Center for Sustainable Energy®

- Independent non-profit organization
  - Program management
  - Training and education
  - Technical assistance
- ZNE work is funded by the San Diego Regional Energy Partnership
San Diego Regional Energy Partnership

- City of San Diego
- County of San Diego
- City of Chula Vista
- San Diego Association of Governments (SANDAG)
- Port of San Diego
- San Diego Gas & Electric
Today’s Panel

• **Erin Malcolm-Brandt**, Project Manager, Center for Sustainable Energy

• **Nicholas Oliver**, Project Associate, Center for Sustainable Energy

• **Kelly Knutsen**, Policy Advisor, CALSEIA

• **William Chen**, Chief Operations Officer and VP of Engineering, Adroit Energy

• Q&A
What is “Zero Net Energy”?

**California Energy Commission:** A Zero-Net-Energy Code Building is one where the net amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single “project” seeking development entitlements and building code permits, measured using the California Energy Commission’s Time Dependent Valuation (TDV) metric.
• Community renewable energy vs. on-site

• Time Dependent Value (TDV):
  – Depends on time of day, season, and climate zone
  – Includes electric, natural gas, and propane use

• Not about operations; it’s about how the building is modeled/designed
Department of Energy: A Zero Energy Building is an energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.
California’s ZNE Goals

• All new residential construction will be ZNE by 2020

• All new and 50 percent of existing state-owned public buildings will be ZNE by 2025

• All new and 50 percent of existing commercial buildings will be ZNE by 2030
How Does California Achieve ZNE Goals?

• Title 24, Part 6
  – Building Energy Efficiency Standards (AKA energy code)
  – Updated every three years
  – 2013 Standards went into effect on July 1, 2014
  – 2016 Standards were published on July 1, 2016 and will go into effect on January 1, 2017

• Title 20
  – Appliance Standards
  – Updated periodically
  – Addresses plug loads
    • Potentially more room for improvement than in EE
ZNE ROADMAP FOR LOCAL GOVERNMENTS

www.energycenter.org/zne
Solar Water Heating and ZNE

Retrofit Example From San Diego

92 Unit Multifamily Building

• 13,600 therms consumed per year before installation (includes heating)
• 9,500 therms consumer per year after installation
  – This represents significant savings without having to redesign the entire heating system for this building. The solar water heating system ties right into the existing plumbing infrastructure
ZNE and Solar Thermal

To Create a Zero Energy Building...

**STEP 1** Increase energy efficiency
- Efficient building construction
- Efficient systems and appliances
- Operations and maintenance
- Change in user behavior

**STEP 2** Address remaining needs with on-site renewable energy generation

ZNE and Solar Water Heating

**First Steps**

- High performance insulation
- High performance windows
- Low-flow water fixtures
- Daylighting & shading
- Lighting with controls

**Next Steps!**

- Analyze Plug Loads
- Advanced Energy Storage
- Rooftop solar PV
- Solar thermal water heating system

Achieving Zero Net Energy:
How Solar Water Heating Helps
CSE ZNE Webinar Series

September 21, 2016
Presented by San Diego Regional Energy Partnership and Center for Sustainable Energy
What is “Zero Net Energy”?

A Zero-Net-Energy Code Building is one where the net amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single “project” seeking development entitlements and building code permits, measured using the California Energy Commission’s Time Dependent Valuation metric.

Solar Thermal

• Works with any backup
• Works in conjunction with the existing system
• Not required to replace existing water heater
  o Can reduce gas use in existing buildings

• Complements well with other energy systems in new construction
  o Can help to avoid gas use in new buildings
Single Family Solar Water Heating

- Typical SWH system 1-3 collectors (32-120 sq. ft.)
- Size according to gallons of hot water used per day (GPD)
- Number of occupants
  - 1st person = 20 GPD; 2nd person = 15 GPD;
  - Each person thereafter = 10 GPD
- Rules of thumb:
  - 1 ft$^2$ of collector area per GPD
  - 1.5 gallons of storage per ft$^2$ of collector area
Multifamily/Commercial Solar Thermal

- Most effective with a central boiler
- Rules of thumb:
  - 1 ft$^2$ of collector area per GPD
  - 1.5 gallons of storage per ft$^2$ of collector area
- System size will vary for other applications based on the temperature needed for that use
Types of Solar Water Heating Systems
Two Basic Types

<table>
<thead>
<tr>
<th>PASSIVE</th>
<th>ACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Pumps</td>
<td>Pumps move water through the system</td>
</tr>
<tr>
<td>1. Integral Collector Storage</td>
<td>3. Direct Forced Circulation</td>
</tr>
<tr>
<td></td>
<td>5. Closed-loop – Drain-back</td>
</tr>
</tbody>
</table>
1. Example Passive System (ICS)
1. ICS System (Passive)

Water stored in collector

Source: SunEarth
2. Thermosyphon System (Passive)

Water stored in Tank

Source: SunEarth

CleanTech
Active Systems

- Use heat exchange fluid separated from potable water
- Pump circulates this fluid through collectors and storage tanks
4. IFC (Active)

*Closed-Loop Glycol*
5. IFC (Active)
Closed-Loop Drain-Back
CSI-Thermal Program Background

• Ratepayer funded rebate program
• For customers of the 4 California Investor Owned Utilities overseen by the California Public Utilities Commission
  – San Diego Gas & Electric (CSE program administrator)
  – Southern California Gas
  – Pacific Gas & Electric
  – Southern California Edison
CSI-Thermal Program Background

- Rebate available for natural gas displacing systems
- Rebates reduce over time as more systems are installed
- Reservations accepted through Dec 31, 2017 or when the rebate funds run out
CSI-Thermal Program

Single Family End Uses

• Domestic water heating
• No Single Family Pool Heating

Eligible Multifamily/Commercial End Uses

• Domestic water heating
• Process heat
• Space Cooling
• Space Heating
• Combination Systems
• Pool Heating
## Incentive Budget Per Program Administrator

<table>
<thead>
<tr>
<th>Program Administrator</th>
<th>Natural Gas Budget ($ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG&amp;E</td>
<td>$60.45</td>
</tr>
<tr>
<td>CSE</td>
<td>$15.5</td>
</tr>
<tr>
<td>SoCalGas</td>
<td>$79.05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$155.0</strong></td>
</tr>
</tbody>
</table>
Low Income Program

- Available to qualifying natural gas-displacing SWH systems
- Total budget of the Low Income Program is $50 million

<table>
<thead>
<tr>
<th>Program Administrator</th>
<th>Budget Allocation</th>
<th>Total Incentive Budget (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG&amp;E</td>
<td>39%</td>
<td>$19.5</td>
</tr>
<tr>
<td>CSE</td>
<td>10%</td>
<td>$5.0</td>
</tr>
<tr>
<td>SCG</td>
<td>51%</td>
<td>$25.5</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>$50</td>
</tr>
</tbody>
</table>
## Incentive Structure

### Natural Gas DHW – Single Family

<table>
<thead>
<tr>
<th>Step</th>
<th>Customer Class</th>
<th>$/therm displaced</th>
<th>Maximum Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single Family</td>
<td>$29.85*</td>
<td>$4,366**</td>
</tr>
<tr>
<td>2</td>
<td>Single Family</td>
<td>$25.37</td>
<td>$3,710</td>
</tr>
<tr>
<td>3</td>
<td>Single Family</td>
<td>$14.30</td>
<td>$2,091</td>
</tr>
<tr>
<td>4</td>
<td>Single Family</td>
<td>$3.23</td>
<td>$472</td>
</tr>
</tbody>
</table>

* $70 per therm for SCG systems installed between 4/15/2016 and 12/31/2016  
** $10,238 for SCG systems installed between 4/15/2016 and 12/31/2016
## Natural Gas DHW – Commercial/Multifamily

<table>
<thead>
<tr>
<th>Step</th>
<th>Customer Class</th>
<th>$/therm displaced</th>
<th>Maximum Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commercial/Multifamily</td>
<td>$20.19†</td>
<td>$800,000</td>
</tr>
<tr>
<td>2</td>
<td>Commercial/Multifamily</td>
<td>$17.16</td>
<td>$800,000</td>
</tr>
<tr>
<td>3</td>
<td>Commercial/Multifamily</td>
<td>$10.15</td>
<td>$800,000</td>
</tr>
<tr>
<td>4</td>
<td>Commercial/Multifamily</td>
<td>$3.13</td>
<td>$800,000</td>
</tr>
</tbody>
</table>

† $25 per therm for SCG systems installed between 4/15/2016 and 12/31/2016
Incentive Structure

Natural Gas Solar Pools – Commercial/Multifamily/Institutional
-50% cap of total system cost

<table>
<thead>
<tr>
<th>Step</th>
<th>Customer Class</th>
<th>$/therm displaced</th>
<th>Maximum Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commercial/Multifamily</td>
<td>$5.00</td>
<td>$500,000</td>
</tr>
<tr>
<td>2</td>
<td>Commercial/Multifamily</td>
<td>$5.00</td>
<td>$500,000</td>
</tr>
<tr>
<td>3</td>
<td>Commercial/Multifamily</td>
<td>$4.00</td>
<td>$500,000</td>
</tr>
<tr>
<td>4</td>
<td>Commercial/Multifamily</td>
<td>$3.00</td>
<td>$500,000</td>
</tr>
</tbody>
</table>

Cap removed for SCG systems during qualifying timeframe. (4/15/2016 – 12/31/2016)
CSI-Thermal Tracker

- Monitor available funding in each step (Live)
- Monitor allocated incentive totals by:
  - Program Administrator
  - Customer Class (res vs. commercial)
  - Fuel Type (natural gas vs. electric/propane)
- Helpful when approaching a decrease in incentive step level
- Available at: www.csithermal.com/tracker
Application Process

• Fully automated online processing database
  [www.csithermal.com](http://www.csithermal.com)
• Users must attend a one-day workshop with one of the PAs and receive a unique registration key
• Contractors must have one of the following active licenses:
  – A, B, C-4, C-36, C-46
  – C-53 Eligible to install solar pool heating systems only
Application Process

• Eligible Contractor completes the application for the customer
• Documents may be submitted online or by mail
• Online documents must be in pdf format
• Program inspection may be required
A Possible Future?
CA SOLAR POLICY
OVERVIEW & LOOKING AHEAD

Kelly Knutsen, Ph.D.
Policy Advisor, CALSEIA
CSE Webinar
September 21, 2016
Solar Thermal Potential

- California homes and businesses use 2.5 billion therms of natural gas annually for heating water
  - ~ 3% of total statewide greenhouse gas emissions
  - ~ equal to the total storage capacity of natural gas in the state, including Aliso Canyon
- 42% of residential natural gas usage is for water heating
  - Solar thermal can reduce nat gas use up to 50 to 80% for an average residential solar water heating system
- CA Manufacturers
- Zero Net Energy Goals
CSI Thermal Facts

- 4.9 million annual therms saved
  - Equivalent of over 42,000 residential installations
  - Over 26,000 metric tons annual CO2 emissions
  - 5,500 cars off the road
- 4,200 applications
- CA commercial/multifamily housing solar thermal market grew 56% annual rate 2015 over 2014 (annual therms saved; both market-rate and low-income multifamily).
- Recent poll: 81% Californians support incentives for solar thermal
Low Income and Disadvantaged Communities

- Demand in low-income multifamily housing buildings high – nearly half applications in 2015
- Original $25 million in funding for low-income customers was exhausted Dec 2015
- Additional $25 million allocated March 2016, relieving $2 million backlog
- “Low-income projects are crucial to maximizing the CSI-Thermal Program’s effectiveness.” –CSI Thermal Program Administrators
- “Our low-income residents are currently benefiting from solar heating and we feel it is important to continue the trend we started just a few years ago.” – Mercy Housing
Industrial Applications

“Energy savings were achieved almost immediately after the commissioning of the solar energy system,” facility’s environmental manager.

- Cargill beef processing plant in Fresno
  - Pre-heated water for food safety/sanitation
  - 10,000 sq ft, 34,000 therms, 228 tons CO2
- Currently $800,000 project cap

Photo and quote: www.cargill.com/news/releases/2013/NA3077689.jsp
Solar and Aliso Canyon Leak

• 100,000 tons of methane
  • 8 million metric tons CO2eq
• In 2014, CA annual greenhouse gas emissions 441.5 MMtons CO2eq
  • 10 million metric tons above 1990 level (met by 2020).
• Solar water heating on ~7% multi-family buildings in LA offsets annual natural gas demand for withdrawals from Aliso Canyon in 2016 for all LA buildings.
• 141 MW solar PV (~1% of the total rooftop solar PV potential in LA or ~1/3 currently installed in LA) offsets annual natural gas demand for electricity generation serviced by withdrawals from Aliso Canyon.
AB 2460 – Assemblymember Irwin

- $250 million for 5 years to 2022
- 50% low-income and disadvantaged communities
- 10% industrial-scale
- Review rebate levels every two years
- 32 supporters – low income/social justice, enviro, industry
- Introduce again in 2017
State and Local Initiatives

• California Air Resources Board (CARB) Climate Change Scoping Plan (goals to 2030)
• Aliso Canyon Action Plan
• Title 24 – Solar Ready and ZNE
• Lancaster, Sebastopol, Santa Monica and San Francisco—requirements to install minimum amount of solar on new buildings
Title 24 “Solar Ready” Requirement

• Effective July 1, 2014, the 2013 Title 24, Part 6 contains “Solar Ready” Requirement.
• New buildings must reserve roof space for the future installation of solar
  • 250 square feet for new single family residences
  • 15% of roof area for multi-family and nonresidential buildings
• Applies if solar is not installed at time of construction.
• Applies to:
  • new residential and hotel buildings of 10 floors or less
  • new nonresidential buildings of 3 floors or less
• Solar Ready Zone:
  • Must be free from obstructions and shading that could interfere with the installation or performance of a future solar system
  • Shading by existing structures and objects reduces the requirement

Slide courtesy Luminalt
San Francisco Better Roofs Ordinance – April 2016

- Piggybacks off of Title 24 “Solar Ready” Requirement
- Solar ready zone must be put to productive use by installing solar energy systems at the time of construction.
- Solar energy system can be solar thermal, solar photovoltaics or a combination
- Where building is shaded by existing structures and objects, the San Francisco’s solar installation requirement is reduced like the Title 24 “Solar Ready” requirement.

Slide courtesy Luminalt
Conclusions

- Solar Thermal – proven tech and potential to help meet environmental goals, support local installation and manufacturing jobs, and lower energy bills for homes and businesses—especially low income and disadvantaged communities.
- Aliso Canyon natural gas leak reminder of state’s heavy reliance on natural gas—electricity and water heating.
- Solar PV and thermal technologies should be included in CA programs – Title 24, Net Zero Homes and Buildings initiatives, Aliso Canyon Action Plans, and CSI-Thermal program.
Thank you!

Questions?

Kelly Knutsen
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510-548-2312
CSE ZNE Webinar Series

September 21, 2016
Presented by San Diego Regional Energy Partnership and Center for Sustainable Energy
Adroit energy

Engineering, procurement, and construction
About Us

- Company History
- Locations
- Project Industries

Adroit Clients

- Intuit
- Marriott
- Kendall-Jackson
- Google
- Turner
- Facebook
- A.O. Reed & Co.
- CHW
- Williams Selyem
- San Diego Mesa College
- DPR Construction
- Balfour Beatty Construction
- Best Western
- San Diego Miramar College
- The City of San Diego
- United States Army
- United States Navy
- The Local
- Bridge Housing
- JWDA
- Intel
What we do

- Engineering, Procurement and Construction
- Integrated Design Process
- Integrated Project Delivery
- Decision Support
- Cost Estimating
- Net Zero Approach
- Advanced Energy Modeling
- Title 24 Compliance Reports
Technologies and Systems

- Solar Thermal
- Radiant Heating/Cooling
- Geothermal
- Pool Heating
- Solar Cooling
- HVAC
- Solar Cogeneration
- Solar Electric
- Energy Storage
- Fuel Cell Cogeneration
- Building Automation, Controls, and Monitoring
Reaching Net Zero

Basic Overview

- Solar Hot Water
- Pool Heating
- Automated Monitor
- Solar PV
- Energy Storage
- Radiant Heating & Cooling
- Ground Source Geothermal
Google Headquarters

Employee Dining Hall and Laundry Facility

Design Build

1200 sq ft Solar Hot Water System

kWh Offset: 11,188
Solar Photovoltaics

Basic Overview

Diagram showing components of a solar photovoltaic system:
- **Solar Cells**
- **AC Power Supply**
- **Inverter**
- **Outlets**
- **Meter**
## Solar Thermal vs. Solar Photovoltaics

### Basic Overview

<table>
<thead>
<tr>
<th>Function</th>
<th>Solar Thermal</th>
<th>Solar Photovoltaics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average commercial system efficiency</strong></td>
<td>50%-80%</td>
<td>7%-19%</td>
</tr>
<tr>
<td><strong>Federal Incentives</strong></td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>CSI State Rebates</strong></td>
<td>50% average commercial system (Up to $800,000)</td>
<td>NO LONGER AVAILABLE (Funding exhausted)</td>
</tr>
<tr>
<td><strong>Average Payback</strong></td>
<td>2-4 Years</td>
<td>3-10 Years</td>
</tr>
<tr>
<td><strong>Functions</strong></td>
<td>Versatile: Ability to combine with solar space heating, solar cooling, and solar pool heating.</td>
<td>Displaces only Electricity</td>
</tr>
</tbody>
</table>
Celadon at 9th and Broadway
250 unit Multi-Family Affordable Housing High Rise
Design Build

- 143 ft PV Vertical Façade
- 31.25 kW
Celadon at 9th and Broadway
250 unit Multi-Family Affordable Housing High Rise
Design Build

2,499 Gallon Tank
Solar Hot Water Panels
**Mission Heights Condominiums**

- **116 Units**
- **Solar Hot Water**

### Total Therm Usage

<table>
<thead>
<tr>
<th></th>
<th>BEFORE</th>
<th>SOFTWARE ESTIMATE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therms</td>
<td>8,878</td>
<td>5,303</td>
<td>3,904</td>
</tr>
</tbody>
</table>

56% Reduction

### Total Gas Bills

<table>
<thead>
<tr>
<th></th>
<th>BEFORE</th>
<th>SOFTWARE ESTIMATE</th>
<th>AFTER</th>
</tr>
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<tbody>
<tr>
<td>Cost</td>
<td>$10,387.2</td>
<td>$6,204.51</td>
<td>$4,489.60</td>
</tr>
</tbody>
</table>

6
Radiant Heating and Cooling

Basic Overview
The Local Pacific Beach

Radiant Deck Heating
Mesa College Bookstore & Cafeteria

Radiant Heating and Cooling

Design Build
Mesa College Bookstore & Cafeteria
Solar Hot Water
Geothermal

Basic Overview

GEOTHERMAL SYSTEM

RADIATORS

HOT WATER CYLINDER

GEOTHERMAL HEAT PUMP

UNDERFLOOR HEATING

UNDERGROUND TRENCH WITH GEOTHERMAL PIPE LOOPS

Villageplumbingandheating.com
Solar Pool Heating

Basic Overview

Solarcraft.com
Miramar College
Ned Baumer Pool Complex
Design Build, 148 Collector System
Solar Cooling
Basic Overview

How does Solar Cooling Work?

Solar Heat → Heat → Thermally-driven Cooling Process → Chilled Water → Conditioned Air

www.ausSCIG.org
Desert Mountain High School

Largest Solar Cooling system in the world
THANK YOU!

WILLIAM CHEN

William.chen@adroitenenergy.com
Upcoming Webinars

The Role of Permitting in ZNE

- October 19, 10:00-11:30
CSE ZNE Webinar Series

THANK YOU!!!