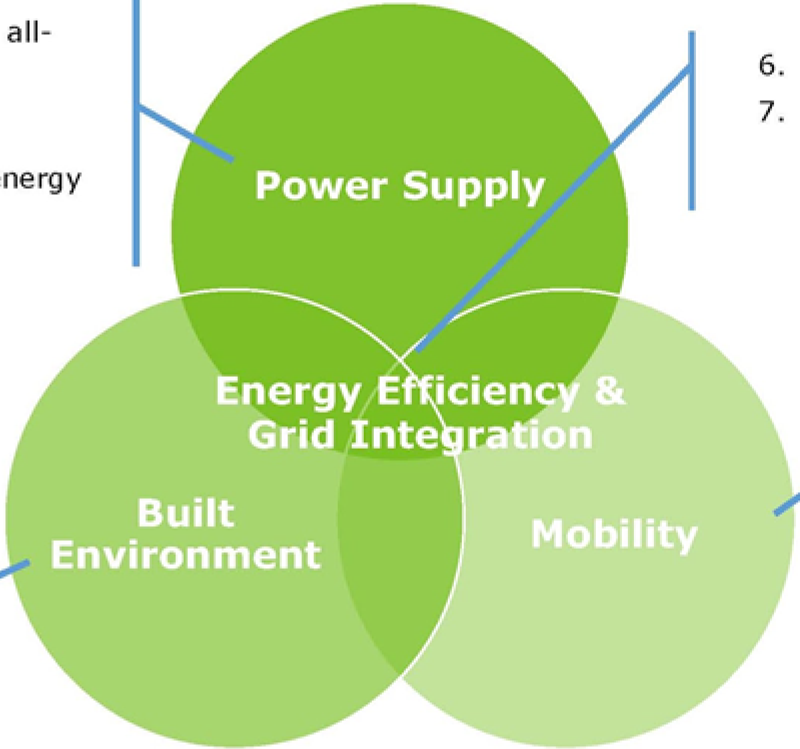
- 110 MW Generating Capacity
- 24x7 resource with evening peak
- Location: Torrance and Lincoln Counties, New Mexico
- Delivers Bucket 1 (PCC1) renewable energy to CAISO
- Will serve ~10% of SVCE load





Program Activity Areas (Draft)

1. Develop new rate products, e.g. all-electric building rate, C&I load-following renewable/storage, dedicated supply
2. Issue RFP for local, distributed energy resources



6. Managed EV charging incentives
7. Develop online resource center for customer education on electrification, efficiency and available programs

3. Develop model specifications for all-electric, commercial and mixed-used buildings
4. All-electric development incentives, showcase projects
5. Expand state policies for building decarbonization

8. Carry out community-wide EV readiness and infrastructure plan
9. Support customer and member agency vehicle fleet electrification
10. Last mile electric commuter solutions

11. Support of green benefits for local employees

Next ‘Watts’ Meeting....

Thank You!!!

SVCleanEnergy.org

844-474-SVCE (7823)

Billing & Customer Service:
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