Data Driven Sustainability – Worth the Pursuit

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CHESC
July 9, 2018
1. **Real Time information:** In addition to real-time dashboards on campus-wide sustainability performance and utilities consumption, Stanford also hosts individual Lucid dashboards for 130 of its largest buildings.

2. **Central Energy Facility autopilot:** Stanford’s Central Energy Facility (CEF) is home to a district level heat recovery system, as part of the Stanford Energy System Innovations (SESI) program reducing campus GHG by 80 percent by 2021. Stanford collaborated with Johnson Controls to create a new patented plant optimization software.

3. **Plug Load inventory:** During the summers of 2014 and 2015, SSBS hired dozens of student interns and supplied them with an internally developed smartphone application. Overall, calculations indicated that plug loads equated to 34 percent of the total campus electricity consumption.
Data Driven Sustainability

Background and Setup at Stanford
The Business Systems initiative in SEM addresses utilities data integration, resource efficiency and data analytics to effectively measure and manage Stanford’s resources.

This initiative improves business processes, promotes data-driven decisions and offers analytical tools to optimize efficiency in the campus infrastructure and operations.
Areas of Work

- eDNA operations and maintenance: 40%
- Metering/Billing Support: 20%
- Reporting, Dashboards, and Analytics (Vendors: Connexx, Lucid): 20%
- Integrations, Custom Tools and Utilities: 20%
1. eDNA Operations, Maintenance

- Support of eDNA historian system and related infrastructure, EBS billing system, and client tools
- Metering data issues research and correction
- Continually monitor and adjust system linkages and data mappings for ‘historized’ source systems.
- Support SEM operations groups and LBRE Finance with ad-hoc queries and data requests
2. Metering and Billing Support

- Billing System Support
- Initial setup and configuration of new meters from the source system into eDNA and eDNA into EBS
- Generation and maintenance of Variance Report for billing reconciliation
- Support SEM operations groups and LBRE Finance with ad-hoc queries and data requests
3. Automation and Integrations

- Data flows and integrations in support of the Stanford Solar Generating Station (SSGS)
- Automations:
  - Energy meter form and inventory
  - Metering issue alerts
  - Billing variance report generation
- R&DE’s utilities management
- Building dashboards data flows
  - Adding support for Zone Management dashboards and notifications
4. Analytics (Dashboards and Reports)

- Types of data collected in SEM:
  - Utilities metering/consumption/CEF distribution system
  - Central Energy Facilities equipment
  - Stanford Solar Generating Station
  - Several weather sources
  - Corrected (data) service

- Types of Analytics
  - Building Dashboards 135 (by Lucid)
  - Systems Dashboards 29 (by Connexx)
  - Systems Reports
    - Billing data based reports in OBIEE
    - Utilities cost and consumption reporting from EBS
    - Water consumption reports
    - Utilities billing reconciliation
    - Ad-hoc
Data Driven Sustainability Example 1

Real Time Information
Campus Dashboards

July 9, 2018
Campus Performance

Stanford maintains a wealth of data aimed at increasing efficiency in campus operations. The university has employed metering on all of its facilities to understand how and where resources are being used since the 1980s. Today, it relies on an integrated system of utilities meters and controls that improve business processes, promote data-driven decisions, and offer analytical tools to optimize efficiency. This system ultimately provides greater visibility and insight into Stanford’s utility infrastructure to operate in the most reliable, safe, and cost-effective way, enabling adept management to conserve resources.

You can explore more details about campus performance, as well as real-time building performance metrics and the collective impact of individuals on campus, by clicking on any of the icons below to view the various dashboards. All of the data is powered through the integrated systems infrastructure, and supported by the business systems initiative.

Campus Dashboards

More than 25 campus-level dashboards help the department of Sustainability and Energy Management monitor and evaluate its services to the university.

- GHG Emissions
- CEF Efficiency
- Energy Use
- Water Use
- Quality
- Reliability
- Financial

Building and Individual Dashboards
GHG Emissions

This dashboard shows Stanford's historical greenhouse gas (GHG) emissions between 1990 and present day and Stanford's projected GHG emissions from present day to 2050. The colored wedges demonstrate the mitigation measures implemented to achieve GHG reductions from business as usual. The colored dots indicate state and international GHG reduction targets—Stanford has already outperformed California’s goal of reducing emissions to 1990 levels by 2020 and the International Paris Accord of reducing emissions 27% below 2005 levels by 2025.
Central Energy Facility

Stanford's Central Energy Facility (CEF) is home to a district level heat recovery system. The heat recovery chillers extract heat from chilled water loop, temporarily stores it at CEF for reuse or repurposes it real time by discharging it into the hot water loop. The annual heating and cooling overlap, and hence, heat recovery potential is shown in this dashboard, a blueprint that is at the heart of Stanford Energy System Innovations (SESI) initiative. This view can be interpreted as the efficiency meter of the CEF, explaining the value of heat recovery at Stanford. Cooling is displayed in MMBTU as the common denominator.

Heating and cooling load compared to HRC production

- HW Loads: 60
- CW Loads: 53
- HW from HRC: 55
- CW from HRC: 39
- Forecast Heating Load: 148
- Forecast Cooling Load: 29
- Budget Cooling Load: 29
- Budget Heating Load: 148
Reliability

Water Quality Reliability

This dashboard explains the overall status of heating and cooling supply and reliability for campus buildings. It displays historical trend of hot and chilled water loads along with monthly unmet loads. This report can help building and facilities managers decide if a potential curtailment is needed. Cooling is displayed in MMBTU as the common denominator.

Note: unmet load data is calculated and updated monthly.
Data Driven Sustainability Example 2
Central Energy Facility Autopilot

*July 9, 2018*
Stanford Energy System Innovations (SESI) is a new sustainable energy program designed to meet the energy needs of Stanford and lead by example. The project transformed the campus energy supply from one based on fossil fuels, to an electrically powered system.

| **68%** | reduction in campus greenhouse gas emissions already, >80% in 2021 |
| **18%** | reduction in campus drinking water use |
| **$420** | million saved over next 35 years, >$485M with new PV |

- Large scale deployment of heat recovery
- Combining best heating and cooling technologies in Europe and North America
Central Energy Plant Optimization Model (CEPOM)/Enterprise Optimization Solution (EOS)

CEPOM/EOS is a patented ‘model predictive control’ forward looking energy modeling and plant dispatch program using over 1,220 variables including projected energy prices, load forecasts, and energy plant equipment and thermal storage capabilities to develop optimal hourly energy system operating plans.
Data Driven Sustainability Example 3
Plug Load Inventory
July 9, 2018
Stanford Plug Load Inventory Overview

- Comprehensive 260-building plug load equipment inventory

- Goals:
  1. Quantify campus plug load energy consumption and understand its composition
  2. Identify viable plug load energy reduction opportunities
  3. Collect data that supports Office of Sustainability’s partners
Scope

• Types of equipment included:
  • Standard office equipment
  • Standard lab equipment
  • Common IT equipment
  • Kitchen & break room equipment
  • Gym equipment
  • Other
    • EH&S hazards
    • Water fixtures
    • Occupancy data

• Attributes collected for each type of equipment to provide necessary details for estimating energy consumption

• Inventory covers 93% of campus square footage
### Results (A) – Campus-Wide Context

<table>
<thead>
<tr>
<th>Equipment Count</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Equipment Count</td>
<td>204,000</td>
</tr>
<tr>
<td>Total Energy Consumption (kWh/yr)</td>
<td>77.3 million</td>
</tr>
<tr>
<td>Total annual cost</td>
<td>$9 million</td>
</tr>
<tr>
<td>Plug Load as % of Total Campus Electricity Use</td>
<td>34%</td>
</tr>
</tbody>
</table>

#### Equipment Count

- **Desk Lamp, 17%**
- **Personal Computer, 16%**
- **LCD Monitor, 11%**
- **Phone, 6%**
- **Microwave, 3%**
- **Server, 3%**
- **Fan, 3%**
- **Personal Printer, 3%**
- **Common Refrigerator, 3%**
- **TV / LCD Screen, 2%**
- **Speakers, 2%**
- **Other, 28%**

**Total Equipment Count:** 204,000

**Total Energy Consumption (kWh/yr):** 77.3 million

**Total annual cost:** $9 million

**Plug Load as % of Total Campus Electricity Use:** 34%
Results (B) - Energy Consumption by Equipment Type

Energy Consumption (kWh/yr)

Key:
- IT Equipment
- Lab Equipment
- Office Building Equipment

Plug Load Energy Savings Programs

Estimated to save a total of $2.3 million annually.

<table>
<thead>
<tr>
<th>Program</th>
<th>Expected Cost</th>
<th>Expected Annual Savings</th>
<th>Average ROI</th>
<th>% Plug Load Reduction</th>
<th>Level of Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP &amp; ERP Express</td>
<td>$860,000</td>
<td>$260,000</td>
<td>3.3 years</td>
<td>3.8%</td>
<td>“Guaranteed”</td>
</tr>
<tr>
<td>Space Heating</td>
<td>$68,000</td>
<td>$78,000</td>
<td>0.9 years</td>
<td>1.1%</td>
<td>Likely</td>
</tr>
<tr>
<td>Sustainable IT</td>
<td>$80,000(^1)</td>
<td>$1,400,000(^2)</td>
<td>0.1 years</td>
<td>20%</td>
<td>Likely</td>
</tr>
<tr>
<td>Green Labs</td>
<td>$7,300,000(^3)</td>
<td>$510,000</td>
<td>14 years</td>
<td>7.5%</td>
<td>Somewhat Likely</td>
</tr>
<tr>
<td>Procurement</td>
<td>$0</td>
<td>$85,000</td>
<td>N/A</td>
<td>1.2%</td>
<td>Somewhat Likely</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$8,300,000</strong></td>
<td><strong>$2,300,000</strong></td>
<td><strong>3.5 years</strong></td>
<td><strong>34%</strong></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)This does not fully represent the cost of server consolidation, which is currently underway and is largely sponsored by other departments.

\(^2\)Includes avoided cooling costs from server consolidation and virtualization.

\(^3\)This captures the entire cost of upgraded lab equipment but could be lower if equipment only partially subsidized.
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