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AABC Commissioning Group

AIA Provider Number 50111116



# Top Operational and Energy Saving Trends for Data Center Cooling

Course Number: CXENERGY1806



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***United Technologies Corporation***

April 25, 2018

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# Course Description

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Data center operators historically focused on IT infrastructure and management systems to lower CAPEX and OPEX while meeting SLAs for scalability and time-to-market. Operators are now turning to critical infrastructure technologies to potentially extend these gains further. This presentation will highlight the advances made in critical infrastructure technologies for chillers and cooling plants, AHUs, and modular approaches to achieve significant operating and energy expense savings.

# Learning Objectives

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At the end of the this course, participants will be able to:

1. Expand knowledge of advances in data center cooling systems.
2. Broaden understanding for utilizing data center waste heat.
3. Gain insight into the latest advances in modular data center cooling opportunities.
4. Gain insight into the energy expense savings using the modular data center cooling opportunities.



# TOP OPERATIONAL AND ENERGY SAVING TRENDS FOR DATA CENTER COOLING



**United  
Technologies**

**Brad Nacke**

Enterprise Account Leader – Data Centers

# Topics

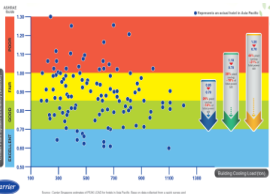
- Advances in Cooling Technologies
- Retrofit and Upgrades Choices
- Success Stories
- Digital Transformation
- Q&A



# Chiller Plant Modernization Solutions

## Assessments

Where are you?



Benchmark

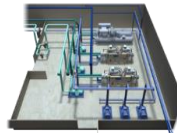
Chiller Plant  
Energy Optimization



Evaluate controls

## Modernization

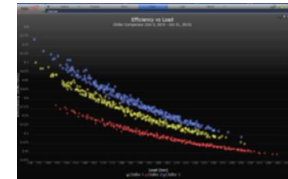
Chiller Plant  
Equipment & Controls



Complete retrofit

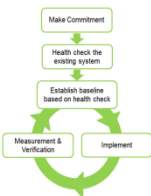
## Services

Chiller Plant Health Management



Ensure high availability,  
lowest OpEx

Chiller Plant Health Check



Baseline health status

CapEx Optimization



Ensure highest ROI for  
investment

Phased Equipment  
Replacement:



- chillers
- pumps
- towers

Modular replacement

Carrier Smart Service



Remote monitoring service



# Technology Advances in Chiller Performance

## Technology Contribution to Cost Savings\*

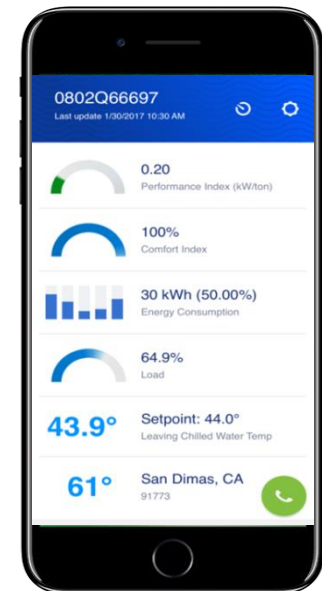
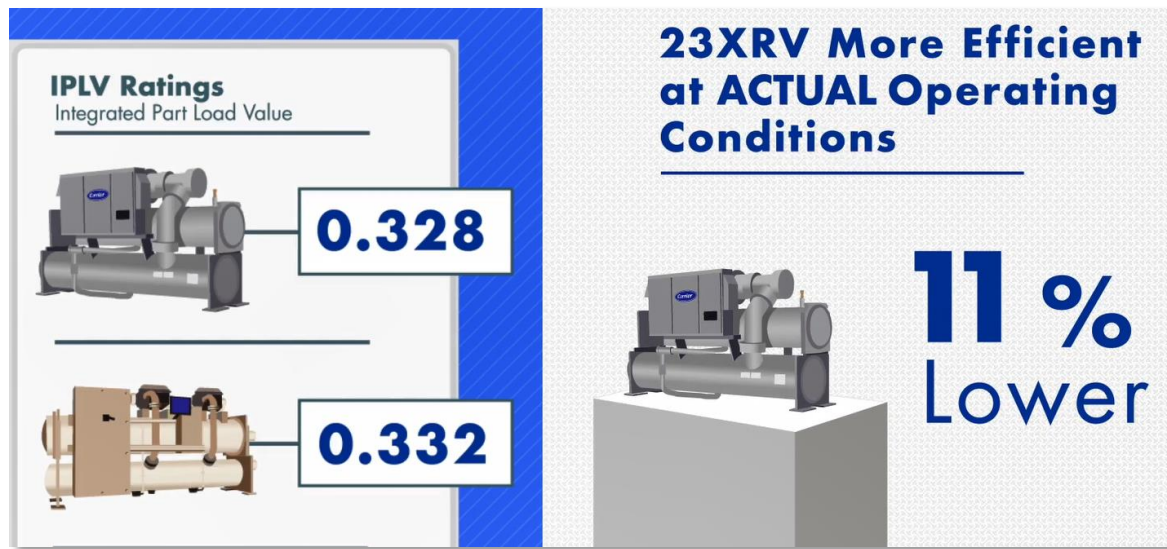
- Energy efficiency
- CapEx/OpEx
- Performance

## Rapid Start

- Restart as a result of an event
- Capacity Recovery vs. Initial Start Time

## Smart Service

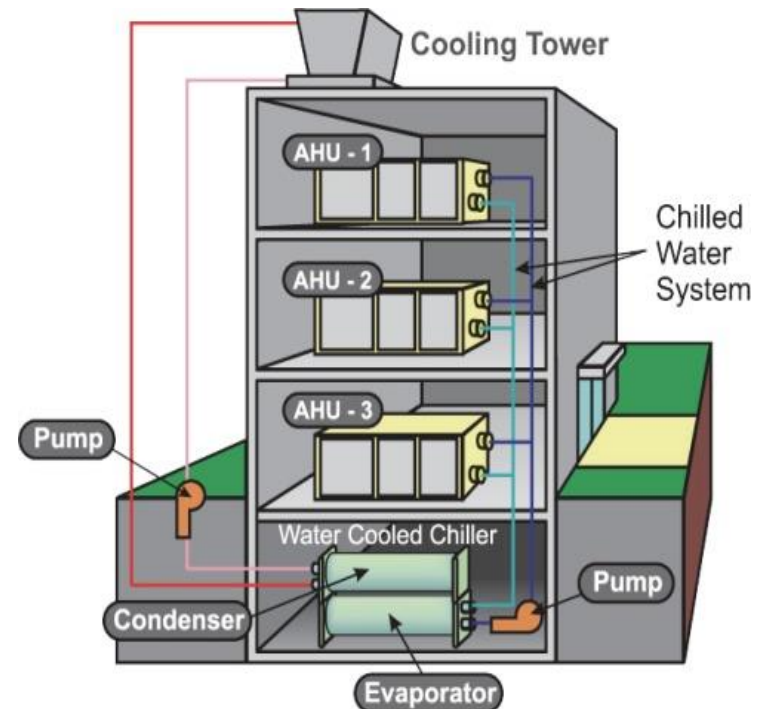
- Remote monitoring of chiller performance
- Fault detection and diagnostics
- Predictive diagnostics
- Customer app for equipment status and service requests
- Improved MTTR



\*US General Services Administration (GSA) whitepaper released Nov. 2017

# Chilled Water System Optimization

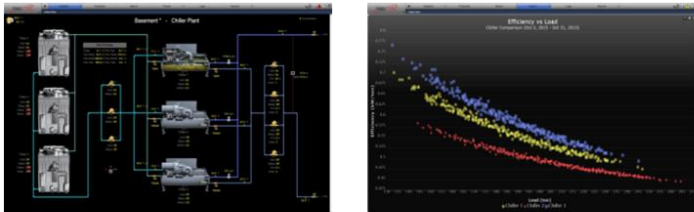
- Holistic approach to chilled water system optimization—considers the energy use of the entire chilled water system, both supply and consumption
- The algorithm automatically adapts to changes in environmental and system conditions over time—working with the mechanical system you have today
- A scalable solution that optimizes the chilled water system alone, the condenser water system alone, or both—with potential energy savings ranging from 3 to 15% based on field tests and simulations



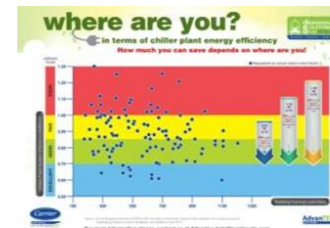
Organizations are yet to realize cost efficiencies from chiller plant optimization

# Chiller Plant Health Manager

- Consolidates performance data into a single, web-accessible monitoring platform, providing the ability to quickly evaluate plant performance
- Chiller plant agnostic
- Expands from a single device to provide rule-based fault diagnostics and detection (FDD) for the entire system
- Field tested with a **10% net energy savings**



Energy consumption, equipment running status, system energy efficiency and load demand visualization.



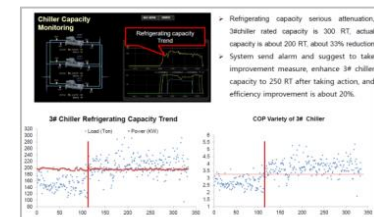
Energy consumption and system efficiency level benchmarking, to understand where are you and build internal database on chiller plant operation.



Identify energy saving opportunity including changing operational behavior, applying optimized control system, improving equipment performance.



Chiller plant data analysis & diagnostics, generate alarm, estimate energy waste, provide recommendation to improve operation.



# Modular Chillers and AHUs

## Rental, Lease, Lease to Own, Purchase or Cooling-as-a-Service

- Fast, repetitive, modular deployment
- Permanent, temporary or supplemental
- Significant savings
  - Shift from CAPEX to OPEX
  - Supports phased new builds to reduce capital spend
  - Supports phased upgrades and retrofits
- Re-tool infrastructure when you update IT equipment
- Supports modular data center concepts
- Complete units – integrated cooling, pump packages, controls



Chiller



Air Conditioner



Cooling Tower



Standard AHU



800 kW Generator



High Volume AHU



# Retrofit and Upgrades



- Wheel the compact chiller through tight spaces
- Link up to **eight units**
- Customized cooling capacity **up to 500 tons**



Container Ready



Knock Down Construction



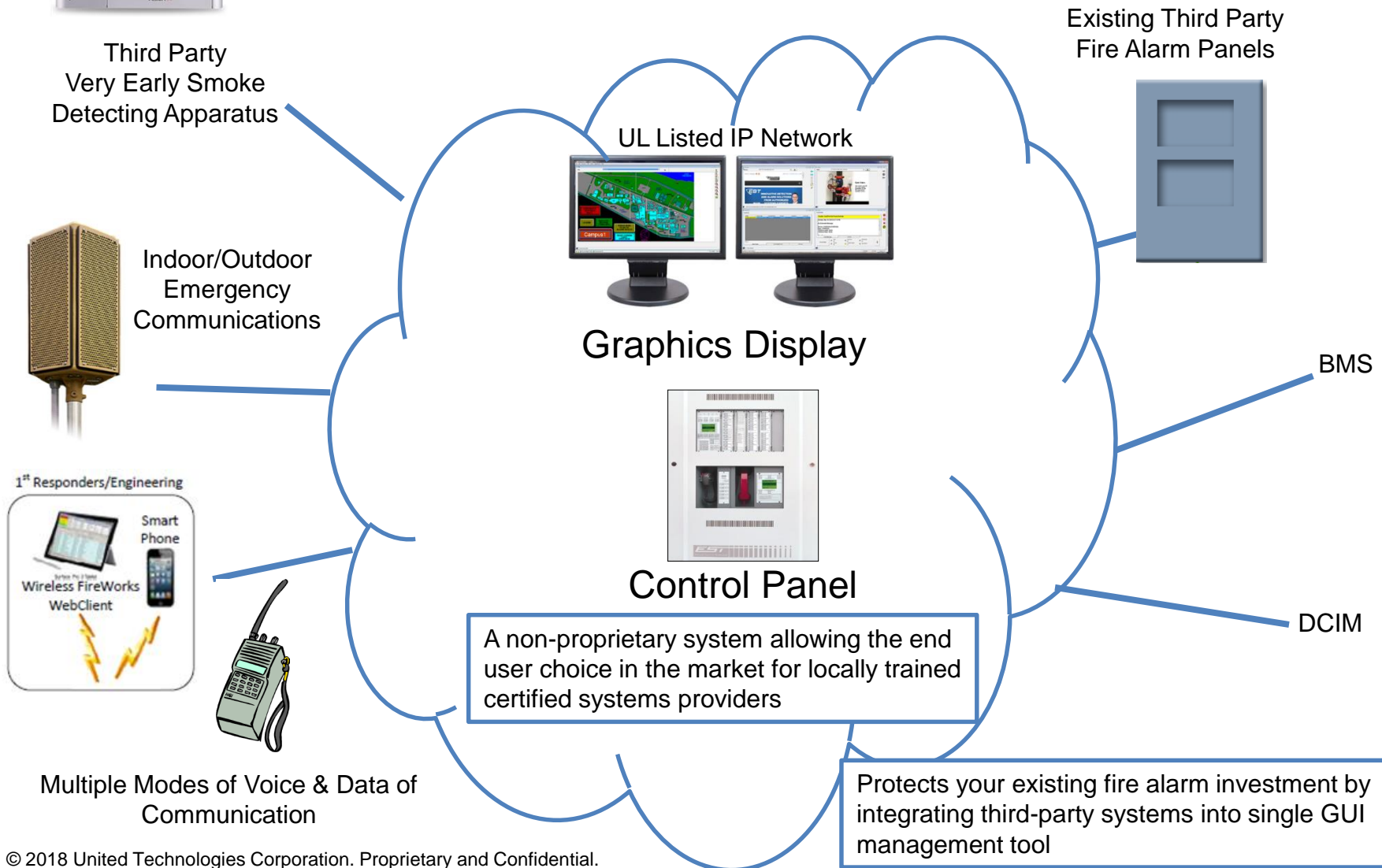
Knock Down Reassembly

# Prepare Your Data Center for the Unexpected



# Retrofits and Upgrades: Fire Safety

Integrated systems provide a platform and infrastructure to manage notification and communication to protect people, property and assets





# Fire Protection: Protecting Your Cloud With Mist



Water Mist Fire Protection



## 21<sup>st</sup> century fire protection for mission-critical facilities

- Fire protection on the total facility with one system
- Proving operational 24/7/365 protection
- Fire protection with minimal disruption and minimal damage with local activation only
- Pre-action dry areas
- Able to provide reporting and monitored by the fire alarm and BMS





# Success Story: Hybrid Cooling Solution

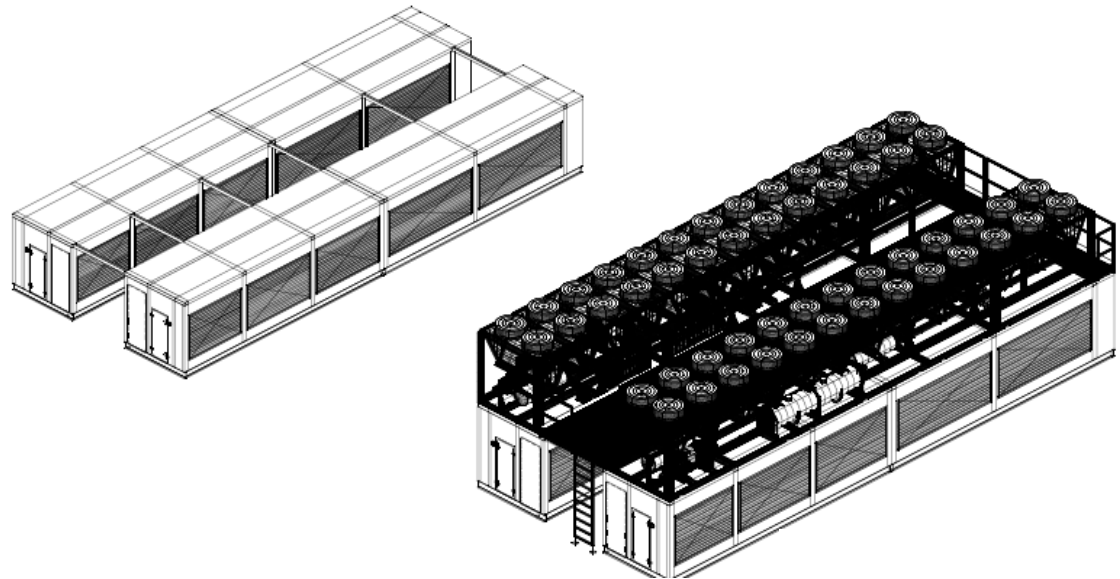
Design for High Power Density Hyperscale environments,  
achieving reduced average PUE

## Project Objectives

- Reduce cooling square footage to match higher server rack density
- Average PUE below 1.4 w/o using water cooled chillers

## Carrier Accomplishments

- Average PUE of 1.158 with Air Cooled Chiller and 1.089 with waterside economization
- Air Cooled Chiller square footage matches the Server Rack density



Customization, Modularity, High Efficiency

# Success Story: High Power Density Rack Solution

Data **COMPLETE**

## HYBRID CO<sub>2</sub> HIGH DENSITY, HIGH EFFICIENCY RACK COOLING

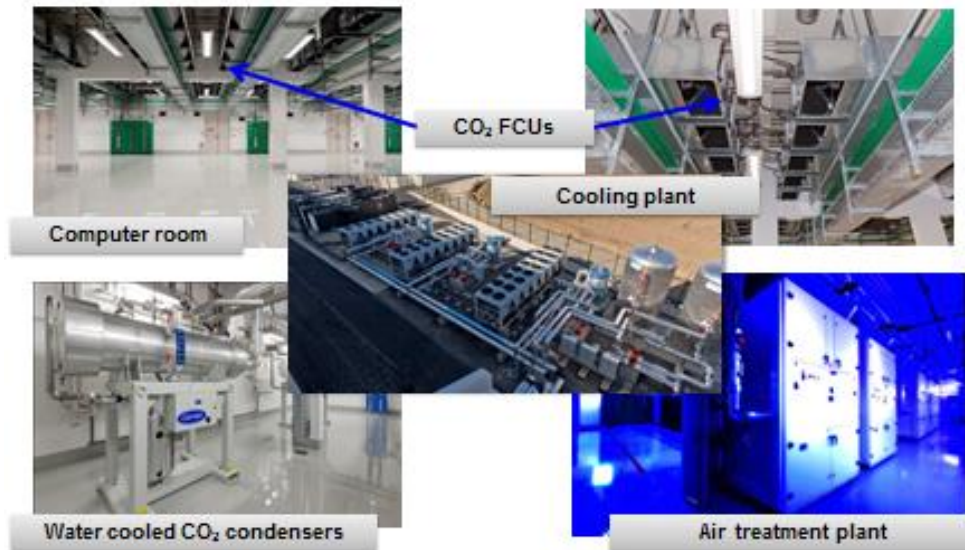
### THE CHALLENGES



**Increase power density,  
flexibility and reliability**

- 1.5kW/m<sup>2</sup> to 3kW/m<sup>2</sup>
- Reduce HFC usage
- Optimize energy use
- Eliminate water in IT room

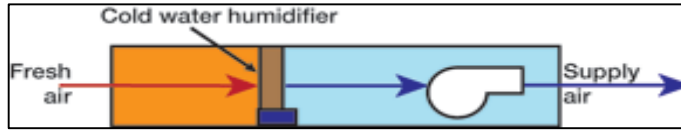
### THE SOLUTION



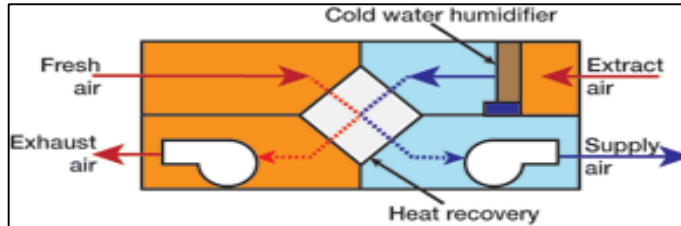
- **Improve system redundancy**
- **Eliminate hotspots**
- **Obtain 10% additional energy savings**

# Success Story: Custom Air Handler

Direct evaporative - DEC



Indirect Evaporative  
IDEC

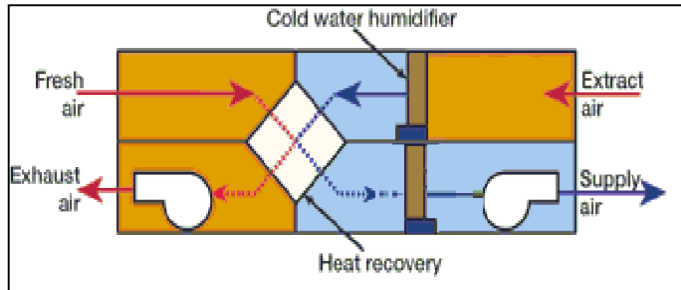


**Locale & Customer Preference**

Sensible cooling & humidification

Sensible cooling only

2 stage Indirect  
Evaporative  
IDEC



1 Stage of sensible cooling + 1 stage of sensible cooling & humidification

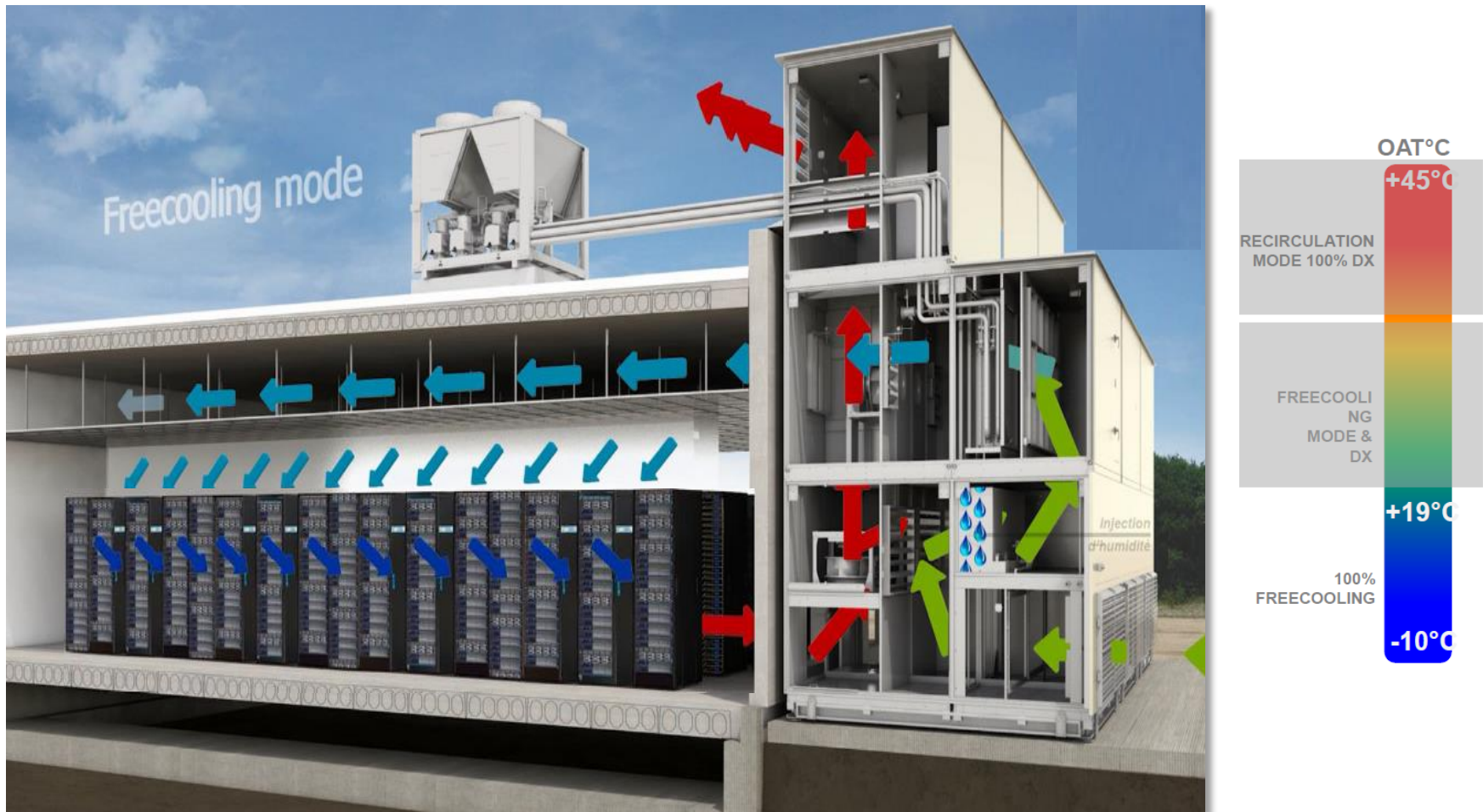
Direct/Indirect Evaporative Cooling





# Success Story: Modular Solution with Free Cooling

## Custom Air Handling Unit, Condensing Unit and Controls

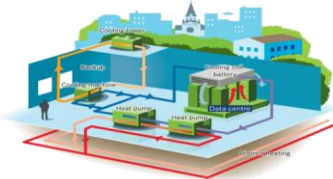


In Paris, based on a 2750kW full load, year-round performance of 10.8 EER

# Success Story: Data Centers and District Heating

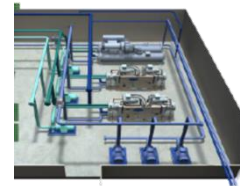
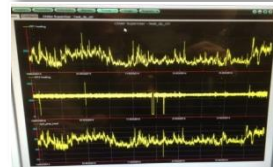
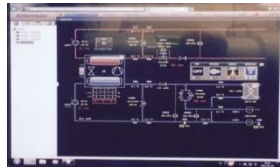
Smart urbanization – data center heat recycled and reused

## OPTIMIZED HEAT RECOVERY



HEAT RECOVERY  
(Data center, industrial  
processes, etc.)

## AdvanTEC EXPERTISE & BENEFITS



HYDRONIC SYSTEM  
ANALYSIS & ENERGY  
OPTIMIZATION

## APPLICATIONS

- Aid municipalities and local utilities with **waste heat recovery and reuse**
- Supply district heating with **high temperature heat pumps and relevant technology services**
- Helps companies reduce emissions, meet energy reduction targets and **green objectives**

## INTEGRATION SOLUTIONS

## ENERGY SAVINGS

## SMARTER URBANIZATION

# Intelligent Building Design

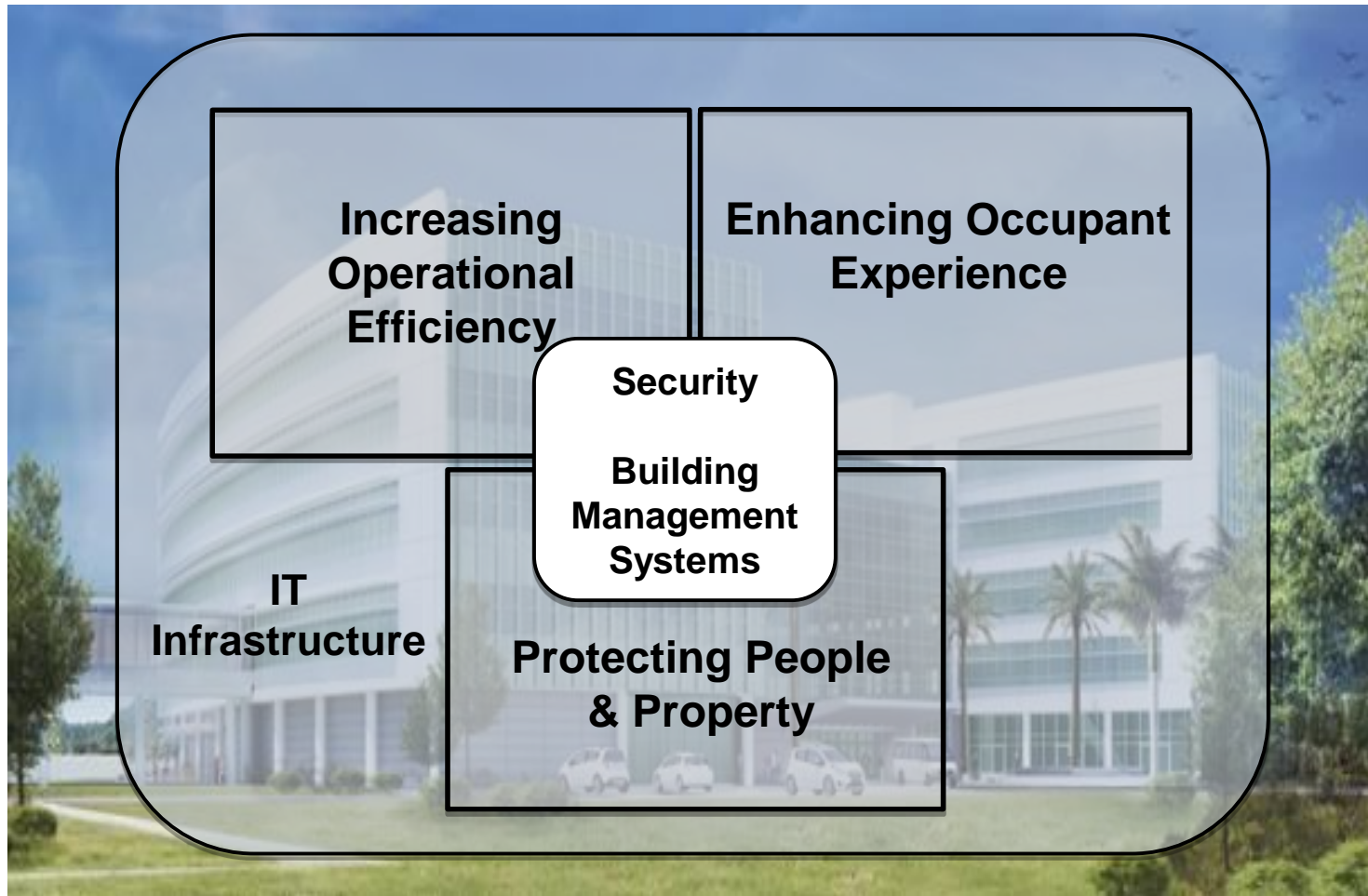


Digitally integrated, state-of-the-art headquarters office, conference center, and customer showcase

- 224,000 square-foot facility on 30 acres
- 600+ employees, up to 500 conference center attendees
- Being developed to the U.S. Green Building Council's LEED® Platinum standard
- Designed to allow up to 28% power supplied by onsite PV
- Showcase for a smart, high performance multi-use building



# Intelligent Building Solutions



# Energy Efficiency

## High Efficiency Equipment



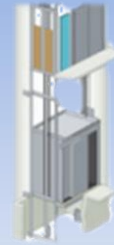
Efficient Variable  
Speed Chillers



LED Lighting  
Systems



Variable Refrigerant  
Flow Technology



Regenerative  
Elevators



## Controls and Integrated Solutions



Integrated Building  
System Controls



Advanced Plant  
Control Algorithms



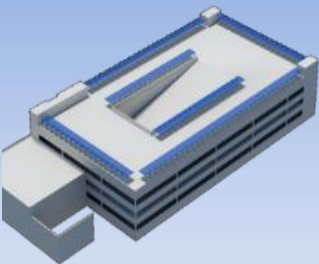
Occupant Detection  
and Response



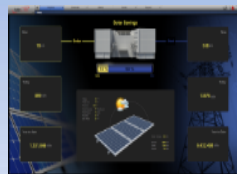
Traffic Dispatching  
Optimization



## Smart Grid



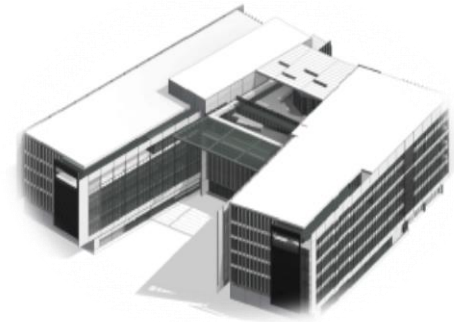
Onsite Solar  
Generation



Net Metering & Real  
Time Monitoring



Utility Demand  
Response



**50%**  
less annual energy  
costs than a  
standard office  
building

ASHRAE 90.1-2010  
Appendix G



# Operational Efficiency

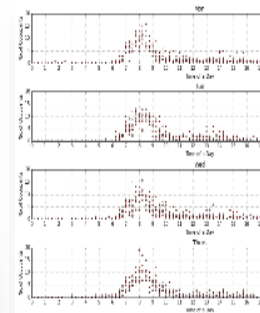
## Solutions

- Series-counter-flow chiller plant controls
- Chiller plant and HVAC airside fault detection and diagnostics
- Demand controlled ventilation
- Conference room schedule integration for HVAC
- Occupancy based HVAC schedule optimization
- Building energy monitoring & controls
- Demand response load-shedding controls

**Collect  
Occupancy  
Data**



**Trend, Analyze  
and Predict**

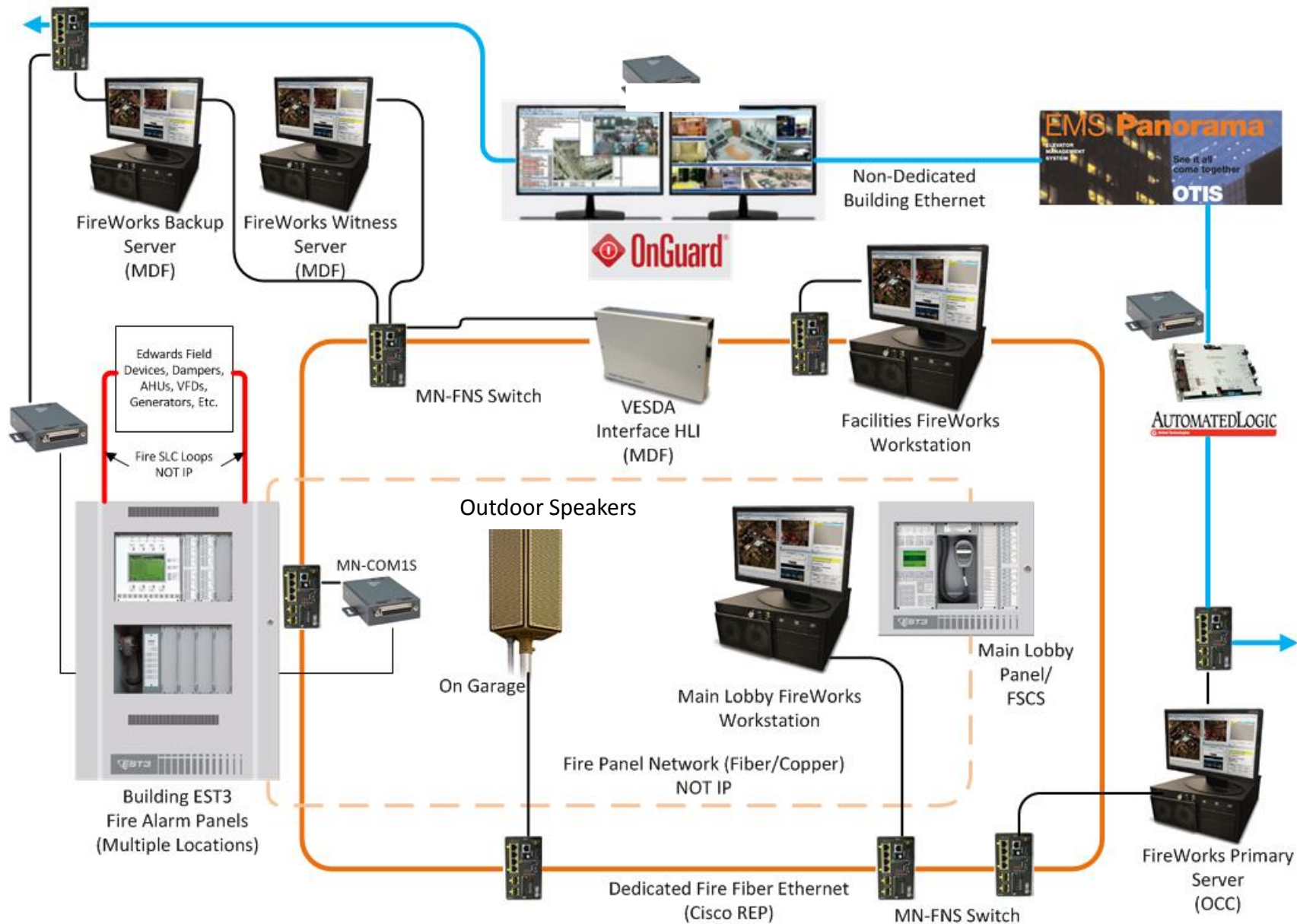


**Automatically Adjust  
HVAC Schedules**

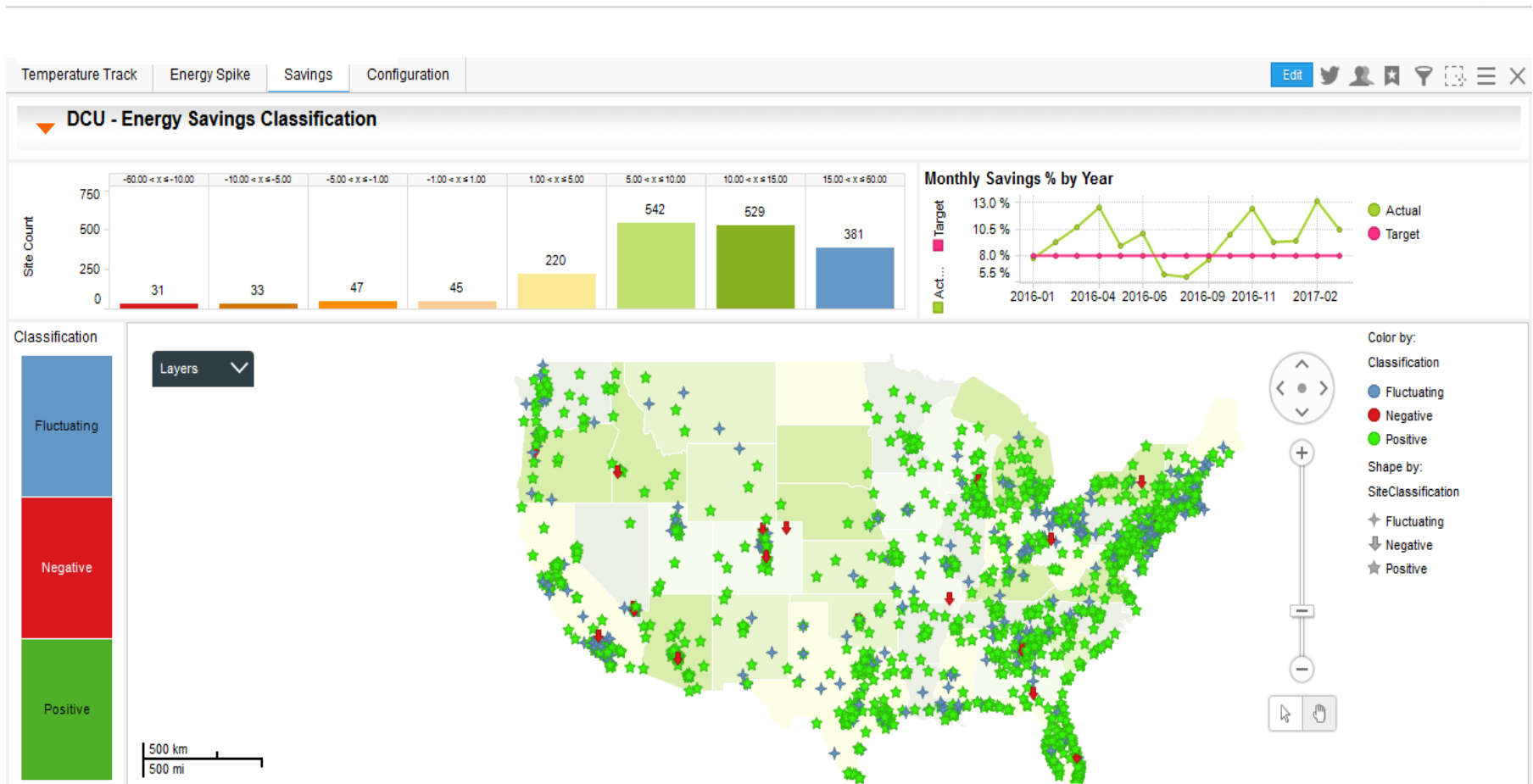


Our HVAC controls learn and adapt to how the building is actually used – saving energy while maintaining optimum comfort

# Cross-Platform Integration Example



# Intelligent Buildings: Energy Savings Summary



IoT data provides an enterprise view

# Data-Driven Financial and ROI Modeling

- Meet energy efficiency and sustainability goals
- Infrastructure modernization
- Lower energy and operating cost
- Reduce deferred maintenance burden
- System reliability and redundancy
- Reduced carbon footprint
- Potential for rebates and grants

Option B		Jackson Graham	System Maintenance	Landover Bus Garage	Carmen Turner Facility	Shady Grove						
1	Lighting Upgrades & Controls	✓	✓	✓	✓	✓						
2	Domestic Water Conservation	✓	✓	✓	✓	✓						
3	EMCS Upgrades	✓	✓	✓	✓	✓						
4	Chilled Water Plant Revitalization	✓										
4A	Chiller Replacement	✓										
4B	Cooling Tower Replacement	✓										
4C	Chilled Water Pump VFDs	✓										
5	AHU Upgrades											
5A	Replace Heat Recovery Units			✓								
5B	Replace Rooftop DX Units			✓								
5C	Variable Speed Drives on AHUs	✓										
6	Waste Oil Boiler			✓								
7	High Efficiency Boilers			•	•							
8	High Speed Fabric Doors		✓									
9	Photovoltaic Array	•				✓						
10	Utility Monitoring System	✓	✓	✓	✓	✓						
11	MetroSave	✓	✓	✓	✓	✓						

Capitalize Construction Interest? ☒ Yes    Interest Rate: 4.13%    Term: 10    Escalation: 2.75%

<==Press    ☐ Standard Payments    ☒ Stepped Payments

Total Project Cost	\$7,460,709
Rebates	\$0
Interest on Financing	-\$2,422,547
Total Cost over 10 Years	\$5,038,162
Lease Payments	\$5,038,162
Service Payments	\$59,559
Total Payments	\$5,097,720
First Year Savings	\$792,118
Total 10 Year Savings	\$8,976,890
10 Yr Net Cash Flow	\$3,879,170

Our software enables the customization of project scope to meet business objectives

This concludes The American Institute of  
Architects Continuing Education Systems Course



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