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Prioritizing Persistence: Approaches and Technologies that Enable Lasting Results

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AIA Quality Assurance

Learning Objectives

1. To develop a framework to understand the features and capabilities of Energy Information Systems (EIS)
2. To understand overall trends and state of the technology
3. To understand real-world uses of EIS in the commercial sector

AIA Quality Assurance

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Outline

- EIS definition and research scope
- EIS characterization framework
- Commercial EIS evaluations
- UC Merced case study highlights
- Conclusions
- Future work

EIS Definition

EIS comprise

- Software, data acq. hardware, and communication systems
  - To collect, analyze and display building energy information

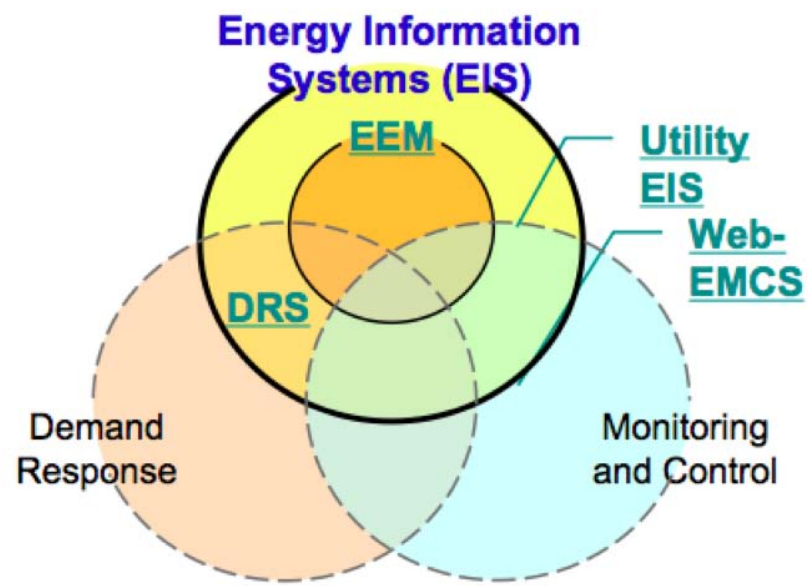
EIS provide

- Web-accessible hourly whole-building electric data
- Analytical and graphical capabilities
- Processed data, i.e., weather, energy price signals, and demand response (DR) information

EIS Definition

Four general types of EIS

1. Utility EIS
2. DR systems,
3. Web-based EMCS
4. Enterprise energy management (EEM) tools

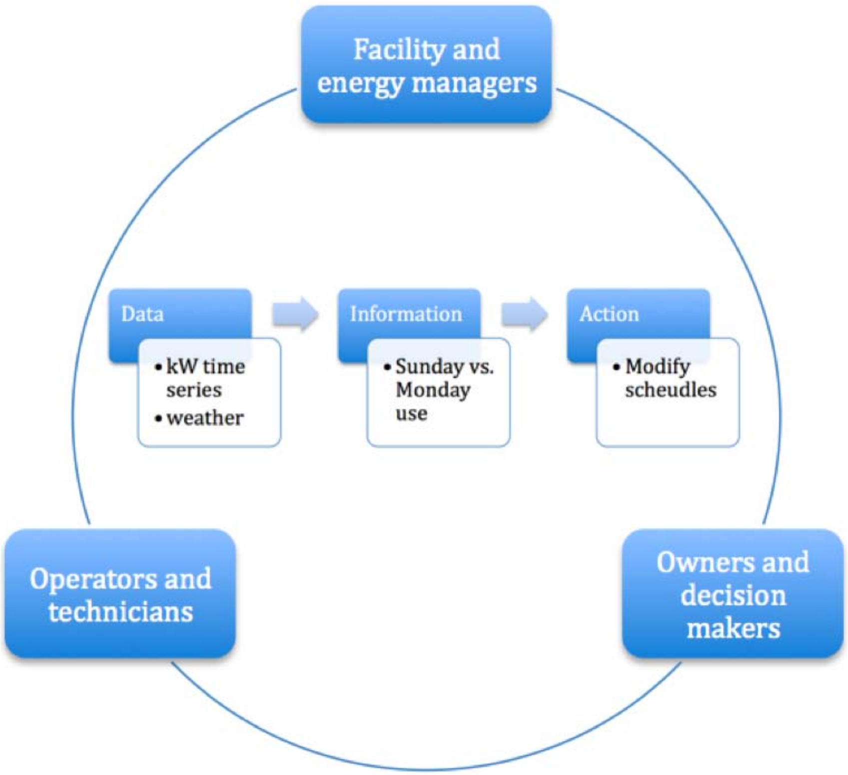


EIS are NOT

- Most EMCS and equipment FDD
- Energy information dashboards
- Batch analysis tools
- GHG footprint calculators

EIS Importance

EIS process *data* into *information*, and provide the informational link between the actors who impact efficiency



EIS Research Scope

3-part project, over 9-month period

- Develop a framework to characterize EIS features
- Apply framework to evaluate ~30 commercial technologies
- Perform case studies to understand real-world EIS use for aggressive energy savings
- Feedback and input from Technical Advisory Group

Findings useful for

- Building operators and energy managers,
- EIS vendors/developers and service providers
- Policy makers, and researchers

EIS Characterization Framework

8 categories with 5-10 features each

- Data collection, transmission, storage and security
  - Storage capacity, upload frequency, supported protocols and interoperability, archived and exported data formats
- Display and visualization
  - Overlays, plotting intervals, x-y plotting, DR event status
- Energy, financial and advanced analyses
  - Forecasting, benchmarking, costing, renewables, carbon
- Demand response
- Remote control and management
- General info
  - cost, licensing, target users, etc..

Commercial EIS Evaluations

Vendor	EIS
Agilewaves	The Resource Monitor
Apogee Interactive	Commercial Energy Suite
Automated Energy	
Automated Logic	Web-CTRL
Chevron Energy Solutions	Utility Vision
Energy Connect	Web Connect
EnergyICT	EIServer and modules
EnerNOC	Power/CarbonTrak
Envinta	ENTERPRIZE.EM
FactoryIQ	eMetrics
	Green Energy Management System (GEMS)
Gridlogix	Automated Enterprise Management
Interval Data Systems	EnergyWitness
Itron	EEM Suite

Vendor	EIS
Matrikon	Operational Insight
NorthWrite	Energy WorkSite
Novar	
Noveda	Facilimetrix
Powerit Solutions	Spara EMS
PowerLogic	Energy Profiler Online
PowerLogic	Ion EEM
Richards Zeta	Mediator
SAIC	Enterprise Energy Dashboard (E2D)
Small Energy Group	Pulse Energy
Stonewater Controls	InSpire
Tridium	Vykon Energy Suite
Ziphany	Energy operation, information, DR platforms

EIS Business Models

- Difficult to map EIS to traditional software business models
  - Standard software products, enterprise client-server applications, SaaS/ASP and turnkey solutions
  - Optional services, customization, data and IT management, pricing variants blur lines between models

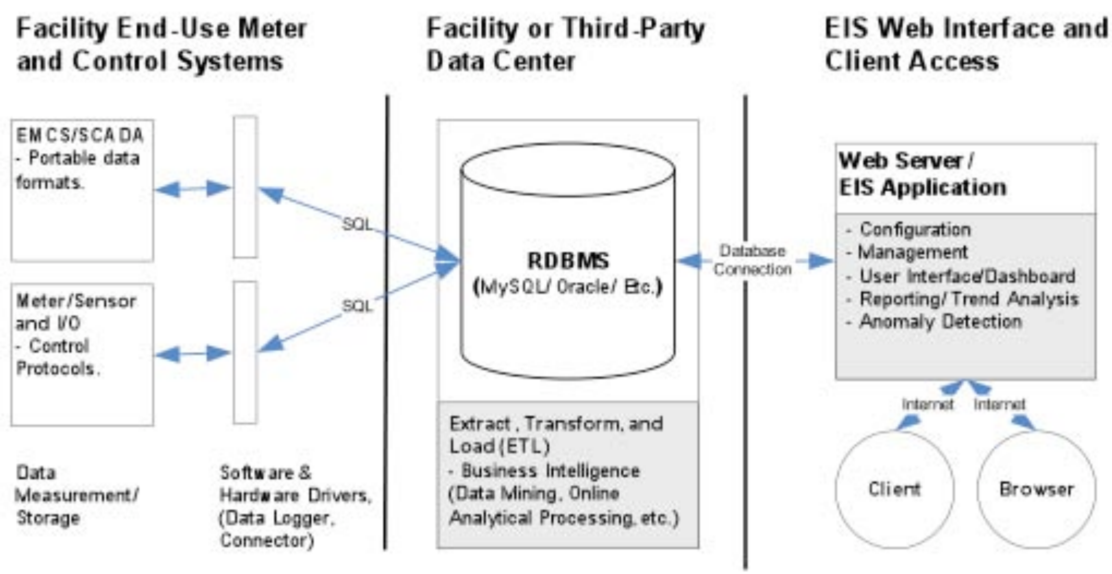
Trends

- Commonly SaaS, no/optional hardware based on client needs, rarely client-server apps
- Services are frequently optional or bundled
- Some EIS are free, offered with energy analysis service agreements, or large utility customers

EIS Architectures

Three typical layers comprise EIS architectures

- Facility Meter and Control Systems measure loads using protocols such as BACnet, and Modbus
- Data Center to warehouse EIS trend data
- Web Interface



Evaluation Findings, State of Technology

Display and visualization

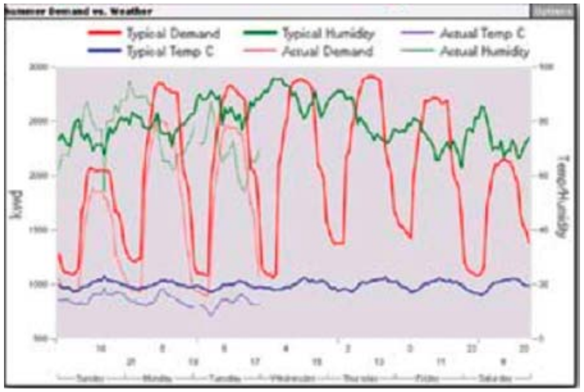
- Load profiling, point overlay, and aggregate totaling are widely accommodated
- X-y scatter plotting is under-supported
- Flexibility varies: display parameters dynamically altered ‘on-demand’, or statically defined in configurable options
- Display of DR event status universally supported in DR tools

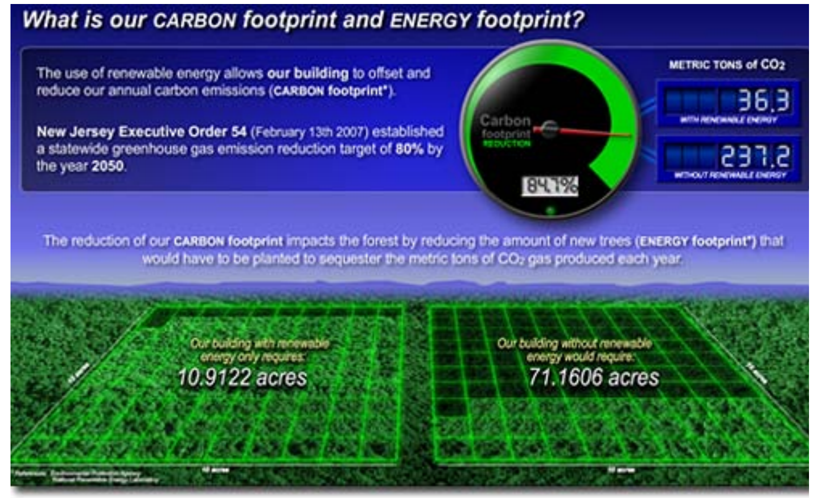
Evaluation Findings, State of Technology

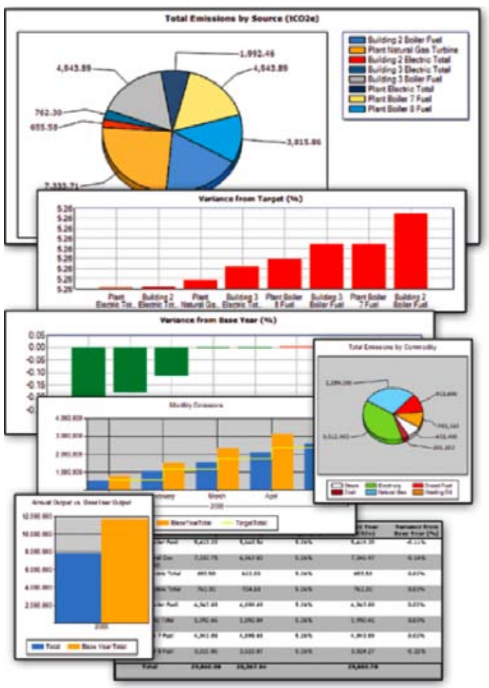
Energy Analysis

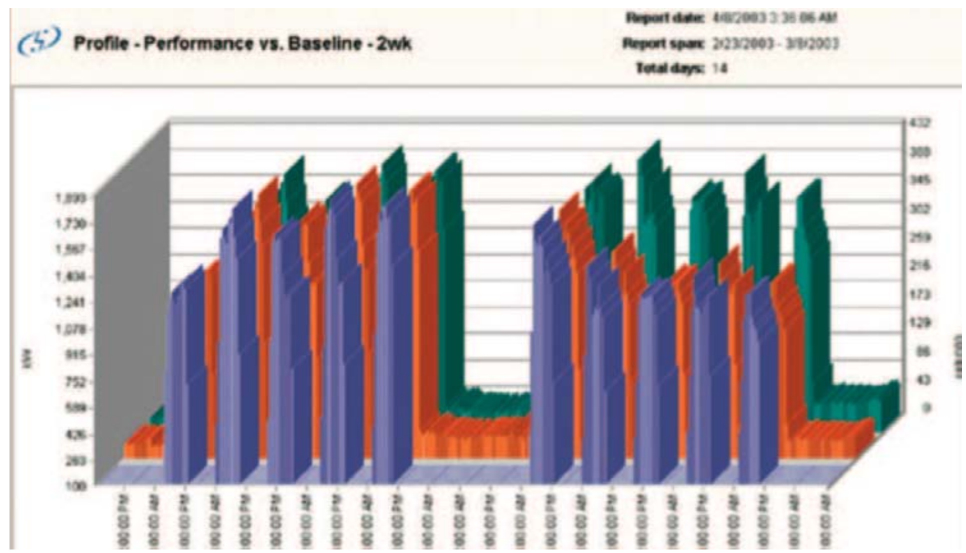
- 2/3 feature carbon tracking and analysis, or configurable options
  - The majority apply a simple energy/CO_2 relationship
  - About half use regional generation stats, other standards
- Normalization is common, rigor varies
  - Defined arithmetic, reports, trends based on other trends
- Historic baselining and multi-site benchmarking are nearly universal
  - Trend or report-based, less often weather-normalized
  - 2 examples of benchmarking against national data sets (IDS uses CBECS and NorthWrite uses Energy Star)

Display and Energy Analysis Screen Shots





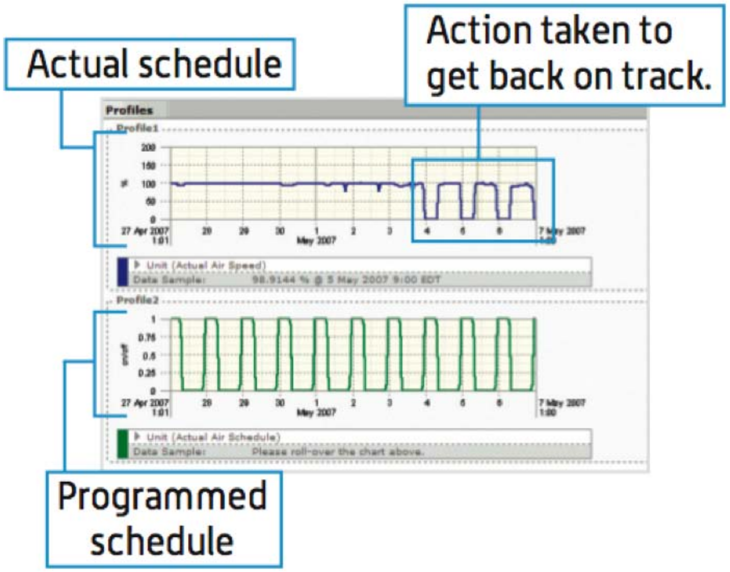




Evaluation Findings, State of Technology

Financial and Advanced Energy Analysis

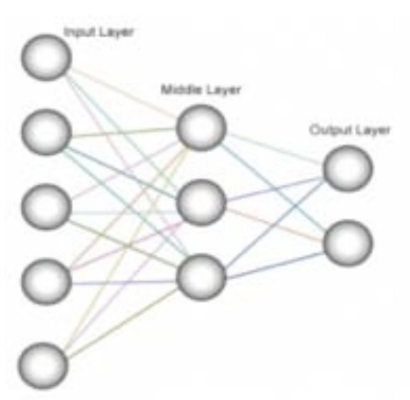
- Corrupted data –flagged or reported; cleansing or correction; link to external software
- Anomaly detection via departures from normal consumption or trend patterns
- FDD rare, some link to 3rd party

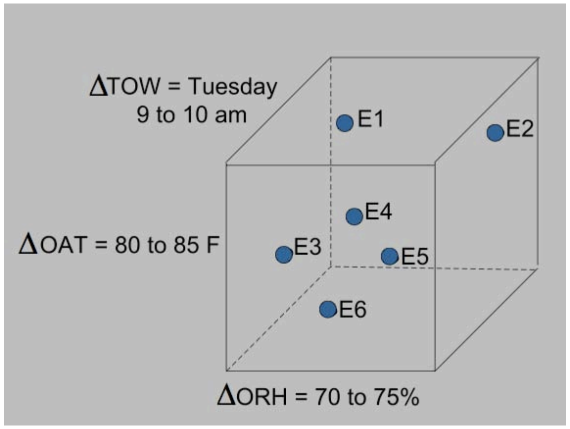


Evaluation Findings, State of Technology

Financial and Advanced Energy Analysis

- Tariff-based costing in ~half the EIS surveyed
  - DR tools of most robust for energy costing
- >half provide forecasting, typically historic trends + weather data, perhaps pricing or cost data
  - EnergyICT uses NN, NorthWrite uses bin methodology





Evaluation Findings, State of Technology

Control and Demand Response

- >half control according to a program via gateway or EMCS
- <half report internet-capable remote control
- DR capabilities have advanced since 2003, converging to a common set of features
  - Auto-DR, electronic notification, utility baseline calculation, response recording, opt/black out dates
- Predicted savings from response is distinguishing feature of today's DR tools

EIS Case Studies

Motivating Questions

- Which features have proved most useful in attaining energy savings?
- What actions are taken based on the information provided via an EIS?
- How much of a building's energy savings can be attributed to the use of an EIS?

Selection Criteria

- Engaged EIS users with a role in commercial energy management
- Aggressive energy savings

UC Merced

Campus Features

- 2005 opening, newest UC campus 800,000 sf, 4 main buildings, central plant, housing/dining

Energy Targets

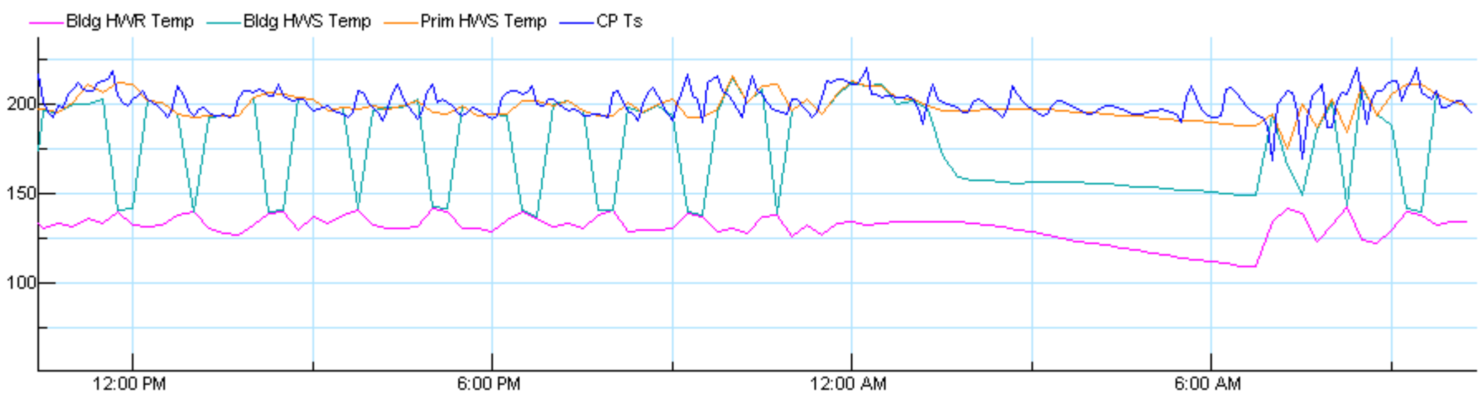
- Efficiency prioritized in design stages
- Goals: 20% better than benchmark, ramping to 35%



UC Merced

Automated Logic Web-CTRL

- Selected for web connectivity, remote monitoring and control capabilities
- EIS uses: energy performance tracking, assessment of utility recharges
- EMCS uses: Building, equipment troubleshooting



UC Merced

Actions from EIS information

- Gas trends and local steam measures to support De-Cxing central steam plant (~10% eff.)
- Confirmation of low heating plant efficiency, unexpected given campus age

2007-2008 Energy Performance

	Campus Gas	Campus Electric	Campus Pk. Demand	Building Electric	Building Pk. Demand	Building Pk. Cooling
Improvement vs. benchmark	27%	34%	37-52%	39-48%	54-55%	16-36%

UC Merced

EIS Challenges

- Network reliability - data corruption, equipment lock-out and false alarming
- Features – no x/y scatter plotting
- Logic-based arithmetic limits automation of identification, correction of corrupt data
- Staffing, resources
  - Uniformity in trend-log sampling rates
  - Distributor relationship and need for routine changes
  - Regular energy analysis beyond EMCS troubleshooting

UC Merced

EIS Strengths

- Plotting and navigation of large data sets (vs. Excel)
- No superfluous unused features
- Realization of UCM as a '***Living Laboratory***'
- Energy manager's implementation wish-list can be accommodated with WebCTRL features

EIS Perspectives

- Prefers accepting limitations of single tool over using a suite of tools
- Need to **link performance and maintenance** – decision support to protect efficiency investments

Conclusions

Distinguishing Characteristics

- Dynamic vs. static definition of reporting, calculation, and plotting parameters
- Rigor in energy analyses - normalization, standards-based calculations, actionable anomaly detection, and forecasting robustness varies

Success Models

- Large enterprises and campuses have demonstrated successful cost-effective EIS use
- What other models for small-medium commercial?
  - Organizational resourcing – onsite vs. service contracted analysis?

EIS Conclusions

Choosing the ‘best EIS’ for a given application

- Begin w/ site operational and energy goals to understand immediate and long-term needs
- ID high-priority features and functionality
- Select most appropriate technology
- An org. w/ tailored benchmark models might prioritize flexible definition of metrics, over dynamic configuration
- A large enterprise that requires proof of retrofit savings may value robust baselining, data cleansing, and tariff-specific energy costing

Future Work

Usability

- Unclear that all users know how to use EIS features to transform time series data into energy-saving information (case studies, utility anecdotes)
- Case studies gave insights, yet several questions require merit further attention
  - To what extent are the features in the framework used, and for what purposes?
  - Which features are potentially useful but underutilized or not available?
  - How can existing functionality be made more valuable?

Future Work

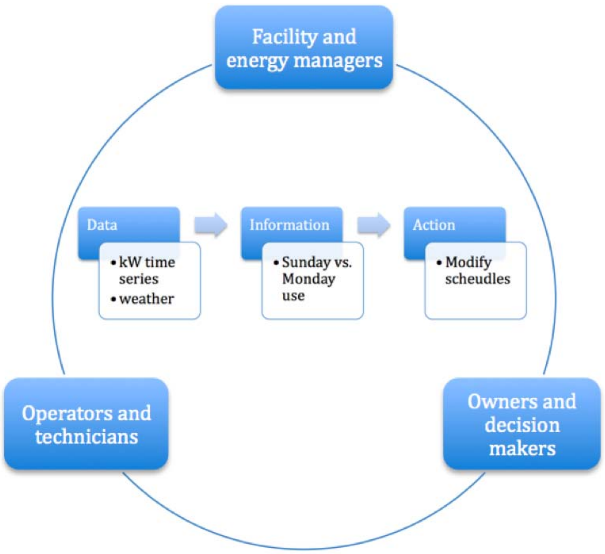
Standardization

- Common metrics, e.g., weather-normalized EUIs, and time series analyses are required
  - Energy use and building performance can be then communicated across owners, throughout the commercial building industry

Future Work

Standardization

- Need to migrate stakeholders to common language
  - An operator may view time series to determine that a chiller is not running according to the off-hours schedule,
  - An energy manager may observe unexpected changes in load duration
  - An owner may note rises in off-peak energy costs



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Thank you for your attention

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