Energy and Climate Plan - Approach

Energy Conservation in Existing Buildings

Energy Efficiency in New Building Design

Energy Supply
1. Energy Conservation in Existing Buildings

Existing Energy Conservation and Efficiency Initiatives

- Energy Retrofit Program
- Whole Building Retrofit Program
- Energy Conservation Incentive Program
- Building Operating Strategies
- Excessive Use Monitoring
- HVAC Recommissioning
- High Efficiency Transformers
- Room Temperature Storage

Stanford saved 240 Million KWH (a full year’s consumption), over the last 15 years.
2. Energy Efficiency in New Building Design

Stanford’s **building standards**

- Require that new buildings be designed to use at least 30% less energy and 25% less water than standard buildings of the same type.
- LEED Gold Equivalent
CURRENT ENERGY SYSTEM
Cardinal Cogeneration Plant - 50MW CCGT (1987)

- Third Party Owned & Operated - contract ends in 2015
- 60% electricity for university - balance to Grid
- Steam & Chilled Water distribution to campus
- Overall trigeneration efficiency ~53%
- Accounts for 85% of university GHG emissions & uses 25% of fresh water supply
Current Combined Heating & Power System (CHP)

Exhaust gases (90% of Campus GHG Emissions)

Cogeneration (CHP)

Waste Heat Steam Generator
Gas Turbine
Reduction Gear
Generator

Air intake

Water Chiller Plant
Cooling Tower

Water (uses 25% of the campus water supply)

Natural Gas

Water

Electricity

To Campus

To PG&E

Steams
Condensate Return
Chilled Water Supply
Chilled Water Return
Electricity
Electricity
Heating
Need for a New Central Energy Facility

Support Academic Mission
- Expansion for Campus and Hospital Growth
- Successor for Cardinal Cogen (2015)

Maintain Economic Viability
- Increase efficiency
- Protect against gas and water cost increase

Lead Sustainability By Example
- Reduce carbon footprint and water use
- Create foundation for green energy portfolio
NEW ENERGY SYSTEM
Discovery of Heat Recovery Potential

- Current campus chilled water system...think of as a system for collecting waste heat, not delivering cold...currently collects unwanted heat from buildings and discharges it to the atmosphere via evaporative cooling towers at the CEF
- At Stanford **Heat recovery** can be used to capture **70% of this heat for re-use** to meet 80% of campus heating needs
Discovery of Heat Recovery Potential

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Heat Recovery Potential

Cooling

Heating
Regeneration (SHP) Heat & Cooling

- 130 °F Hot Water Return
- 170 °F Hot Water Supply
- 42 °F Heat Recovery Chiller
- 58 °F Chilled Water Supply
- 70% less waste heat to atmosphere
- 70% less cooling water (saves 18% of campus DW use)
- Cooling Tower
- Water (70% reduction)
Waste Heat Being Discarded from Cardinal Cogeneration Plant
SESI - Combined Heating & Cooling (CHC)
Comparison of Options Studied

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Central Energy Facility Replacement Options

On-site Gas Cogeneration Options
- Extend Cogen to 2020, then Grid + Heat Recovery
- New Cogen (Steam)
- New Cogen (HW)
- Gas Power (Turbine) + Heat Recovery
- Gas Power (IC Engines) + Heat Recovery

On-site PV + Grid Options
- Grid + 20% Photovoltaic Power + Heat Recovery
- Grid + 33% Photovoltaic Power + Heat Recovery

Grid Power Options
- Grid + Heat Recovery
- Grid, No Heat Recovery

Comparison of NPV 2015-2050 (Millions)

- Electricity
- Natural Gas
- O&M
- Capital
- Water used (ccf)
- Total GHG
Benefits– Financial & Economic Risk

Lowest cost of the options studied (including new cogeneration plant). Savings due to:

- New higher efficiency equipment
- ‘Free’ heat (heat recovery)
- 10% line loss reduction by converting to Hot Water
- Long term O&M savings of HW vs Steam distribution
- Move off 100% reliance on single fuel (gas)
Benefits – 50% GHG Reduction

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Greenhouse Gas Emissions (Category I & II)

Benefits
– 50% GHG Reduction

AB-32
SESi Reductions
IPCC

Business As Usual
Benefits – 20% Water Savings

Domestic Water Demand Projections

Current water supply limit

Projected use with Building Conservation and Heat Recovery

Projected use with continuing Building Conservation

Domestic Water use (mgd)

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Benefits—Safety & Reliability

Boiler Explosion Injures Employee
Patient Airlifted To Vanderbilt Medical Center

University of Utah cited in steam blast that hospitalized 12
April 1st, 2011 @ 5:37pm
By Emiley Morgan

SALT LAKE CITY — A citation issued this week places fault on the University of Utah for a steam blast in a tunnel that sent 12 people to the hospital, some in critical condition.

The citation, which was issued by the Occupational Safety and Health Administration following a months-long investigation, states that "the University of Utah did not inspect or designate a competent person to inspect frequently for the unsafe condition of an open-ended high temperature water pipe in a tunnel system" located at 300 S. 1850 East in Salt Lake City.

Emergency responders work at the scene of a water pipe burst that injured 12 people at the University of Utah on Monday, November 1, 2010. (Kristin Murphy, Deseret News)

Steam explosion jolts Manhattan, killing 1
More than dozen injured, some seriously; crowds flee steam, flying rubble
SES Schematic

**Chilled Water**
- Chiller
- Cooling Tower
- CWR (52°F to 60°F)
- Heat Recovery Chiller
- Heat Exchanger
- Cold Water Storage
- Full CEF + GSHE System & Water Loops
- Ground Water
- Condenser Water
- Hot Water Generator
- Heat Exchanger
- Hot Water Storage
- Chiller
- 80°F to 105°F
- 70°F to 85°F
- HWS (150°F to 170°F)
- HWR (120°F to 140°F)

**Hot Water**
- 60°F to 64°F
- 38°F to 46°F (heat extraction)
- 76°F to 95°F (heat rejection)
- 60°F to 64°F
New SESI Central Energy Facility
Project Components

- Replacement Central Energy Facility: 49%
- New Electrical Substation: 39%
- Hot Water Underground Piping and Building Conversions: 12%

Total Investment $438 Million
Enhancements under study

- Utility scale on-site Photovoltaic power
  - Replaces grid renewables at lower cost (free land and no transmission cost)
Enhancements under study

- **Ground Source Heat Exchange (GSHE)**
  - Augments heat recovery to meet remaining 30% thermal needs
IMPLEMENTATION
Project Components

1. Replacement Central Energy Facility

2. Replacement High-Voltage Substation

3. New Hot Water Distribution System
   Process steam plant
   Temporary Heat Exchange Stations

4. Building Conversions
Overall Conversion Plan
<table>
<thead>
<tr>
<th>Project</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Underground Piping</td>
<td>June 2012-June 2015</td>
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<tr>
<td>Building Conversions</td>
<td>June 2012-June 2015</td>
</tr>
<tr>
<td>Central Energy Facility</td>
<td>October 2012- April 2015</td>
</tr>
</tbody>
</table>
Disruption Mitigations

- Advance notice
- Multiple shifts/Night Work
- Overlay planned maintenance and capital projects
- Use existing tunnels and infrastructure where possible
- Use “Logstor” prefabricated piping system to reduce trenching requirements
RETROFITS SPARK SAVINGS.
Systems retrofits to most energy-intensive buildings on campus are expected to save $4.2 million a year and cut energy use 28%.

Learn more about how Stanford saves energy. >

IN THE NEWS

6/24/10 Graduate School of Business Wins "Green Project of the Year" from Silicon Valley Business Journal
6/26/10 Office of Sustainability to Host Student Open House Friday, October 8th
6/13/10 Sustainable Stanford Increases Presence During New Student Orientation
6/24/10 KQED Features Stanford's Energy Efforts

CLIMATE ACTION
Climate change caused by greenhouse gas emissions is the greatest environmental and socioeconomic challenge and opportunity of our time. To address it, Stanford is developing global solutions and implementing them on campus. High performance buildings, a cutting edge energy system, and a greener campus lifestyle continue Stanford's legacy of environmental leadership in teaching, research, and action. In October 2009, Stanford released a comprehensive and long-range Energy and Climate Action plan that has begun implementation. Click on one of the topics below to see how Stanford University has crafted an Energy and Climate Action Plan that fulfills the promise of sustainability to green the environment, as well as the bottom line.

Sustainable.stanford.edu/climate_action