



SAN DIEGO COMMUNITY COLLEGE DISTRICT



*Systems Thinking Approach to Strategic Utility Management:*

**Meet Critical Needs Using Multiple Integrated Energy Technologies to Reduce Costs and Enhance Performance**



Presented to

**APPA**

Thursday, July 19, 2012

# Systems-Thinking Approach to Utility Management

## SDCCD Overview

- Second Largest Community College District in CA
- Sixth Largest in Nation
- Three Colleges - City, Mesa and Miramar
- Six Continuing Education Campuses
- 125,000 students served plus 140,000 members of the military nationwide
- Total Square Footage - 2,218,031



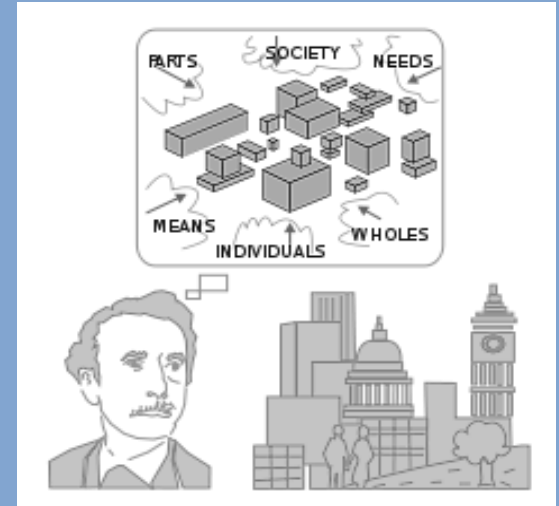
# Systems-Thinking Approach to Utility Management

## Systems Thinking

### What is it?

**Systems thinking** is the process of understanding how things influence one another within a whole.

Systems thinking is not one thing but a set of habits or practices within a framework that is based on the belief that the component parts of a system can best be understood in the context of relationships with each other and with other systems, rather than in isolation.





# Systems-Thinking Approach to Utility Management

## SDCCD's Systems Thinking Approach

- ✓ Green Building Policy
- ✓ Renewable Energy Portfolio
- ✓ Solar Thermal Heating of Aquatics Complexes
- ✓ Thermal Energy Storage
- ✓ Smart Metering

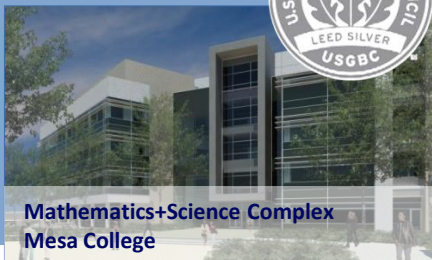
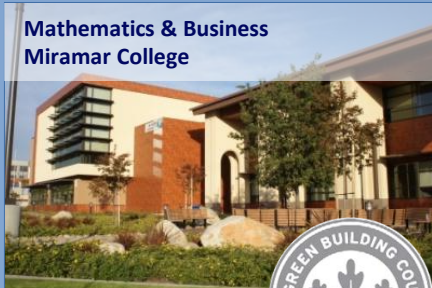




# Systems-Thinking Approach to Utility Management

## SDCCD's LEED Medal Count

SDCCD is on track to obtain a total of 37 LEED certifications - more than any other higher education institution locally.



Miramar College Police Station is first Platinum for a higher education facility in San Diego



# Systems-Thinking Approach to Utility Management

## Space Efficiency & Energy Efficiency as Key Goals

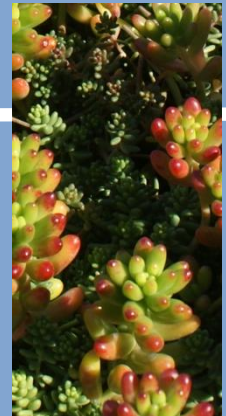
# West City Campus exceeds Title 24 by 43%!



# Systems-Thinking Approach to Utility Management

## Examples of Sustainable Practices

- Solar Chimney
- Variable Refrigerant Volume Systems
- Natural Ventilation
- Green Roofs/Green Screens





# Systems-Thinking Approach to Utility Management

## Examples of Sustainable Practices

### Solar Chimney – Miramar College Police Station

The tower element serves as a solar chimney which is a passive solar strategy to create a flow of natural ventilation. The top of the tower will heat up, and louvers will provide for air exhaust at the high point.

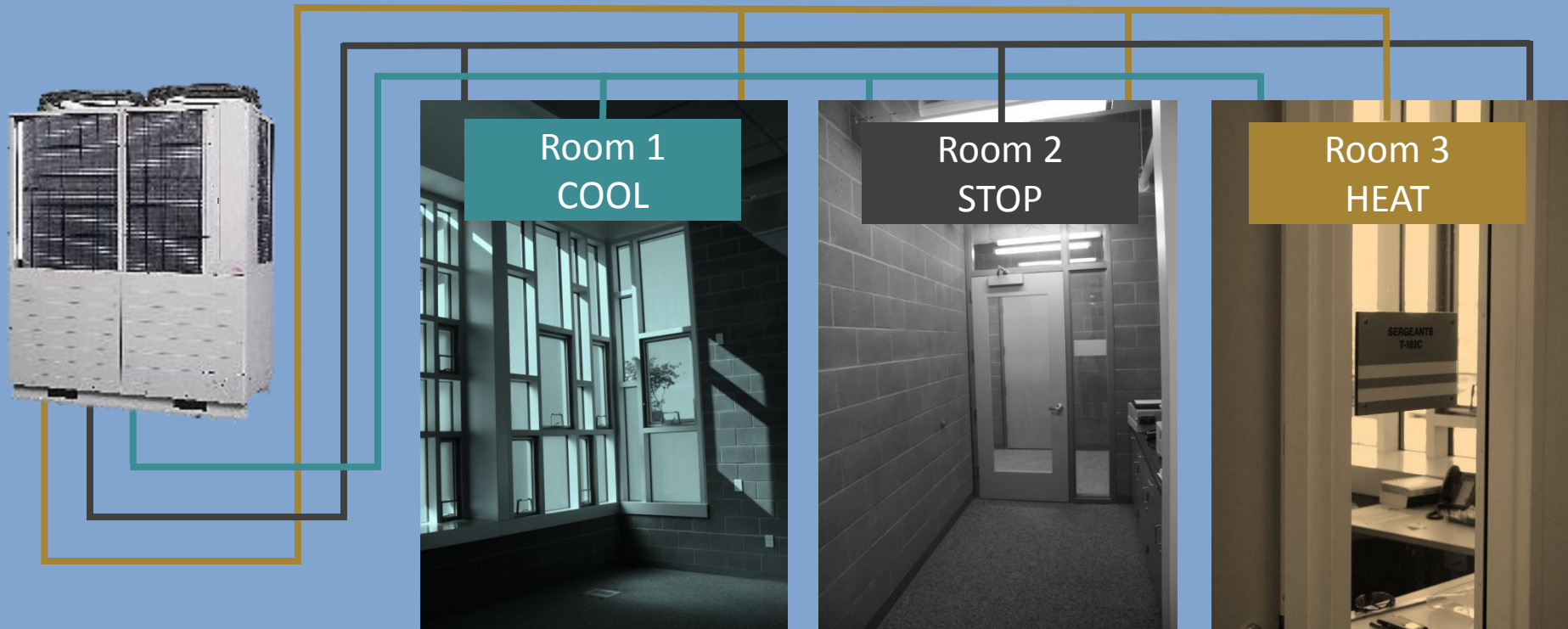


# Systems-Thinking Approach to Utility Management

## Examples of Sustainable Practices

### Variable Refrigerant Volume – Miramar Police Station

VRF provides customized control for different zones by constantly modulating refrigerant temperature and varying ventilation speed, thereby saving energy.





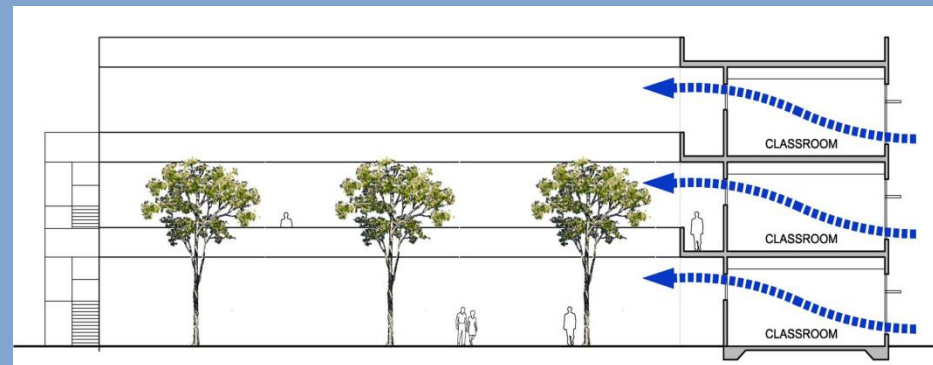
# Systems-Thinking Approach to Utility Management

## Examples of Sustainable Practices

### Natural Ventilation

#### Benefits

- ✓ Lower running costs through lower energy use
- ✓ Less capital cost
- ✓ Lower maintenance costs
- ✓ Increased occupant satisfaction



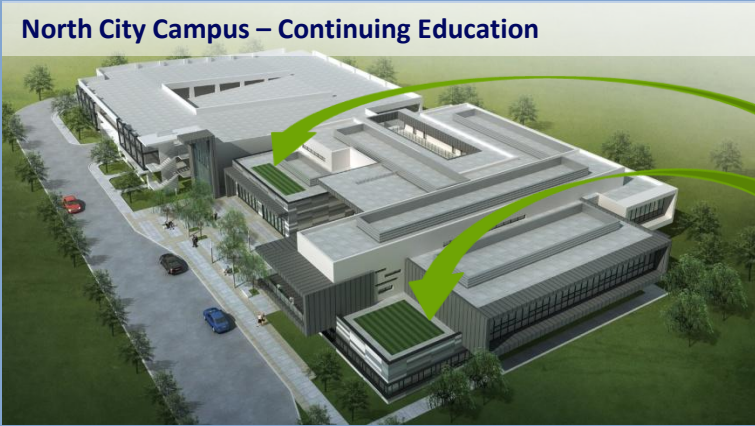


# Systems-Thinking Approach to Utility Management

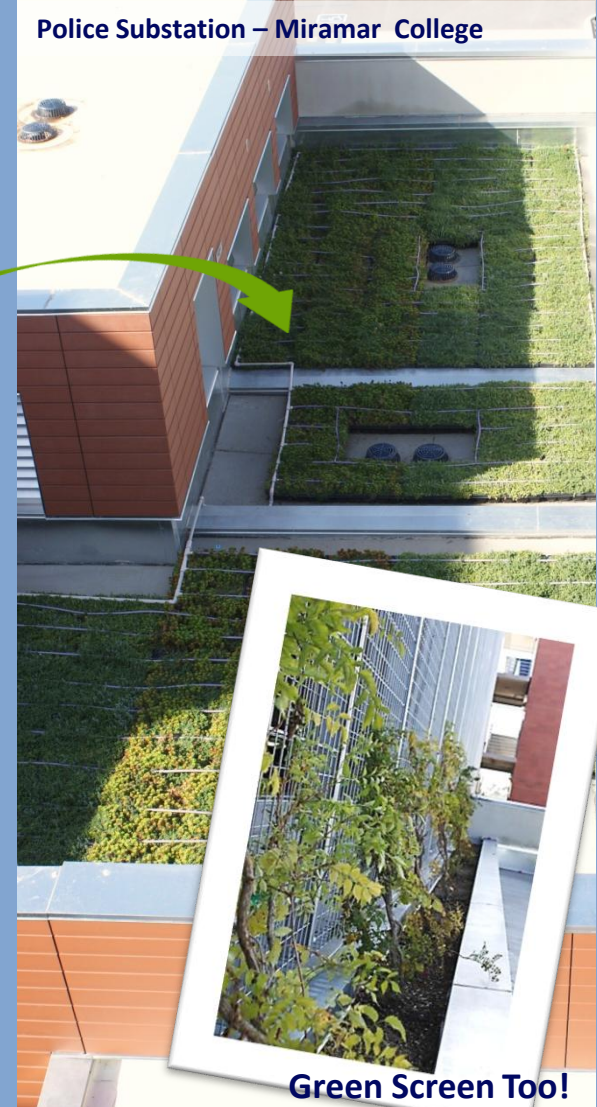
## Examples of Sustainable Practices

### Green Roofs/Green Screens

North City Campus – Continuing Education



Police Substation – Miramar College



Cafeteria/Bookstore – Mesa College



Cafeteria/Bookstore at Mesa College will have rooftop herb garden to support Culinary Arts program.



Green Screen Too!



# San Diego Community College District PV Production – Solar Power



Districtwide - 2.4 MW through Power Purchase Agreement (PPA) generating 4,833 MWh annually

ECC Skills Center - 5.6 kW Utility-owned system generates 98,112 kWh annually

City College CTC - 51 kW District-owned system generates 80,918 kWh annually



# Systems-Thinking Approach to Utility Management

## Renewable Energy Portfolio

### Power Purchase Agreement (PPA)

- Agreement to purchase power from a third-party provider
- 2.445 MW AC – enough to power 650 homes for a year
- 18 percent of current base electrical load
- 26 percent of current peak electrical demand
- Pay only for what power is generated
- Fixed term: 20 years for SDCCD

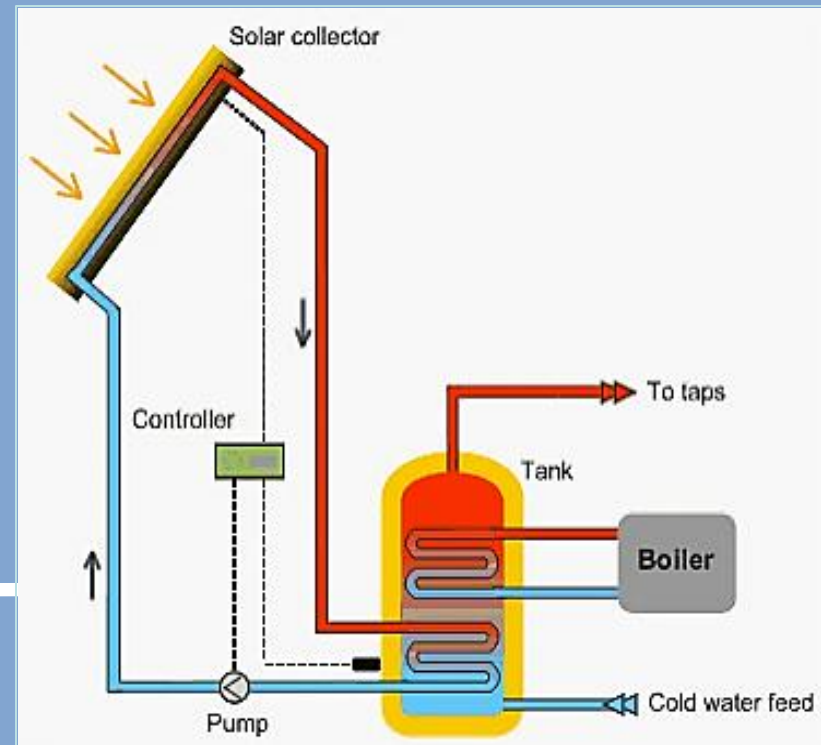
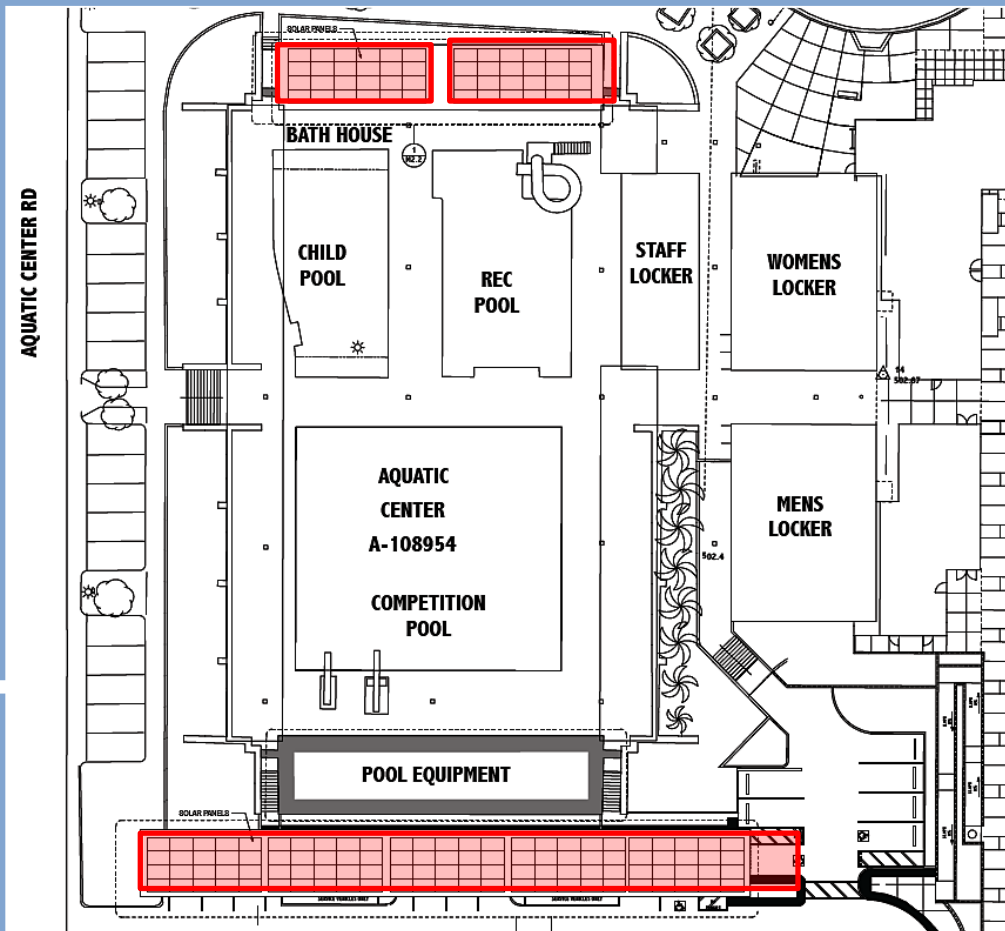




# Systems-Thinking Approach to Utility Management

## Renewable Energy Portfolio

### Solar Thermal Heating of Hourglass Aquatic Complex



# Systems-Thinking Approach to Utility Management

## Renewable Energy Portfolio

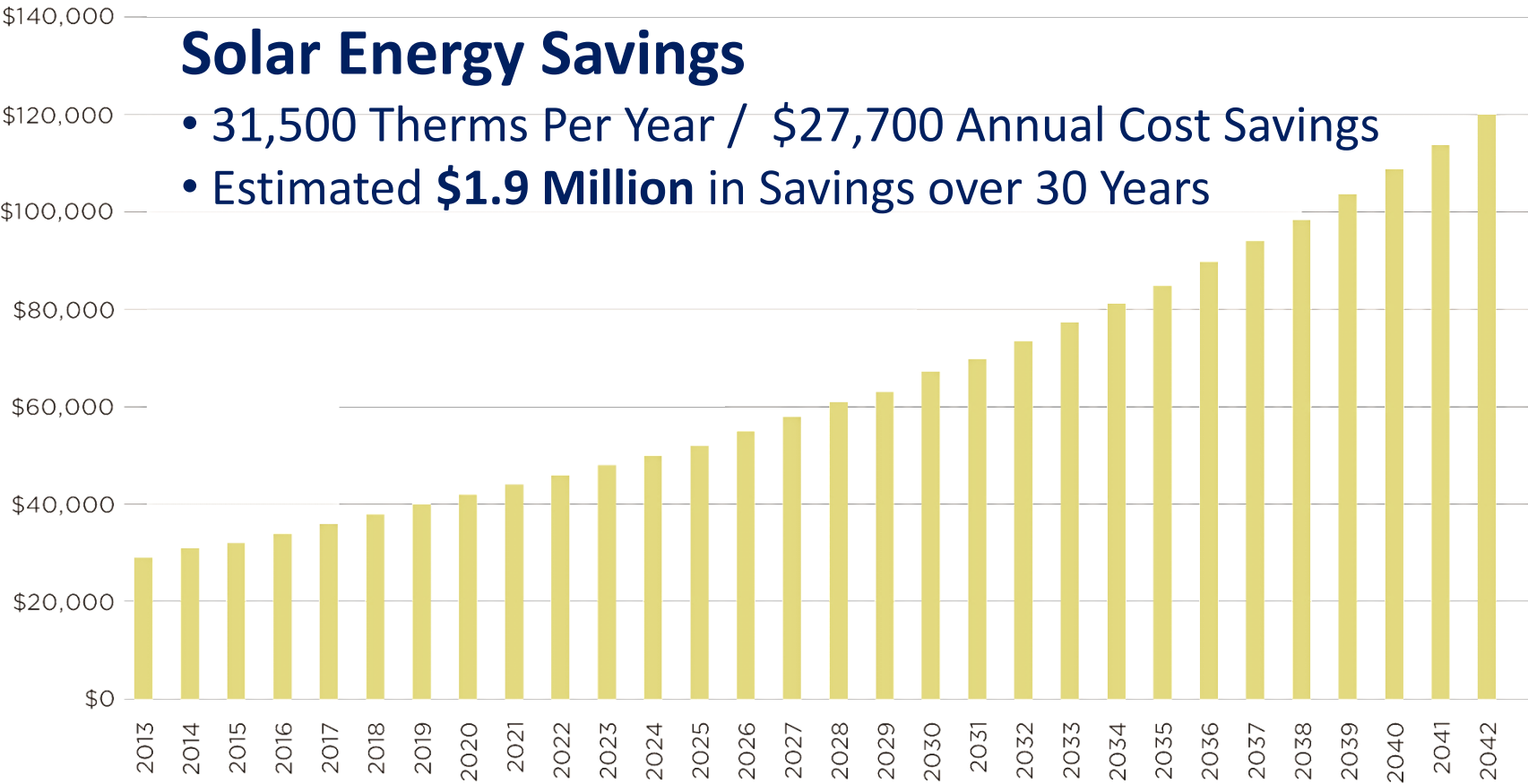
### Solar Thermal Heating of Hourglass Aquatic Complex



# Systems-Thinking Approach to Utility Management

## Renewable Energy Portfolio

### Solar Thermal System – 30 Year Lifecycle Cost Savings





# Systems-Thinking Approach to Utility Management

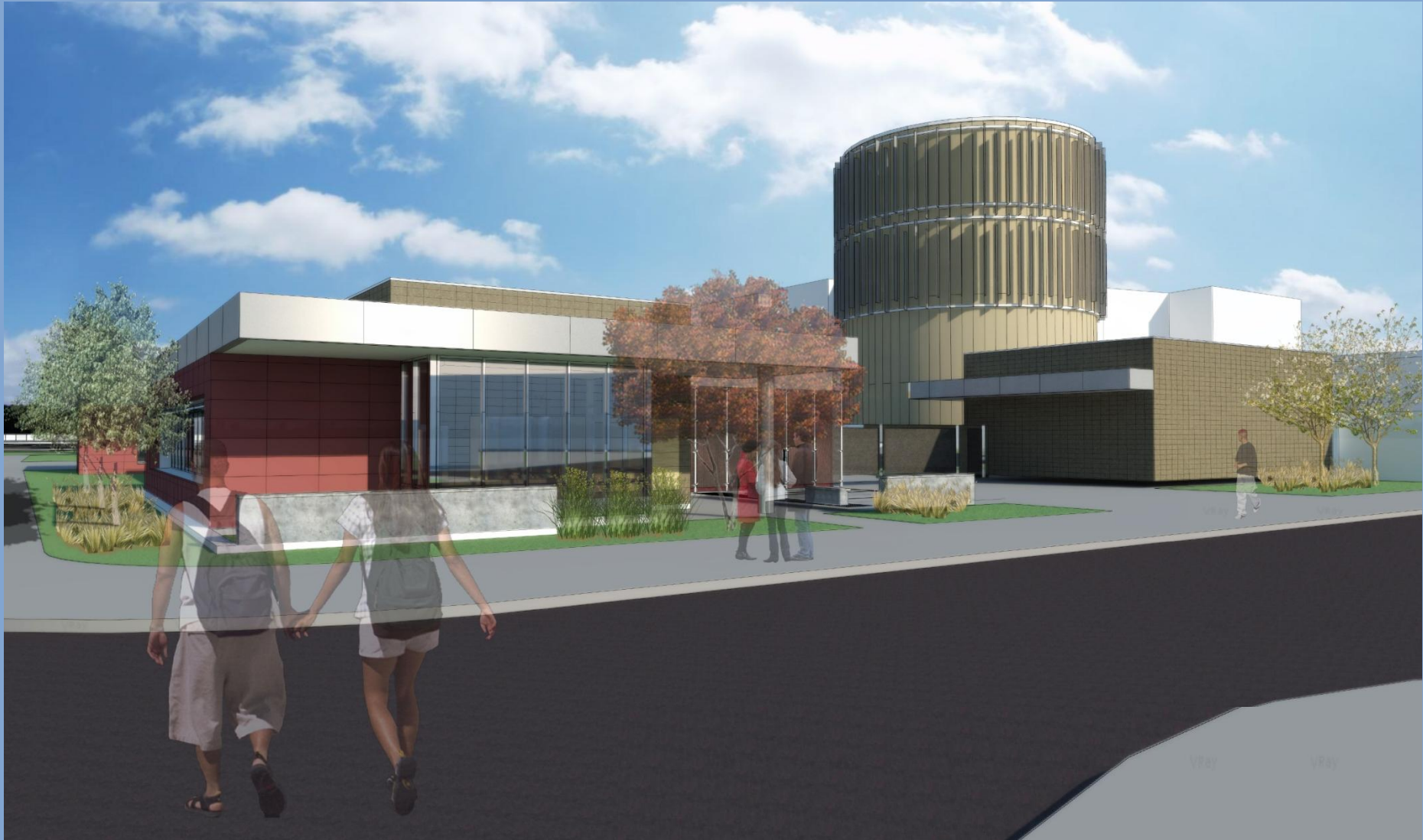
## Decommissioning of Cogeneration Plants

- Thermal performance degraded with time
- Operational challenges of absorption chillers with centrifugal chillers
- Reliability of system uptime and impact on demand charges
- Reduced carbon footprint



# Systems-Thinking Approach to Utility Management

## Thermal Energy Storage





# Systems-Thinking Approach to Utility Management

## Thermal Energy Storage

### Tank Sizing

- 9200 Ton-hours
- Equal to entire campus at full cooling load for six (6) hours
- 1 million gallon tank



### Energy Savings

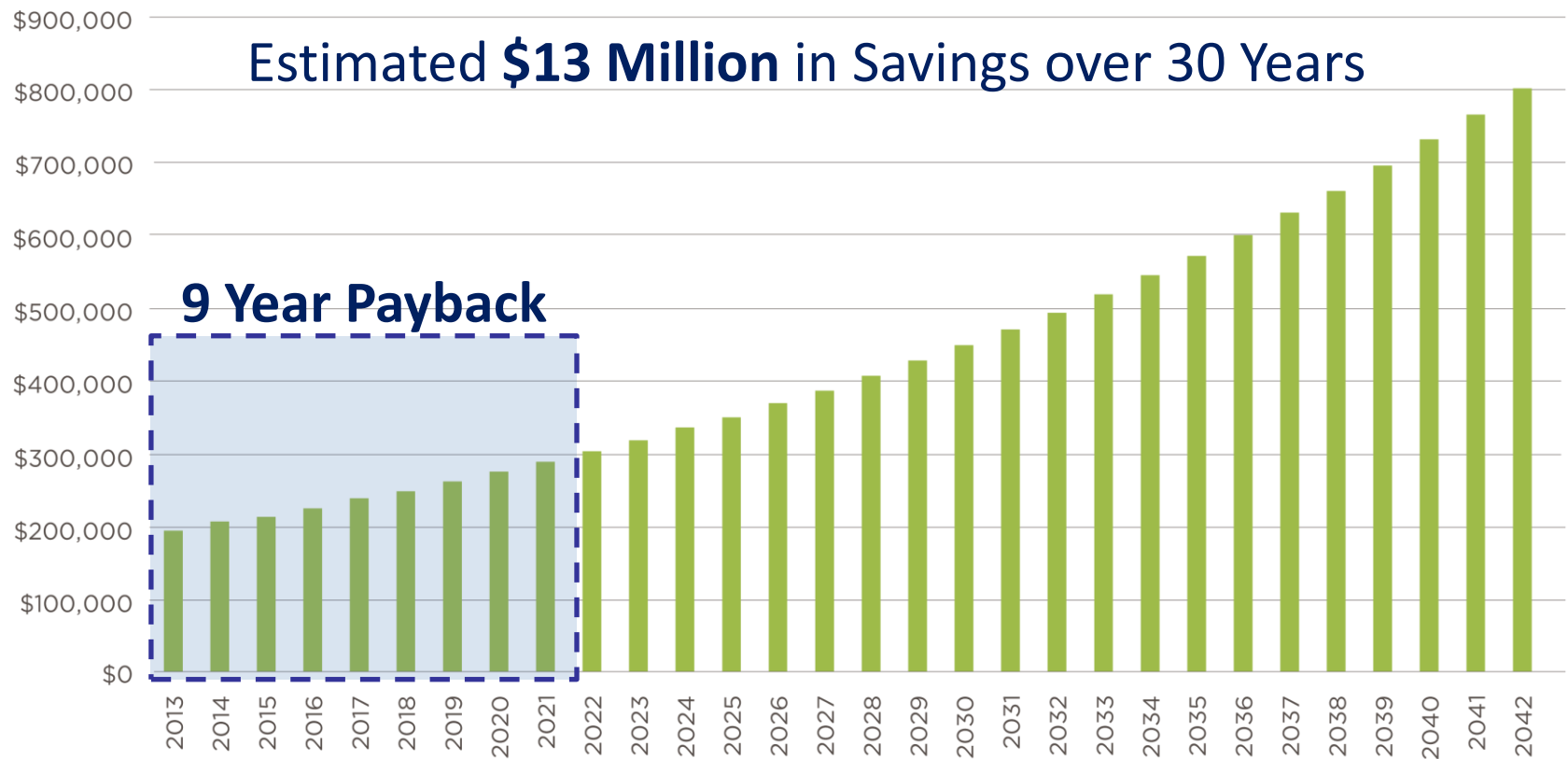
- 764,404 kWh per Year
- \$190,000 Annual Cost Savings



# Systems-Thinking Approach to Utility Management

## Thermal Energy Storage –

### Thermal Energy Storage Tank – 30 Year Lifecycle Cost Savings





# Systems-Thinking Approach to Utility Management

## The Challenge Continued

Too **Cold!**



## Facilities Survey

Too **Hot!**



How do you rate the adequacy of the indoor heating?

**Extremely Dissatisfied – 17.60%**

**Extremely Satisfied – 10.80%**

How do you rate the adequacy of the indoor air conditioning?

**Extremely Dissatisfied – 23.70%**

**Extremely Satisfied – 9.00%**

# San Diego Community College District

## The Current State

### Electrical Usage (kWh) - 2000 – 2011

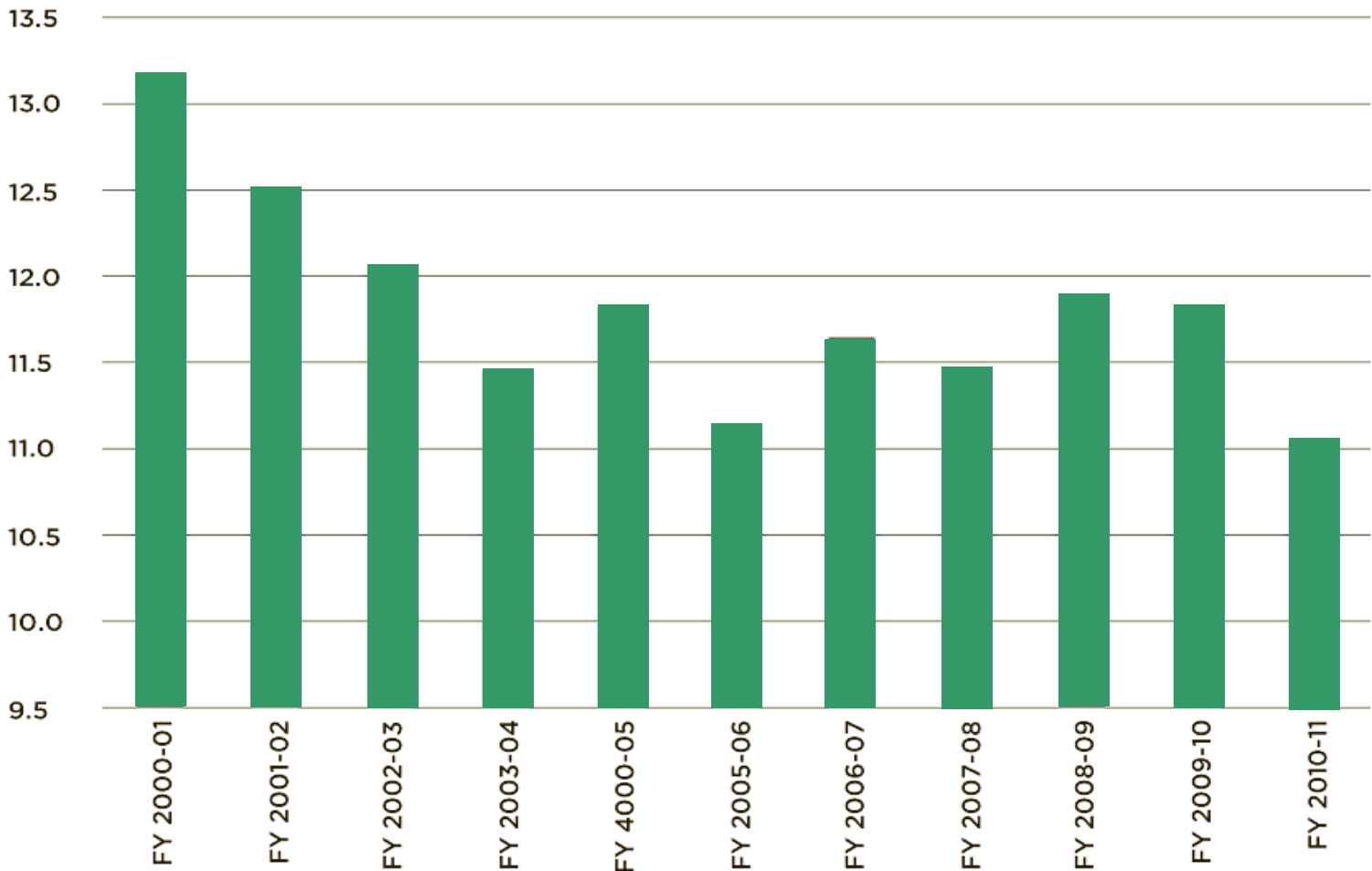




# San Diego Community College District

## Normalized on Square Footage

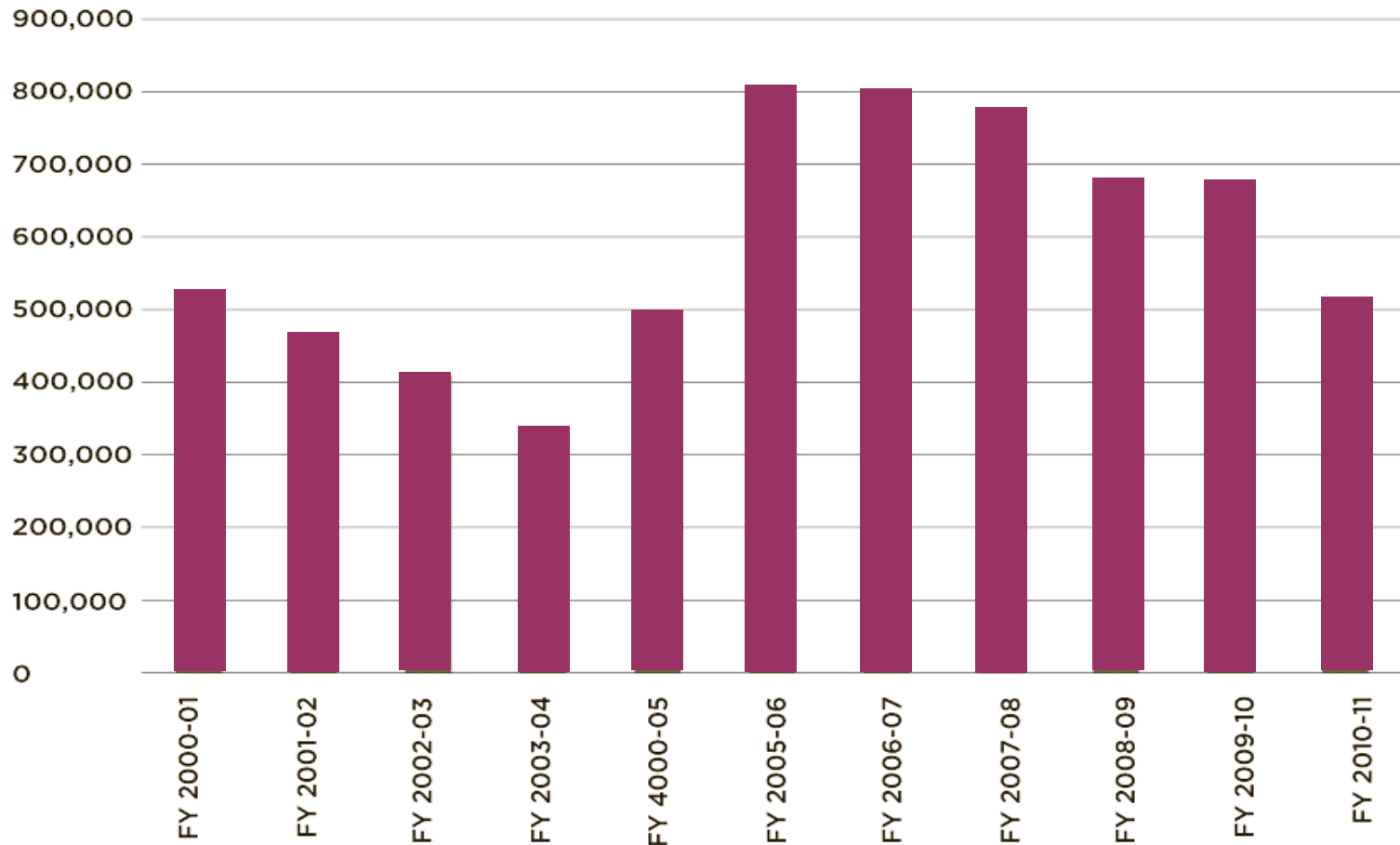
Electrical Usage (kWh) by Square Foot



# San Diego Community College District

## The Current State

### Natural Gas Usage (Therms) -2000 – 2011

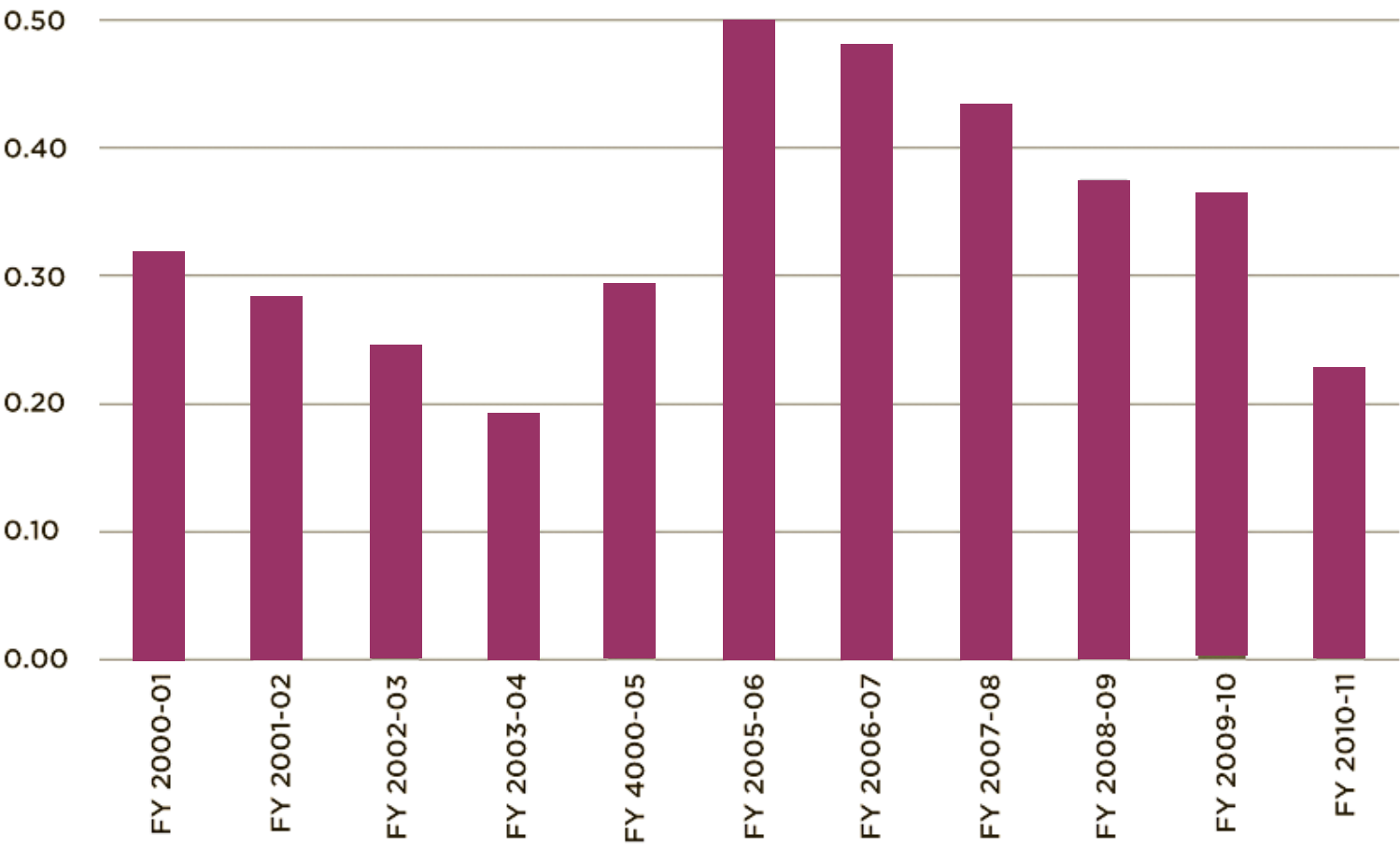




# San Diego Community College District

## Normalized on Square Footage

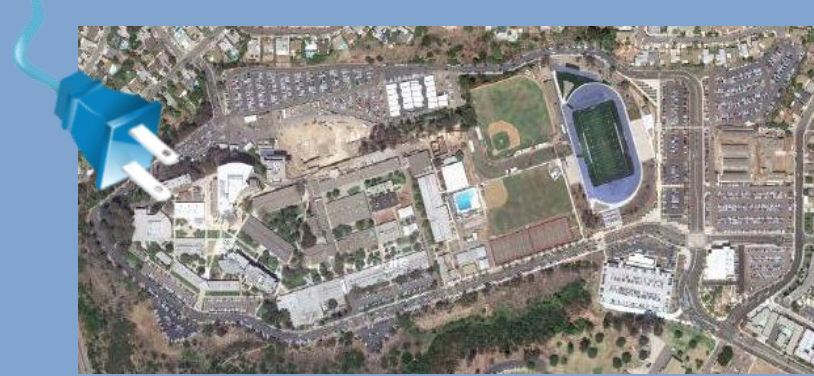
Natural Gas Usage (Therms) by Square Foot



# San Diego Community College District

## The Challenge

### Single electrical meters at Mesa and Miramar Colleges



Mesa College  
2011 kWh – 4,963,172



Miramar College  
2011 kWh – 5,131,596

# San Diego Community College District

## The Challenge Continued

No monitoring of  
chilled/heated hot water  
consumption in buildings



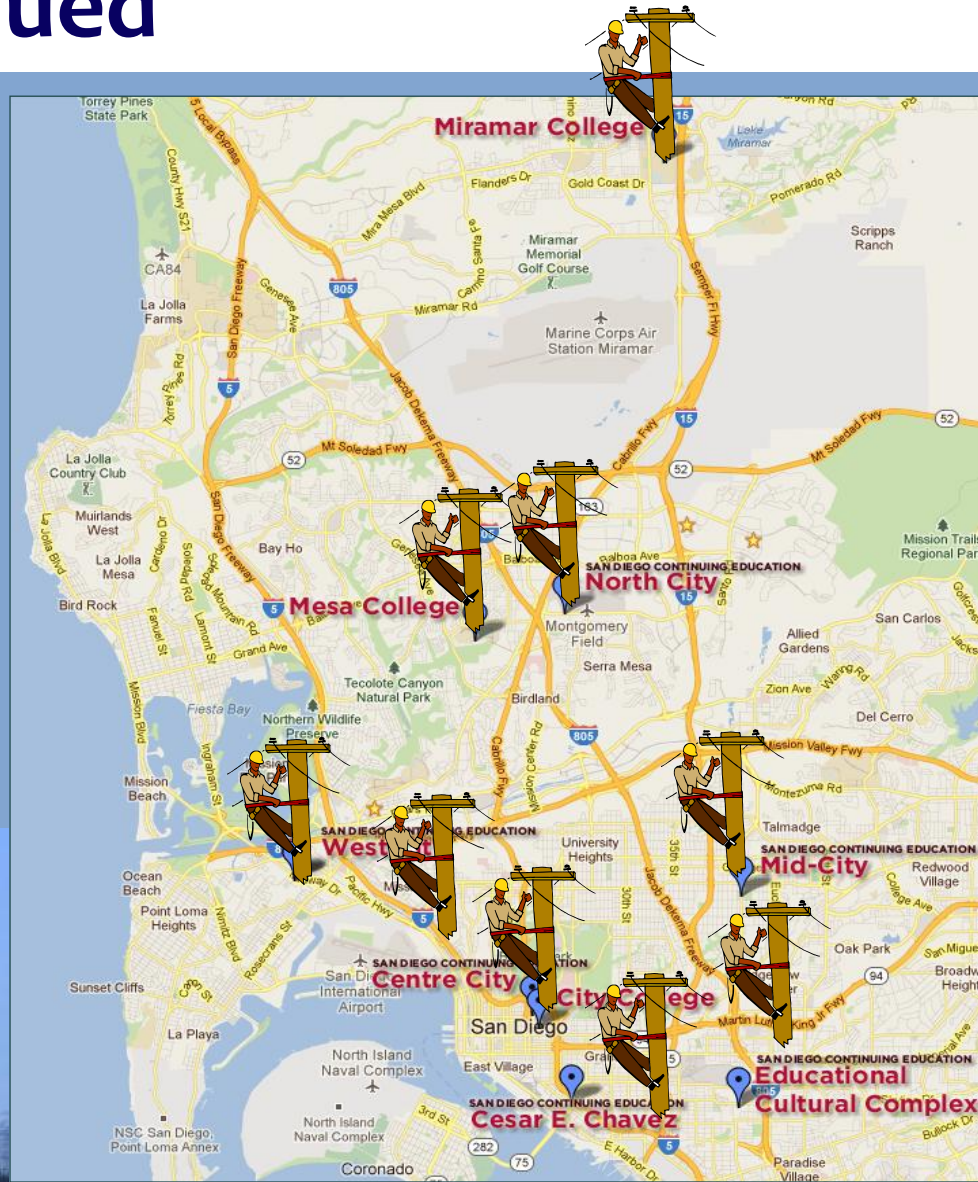


# San Diego Community College District

## The Challenge Continued

SDG&E Demand  
Charges and Demand  
Reduction Load  
Shedding Response

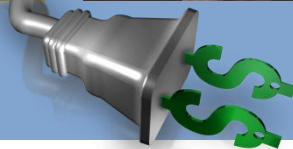
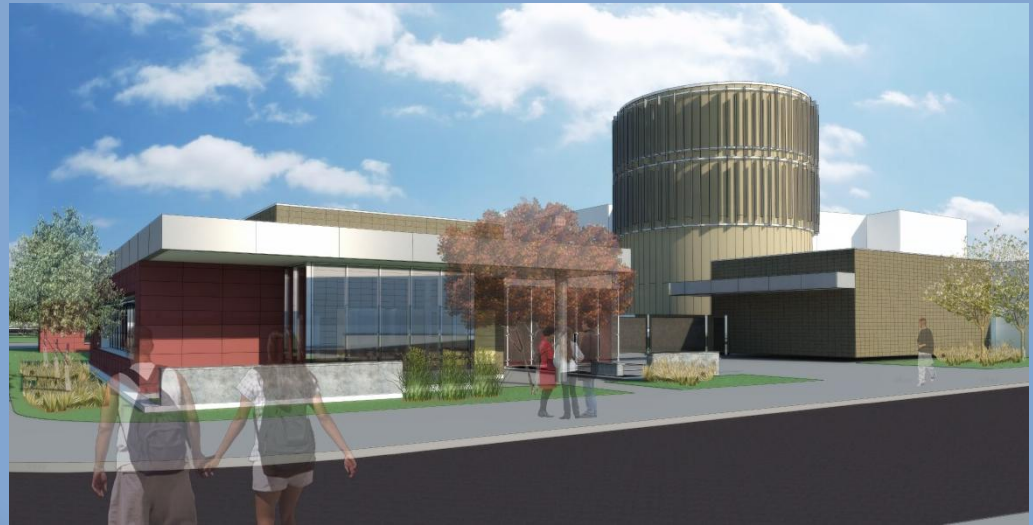
Rate - **\$1.00 kWh**



# San Diego Community College District

## The Challenge Continued

How to leverage PV peak production and thermal energy storage to intelligently manage electrical consumption from grid.

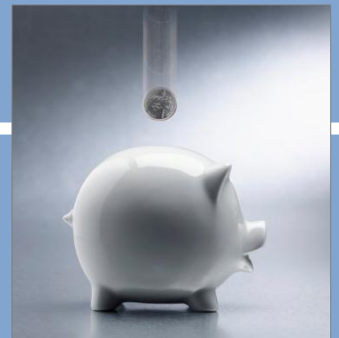




# San Diego Community College District

## The Vision

- Smart metering of energy consumption by building
- Utilize this data to focus maintenance efforts for building performance
- Behavior modification of building occupants





# San Diego Community College District

## Smart Metering

### What is monitored...

- Electrical load
  - ✓ Lighting
  - ✓ Motors
  - ✓ Equipment
  - ✓ Plug loads
- Therms chilled water or heating hot water
- Natural gas therms consumed



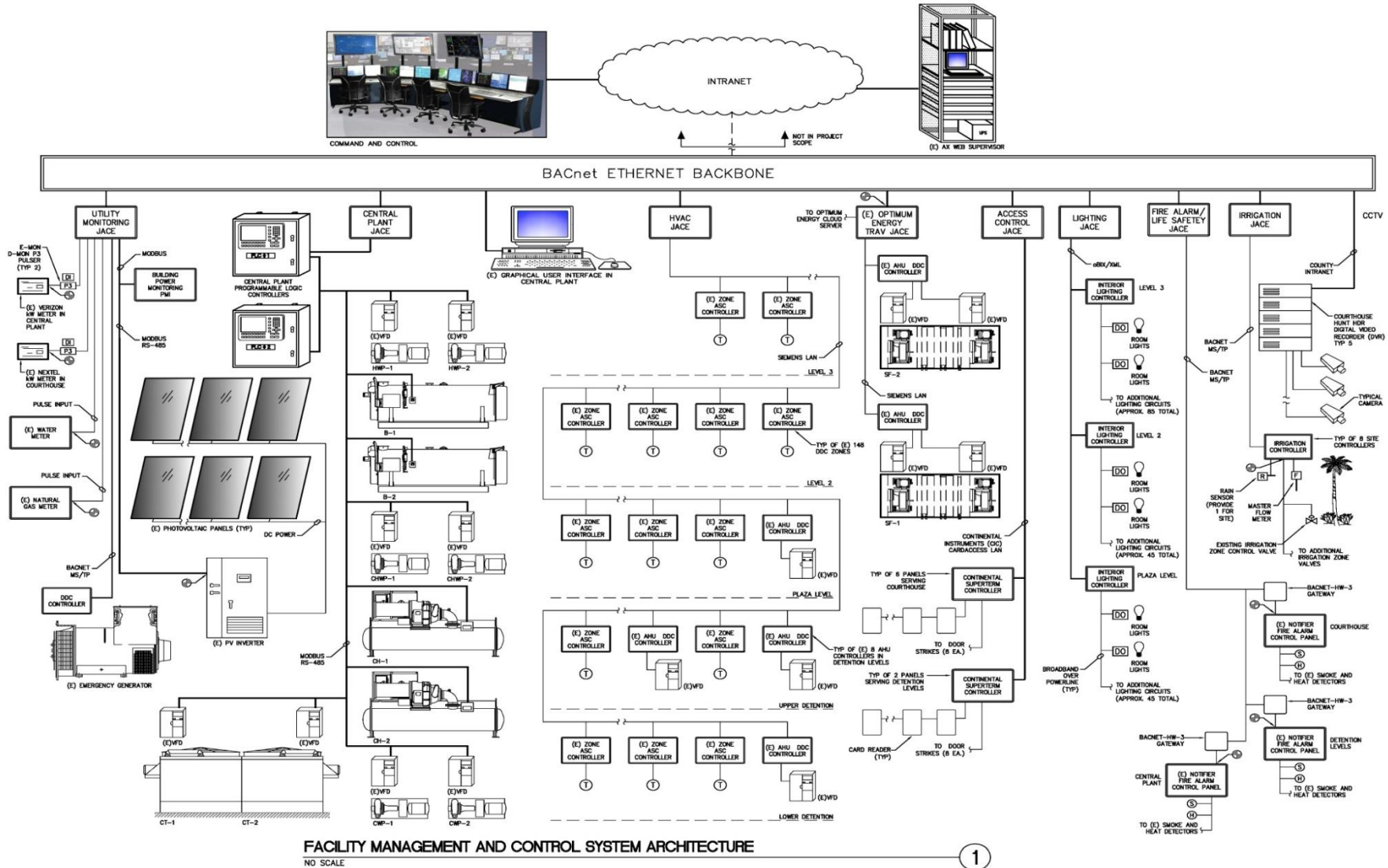
## How is data collected and monitored?

- Using standard EMS across the District to monitor building performance
- Electrical metering with IP address
- Natural gas with IP address
- Tie it together with Java Application Control Engine (JACE)



# San Diego Community College District

## How is data collected and monitored?

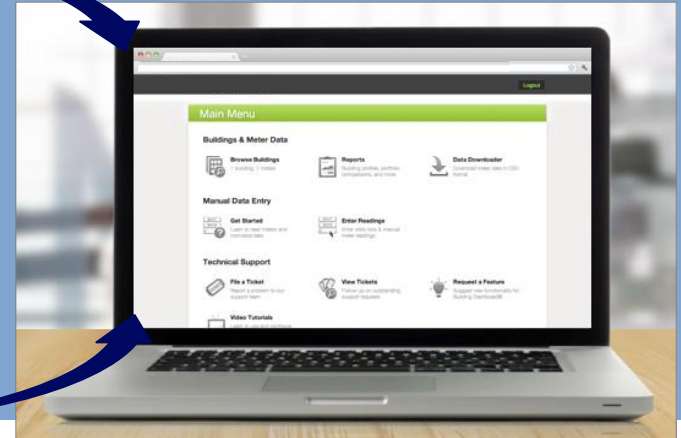




# San Diego Community College District

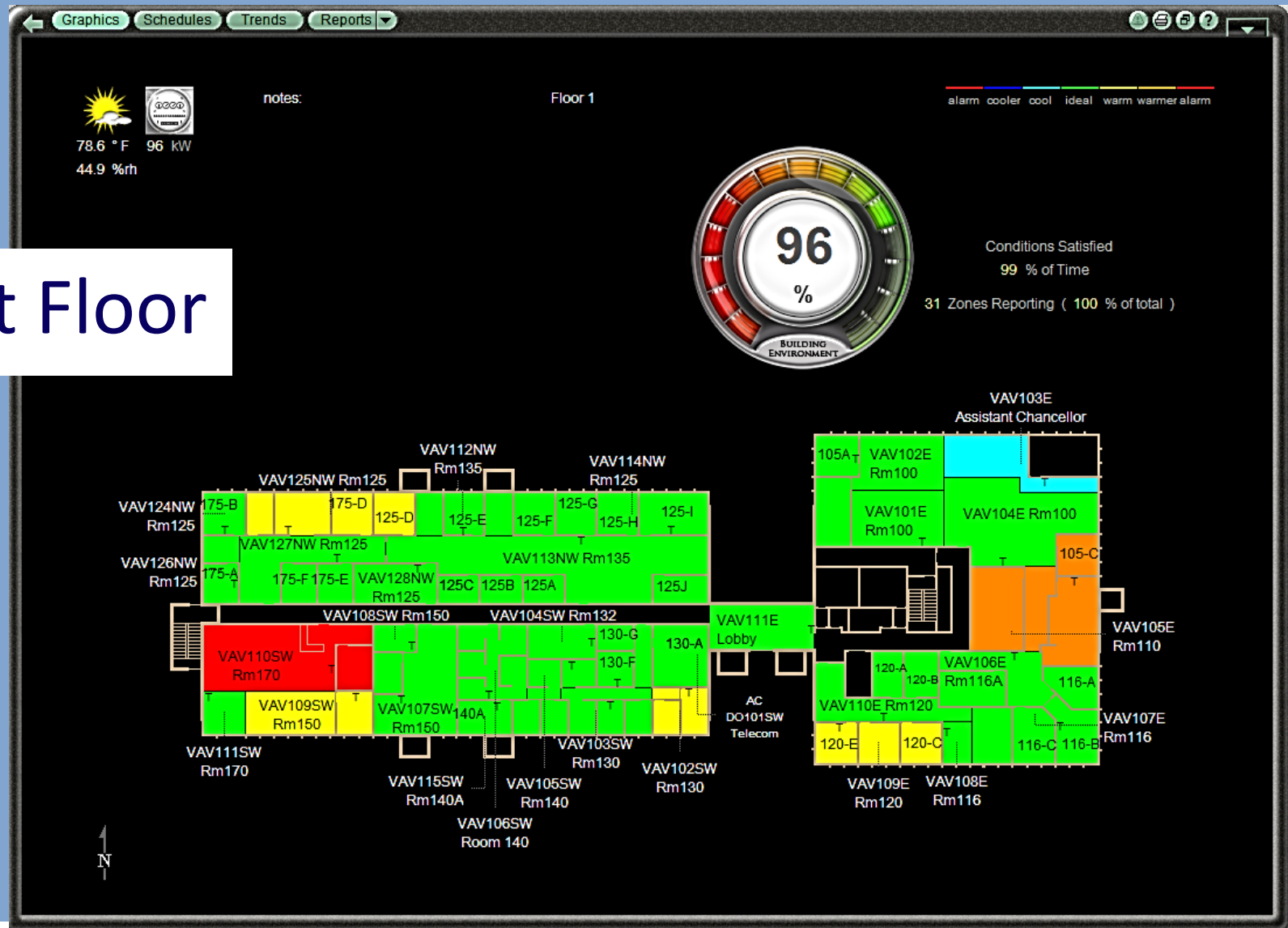
## The Vision

- Dashboards for each campus
- Dashboards for like type buildings
- Dashboards/algorithms for load shedding
- Dashboards for maintenance planning
- Dashboards for building thermal comfort



# San Diego Community College District Monitoring the District Offices – Thermal Comfort

## First Floor



# San Diego Community College District Monitoring the District Offices – Thermal Comfort

## Second Floor





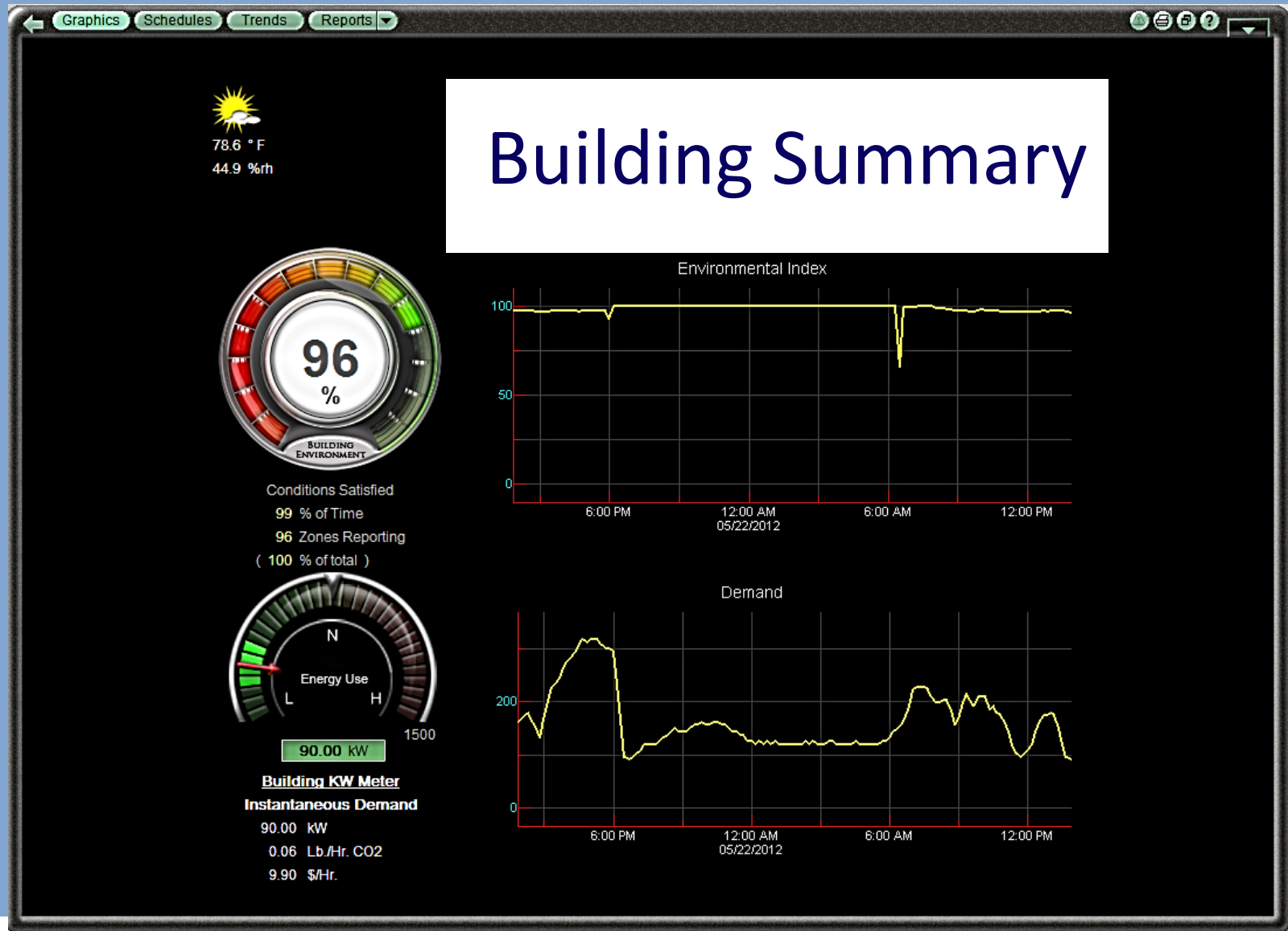
# San Diego Community College District

## Monitoring the District Offices – Thermal Comfort

Third Floor

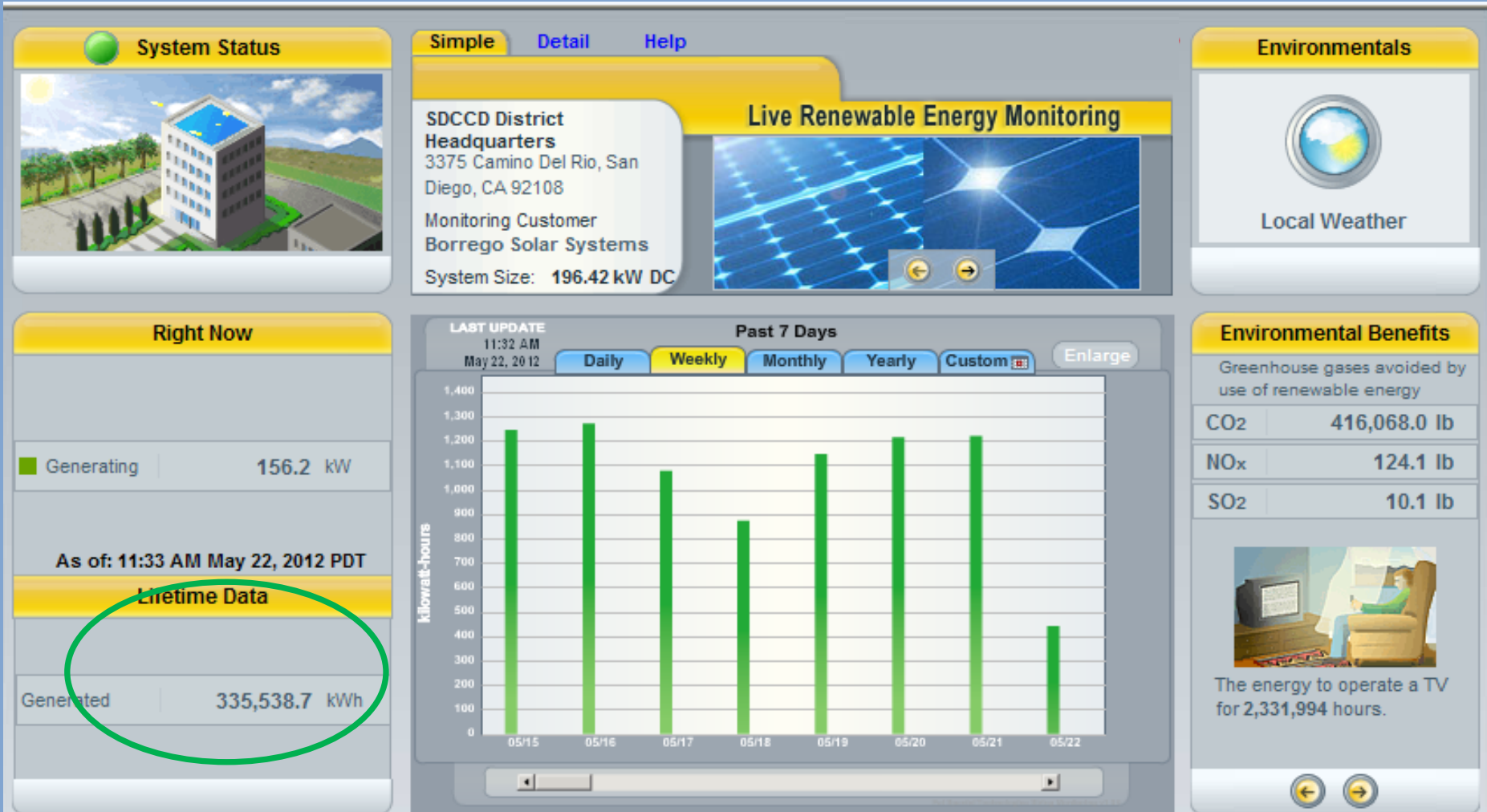


# San Diego Community College District Monitoring the District Offices – Thermal Comfort



# San Diego Community College District Solar PV Power Production Dashboards

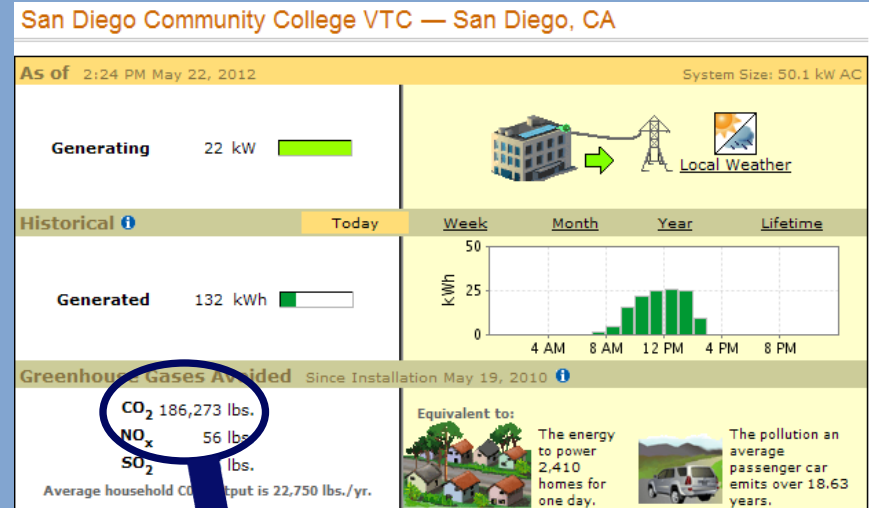
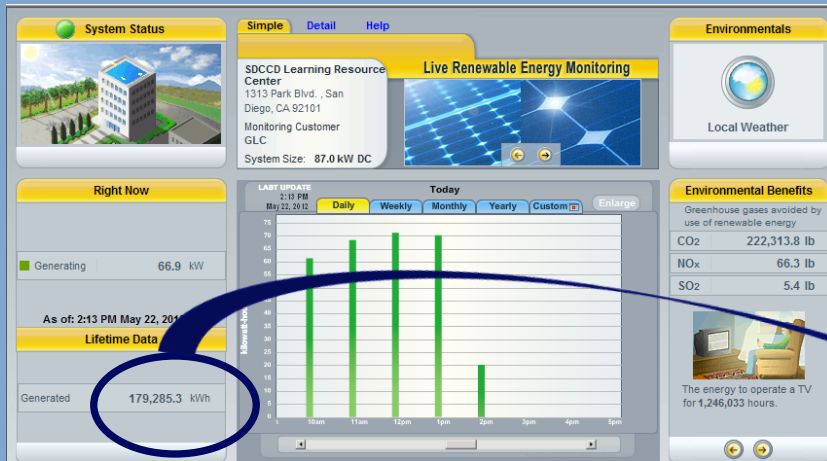
## SDCCD District Headquarters



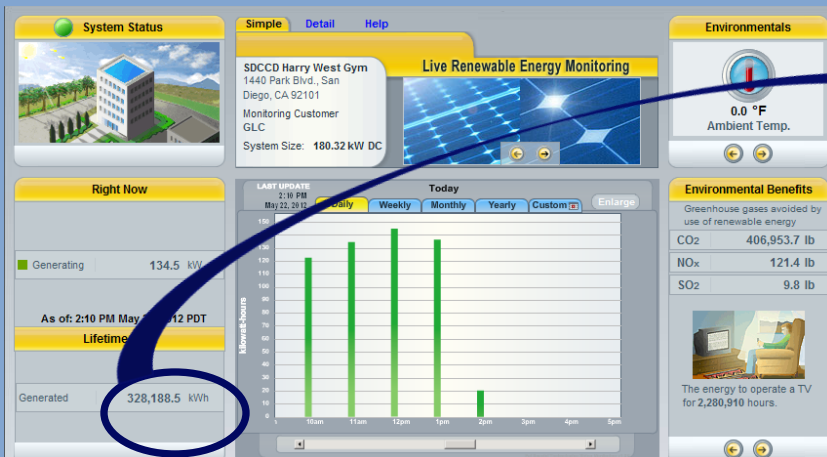


# San Diego Community College District Solar PV Power Production Dashboards

## City College



## Learning Resource Center



## Career Technology Center

**More than  
658,000 combined  
kWh generated to date –  
the equivalent of  
CO<sub>2</sub> emissions from burning  
50,843 gallons of gas**

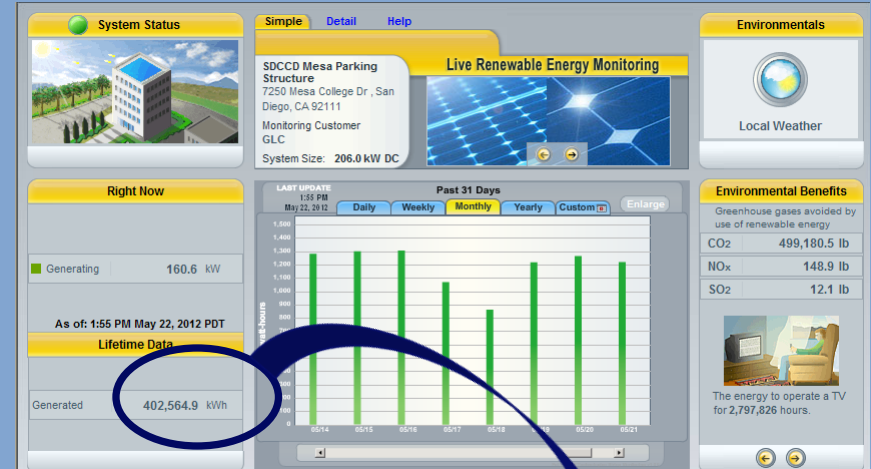
## Harry West Gym

# San Diego Community College District Solar PV Power Production Dashboards

## Mesa College



Parking Lot #1



Parking Structure

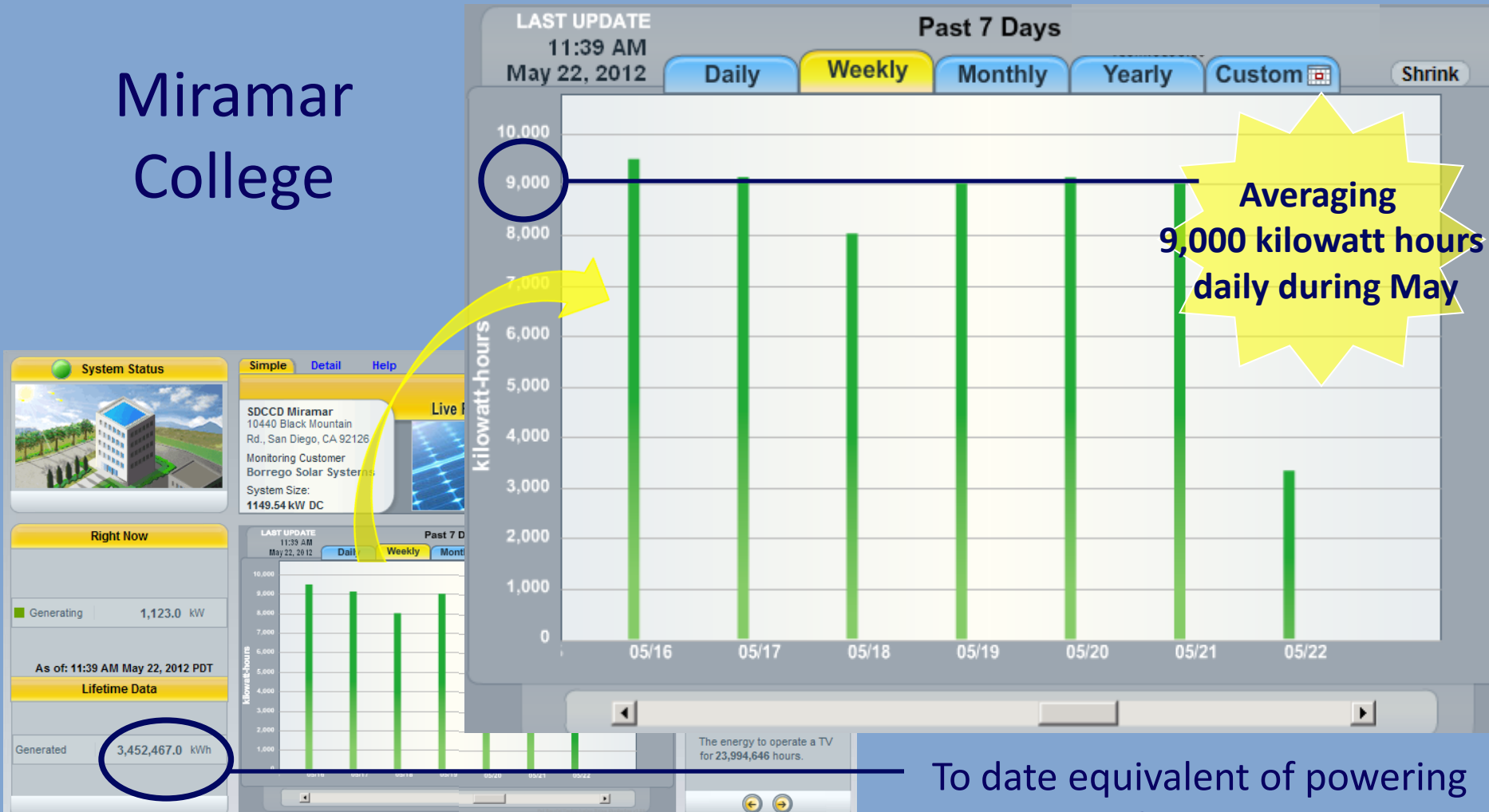


Parking Lot #2

**More than  
2.1 million combined  
kWh generated to date –  
the equivalent of  
1,453 metric tons  
of CO<sub>2</sub>**

# San Diego Community College District Solar PV Power Production Dashboards

## Miramar College



To date equivalent of powering  
297 homes for one year

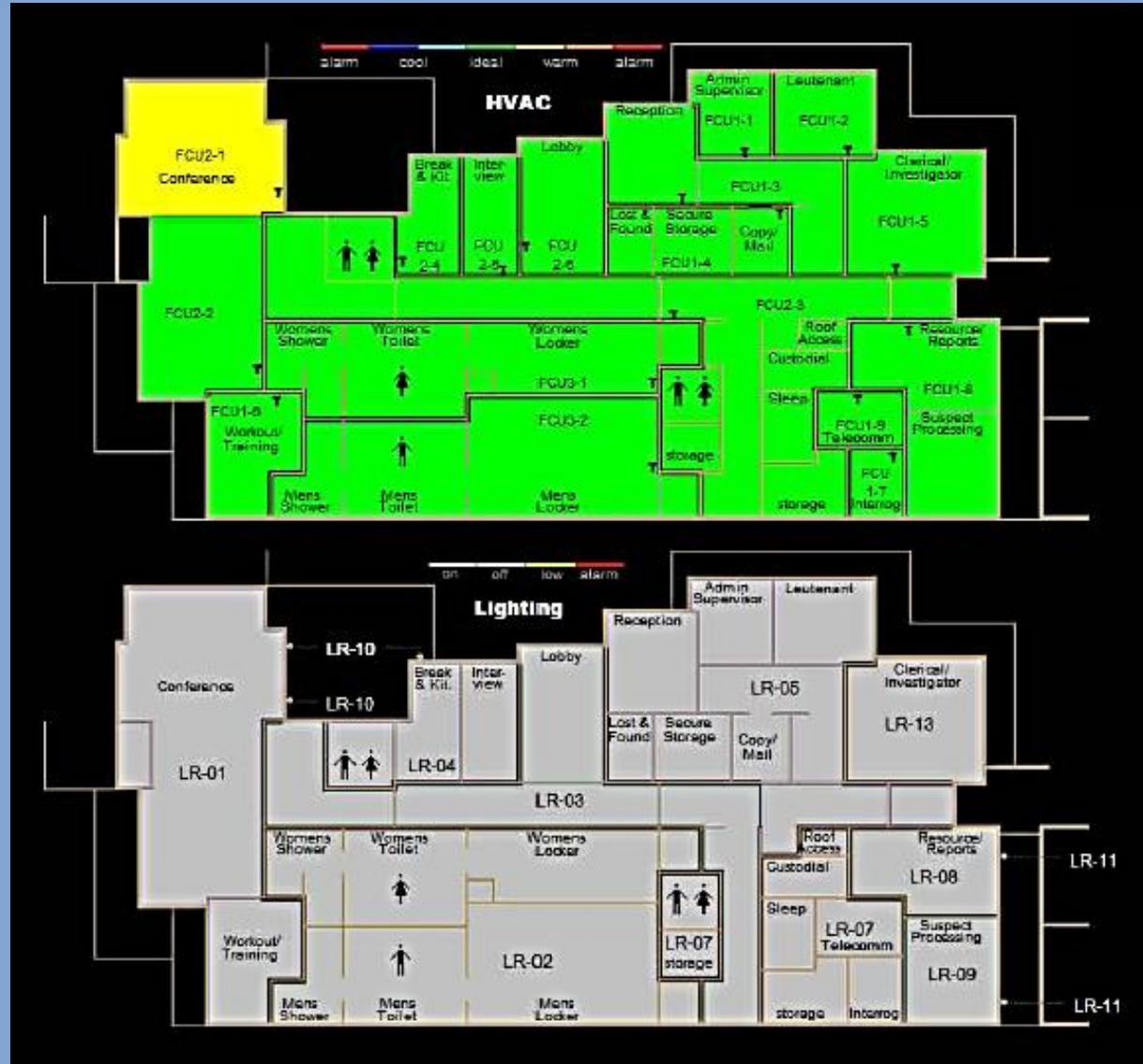


# San Diego Community College District

## Energy Dashboard - Miramar Police Station



- Overview
- Building Status
- HVAC
- Solar Chimney
- Indoor Air Quality
- Plumbing
- Power
- Lighting
- Site/Landscape
- Construction
- Green Innovations
- Weather
- Aerial Map



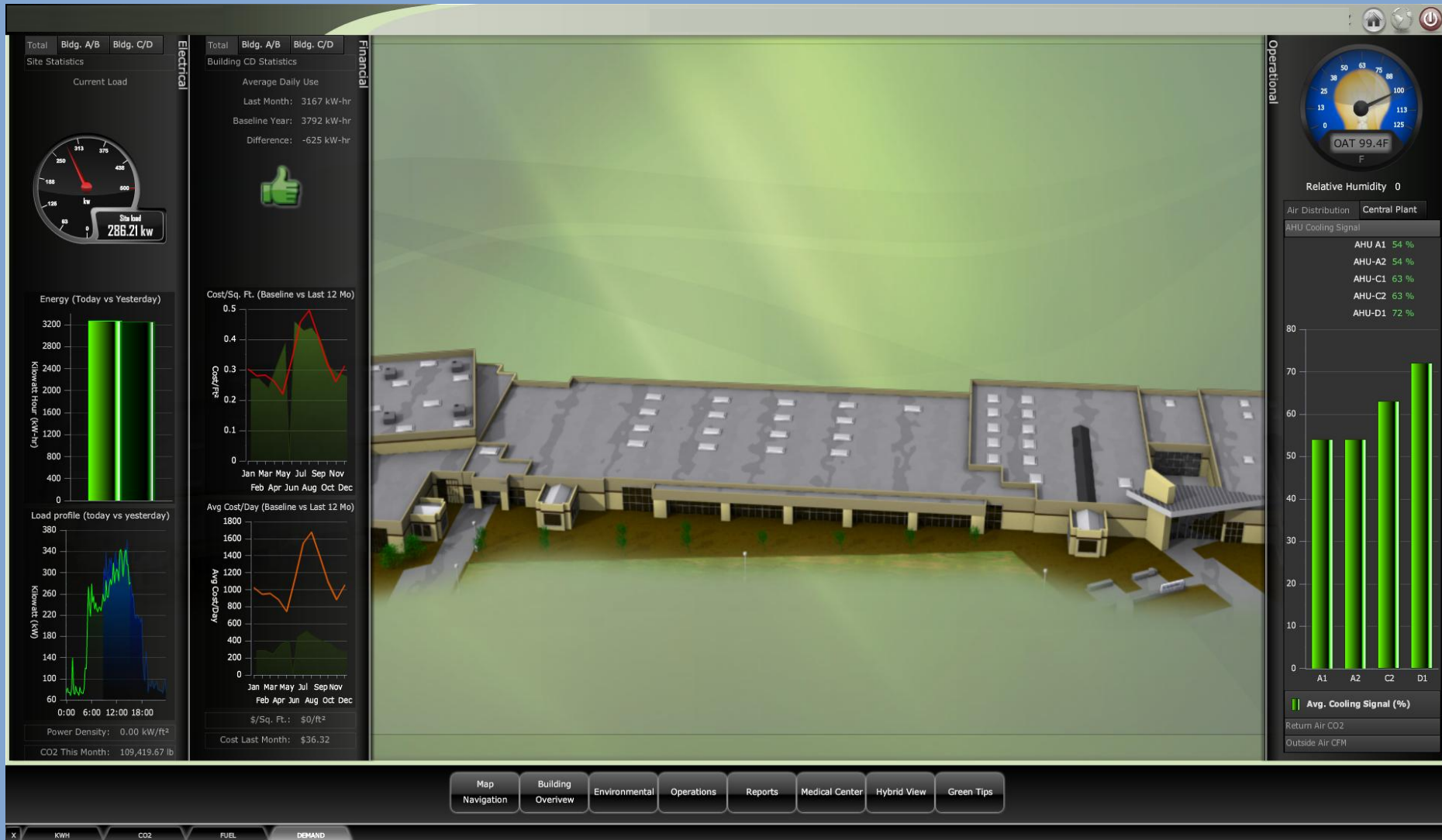
# Major elements of campus dashboards

- Total kW instantaneous by:
  - ✓ Plug load
  - ✓ Motor load
  - ✓ Lighting load
  - ✓ Equipment load
- Total kWh consumed/produced daily
- Total MBtu/Sq. Ft.
- % kWh from renewable resources
- \$\$ for energy conserved



# San Diego Community College District

## What might these dashboards look like?





# San Diego Community College District

## What might these dashboards look like?

### Average Daily Use

69975 kW-hr

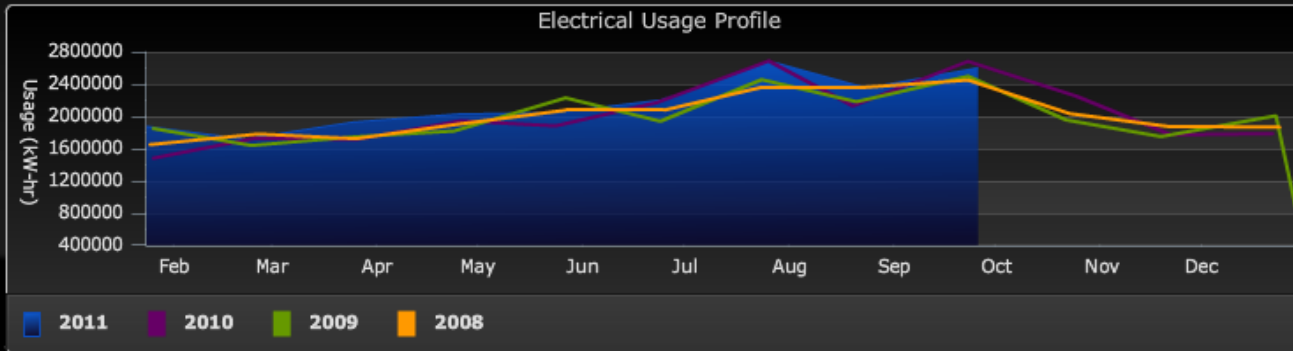
Last Year

68310 kW-hr

Yesterday

-1665 kW-hr

Differential



### Demand

3286 kW

This Month Last Year

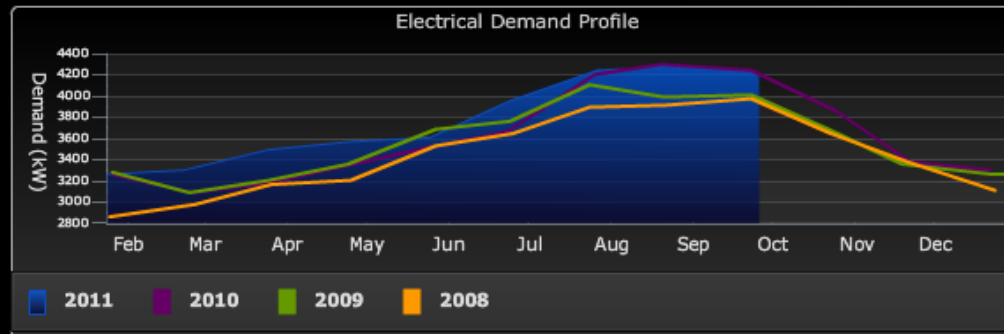
3440 kW

Max Last Month

3328 kW

Max This Month

Current Demand (kW)



Energy used last month is equivalent to:



# San Diego Community College District

## What might these dashboards look like?

Residential Electricity Use Interactive Map



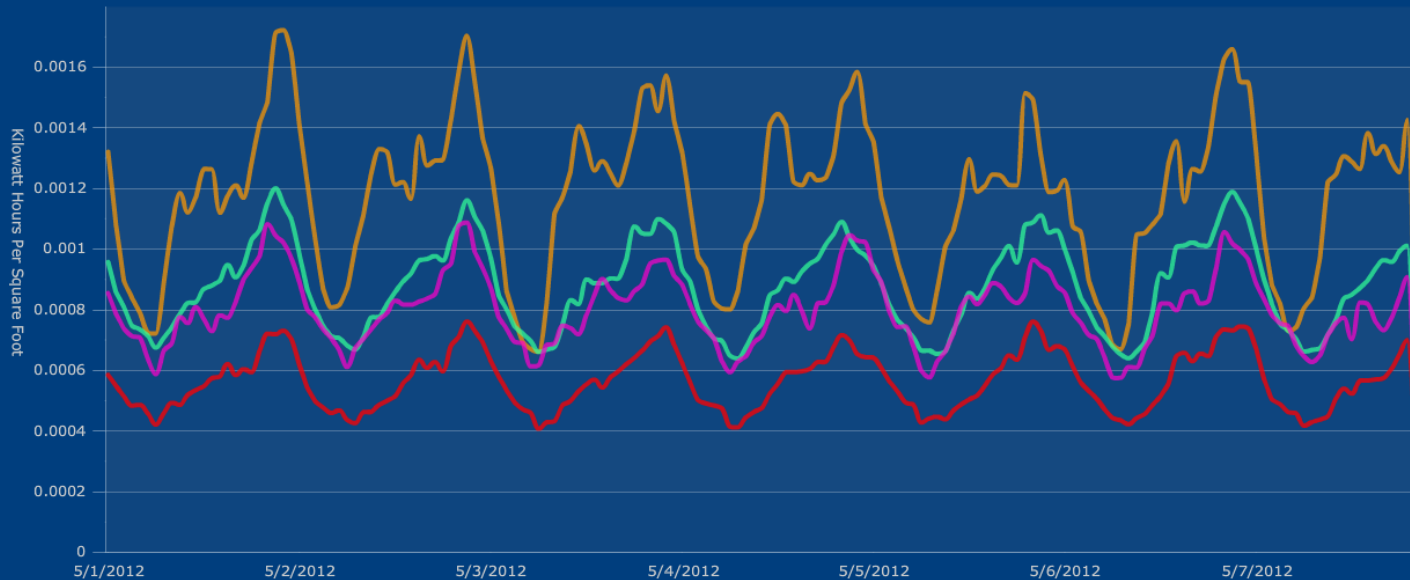
### Courtyard Communities

kWh per Person

kWh per Ft<sup>2</sup>

kWh

kW



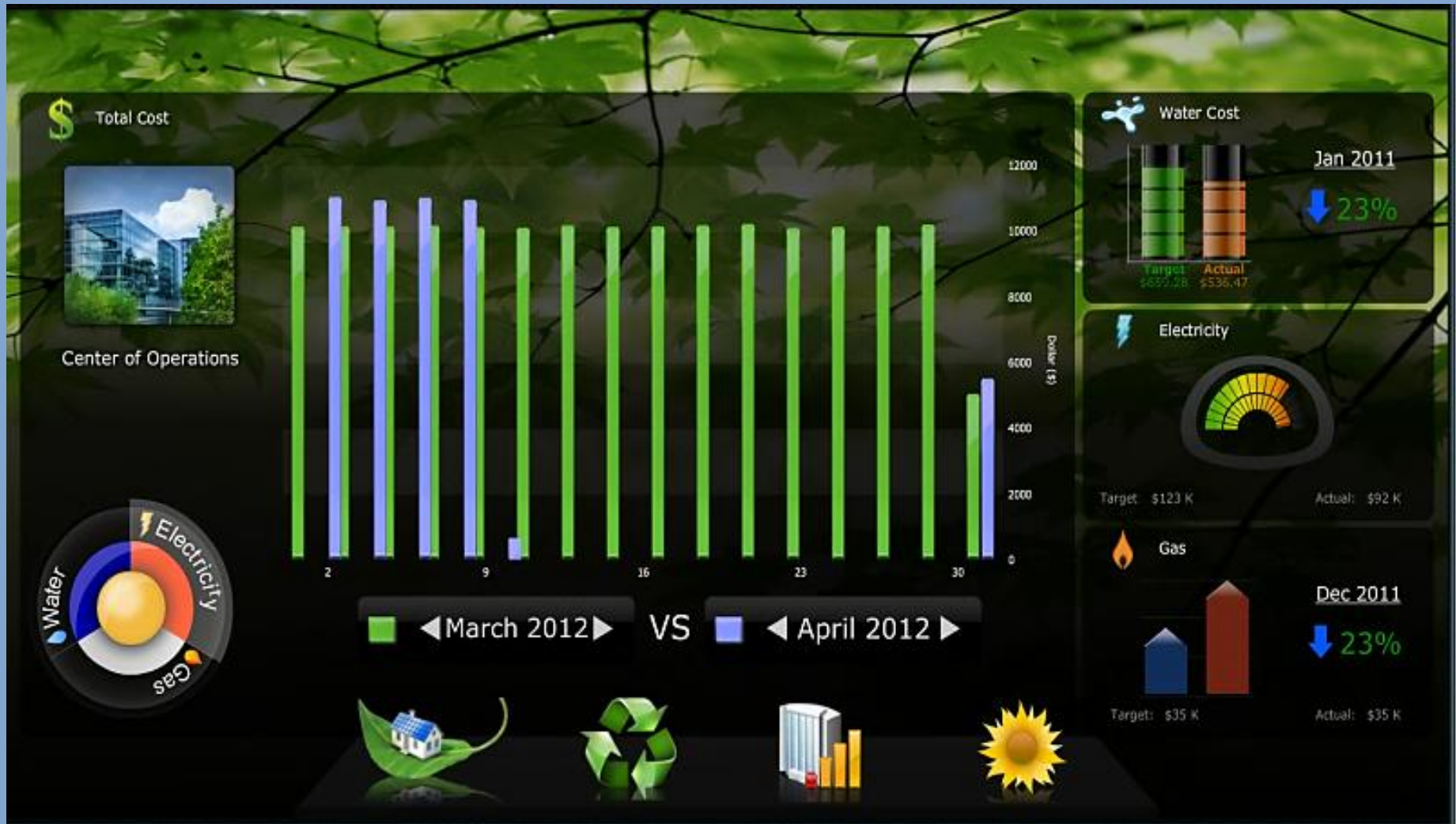
Gillenwater Hall McDonald Hall Raymond Hall Roseberry Hall

Family Housing  
Luxury Apartments  
Courtyard Communities  
Suite Style Halls  
Traditional Halls  
Alarms  
Histories

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# San Diego Community College District

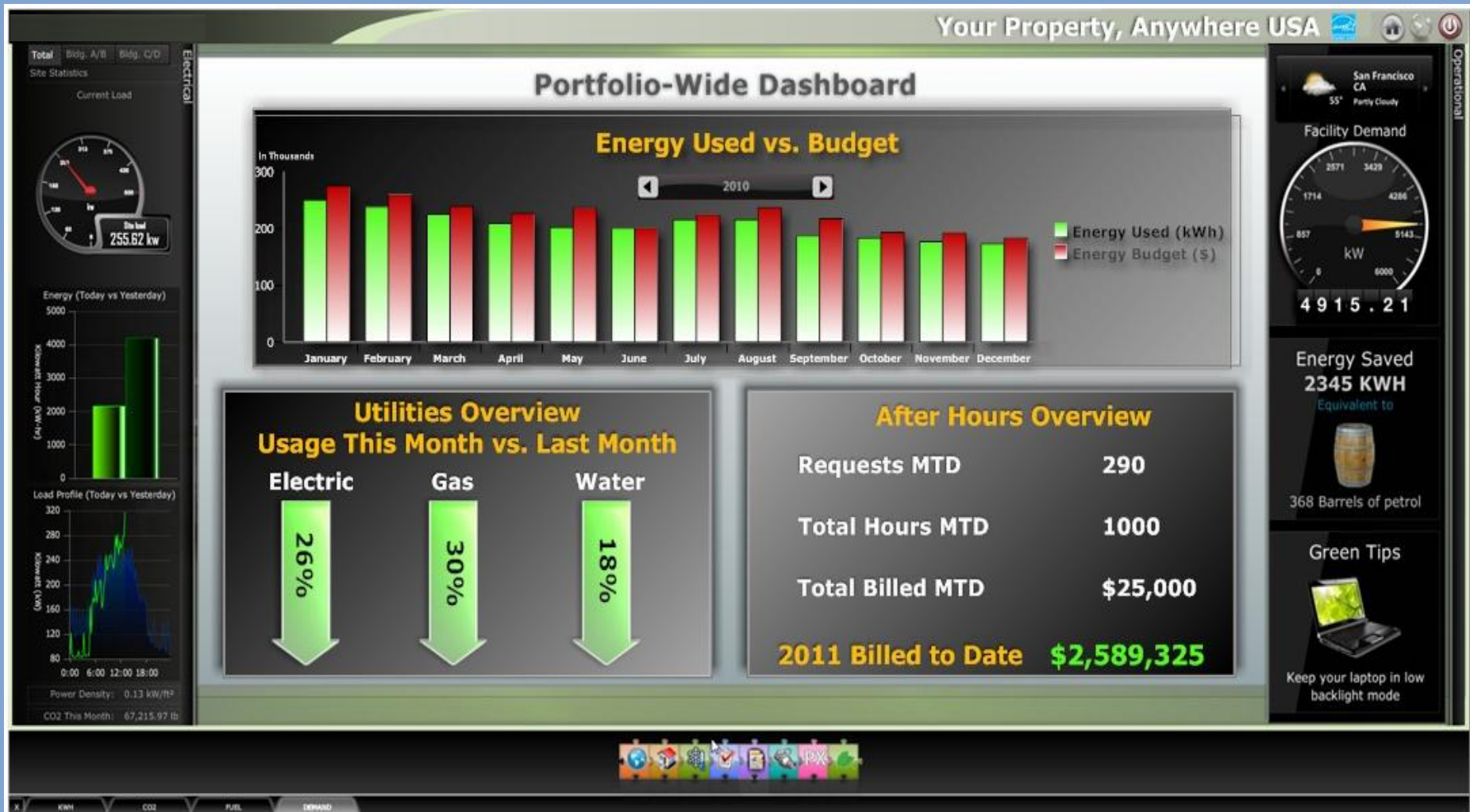
## What might these dashboards look like?





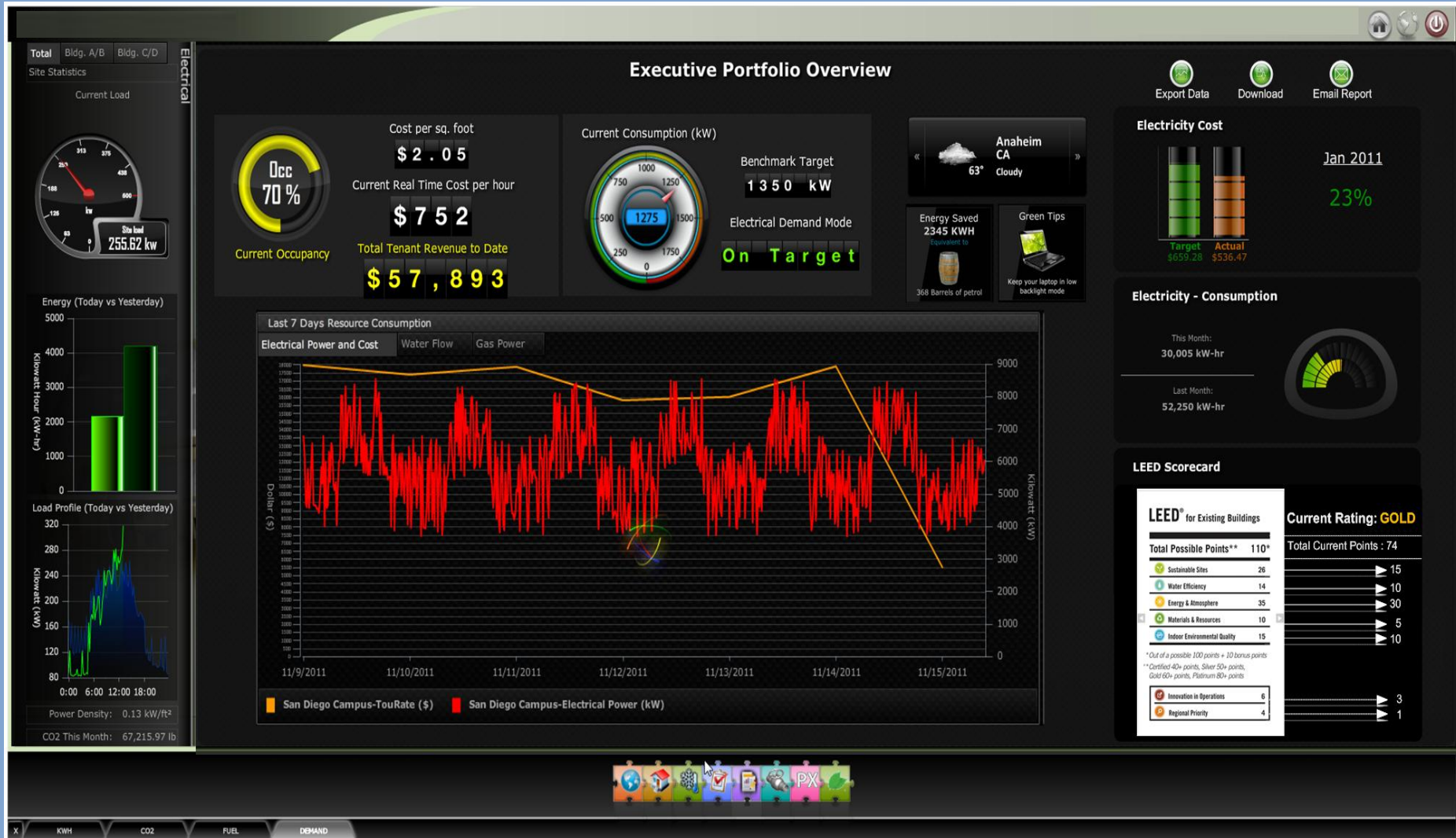
# San Diego Community College District

## What might these dashboards look like?



# San Diego Community College District

## What might these dashboards look like?



# Questions?

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