Building Energy Information Systems and Performance Monitoring Tools

Technical Advisory Group Meeting

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Public Interest Energy Research (PIER) Program
California Institute for Energy and the Environment
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http://eis.lbl.gov/

Meeting Agenda

1. Project Goals and Objectives
2. Technical Advisory Group Role
3. Previous Research at LBNL
4. Key EIS Features Considered
5. Tools and Products to be Evaluated
6. Case Study Research Questions
7. Timeline and Next Steps
8. Discussion Questions for TAG

Appendices – Detailed Framework Questions

1. Project Goals

- **Evaluate** EIS and how they support reducing energy use and costs and emissions from energy use
- **Describe** status of technology and improvements in information management systems
- **Consider** how facility operators and energy managers access to energy information
- **Assess** how EIS can improve demand responsiveness and peak demand reductions
- **Analyze** methods to improve energy information links to non-energy issues – maintenance/operations, other resource consumption (e.g. water)

Specific Objectives

- **Develop** framework to characterize and classify EIS and PM tools for building energy analysis.
- **Evaluate** and characterize current products, tools, and systems used, and developed for commercial buildings.
- **Develop** evaluation concept for case studies to evaluate how facility uses existing and emerging tools
- **Support** state buildings, monitoring based commissioning
- **Update** 2003 report – "Web-based EIS for Energy Management and Demand Response in Commercial Buildings."

Scope does not include end-use, EMCS, or HVAC fault diagnostics

2. Technical Advisory Group

- Karl Brown, UC
- Martha Brook and Norm Bourassa, CEC
- Ron Hofmann, CIEE
- Mark Levi, GSA
- Graham Henderson, BC Hydro
- Len Pettis, Cal State U
- Chuck Frost, UC Berkeley
- John C. Dilliott, UC San Diego
- Glen Lewis, UC Davis
- Roger Levy, Consultant to DR Research Center
- Kathy Turner, New Buildings Institute
- David Jump and Bill Koran, QuEST
- Reinhard Seidl, Taylor Engineering

Technical Advisory Group Role

- Recruit external technical advisors
- Two-way relationship
  - TAG to provide review and feedback to project plans
  - TAG to benefit from results of research
- Initial TAG Plan
  - 1st meeting following draft framework plan (Present)
  - 2nd meeting to discuss findings for incorporation in the draft final report (Spring 2009)
- May hold one more meeting

3. Previous Research at LBNL

- Information Monitoring and Diagnostic System (1993-1998)
- Energy Information System Case Study at UC Santa Barbara (2002)
- GSA Energy and Maintenance Network (GEMnet, 2003)
- Energy Information Systems Report
- Performance Monitoring Specifications
- 2003-2008 Open Automated Demand Response Communication Systems Development

Information Monitoring & Diagnostic System Features

- Research began in 1993
- Data acquisition system
- High quality sensors (power, flows, temps)
- Data visualization tools
- High frequency data
- Automated diagnostic prototype research

IMDS On-Site Archive

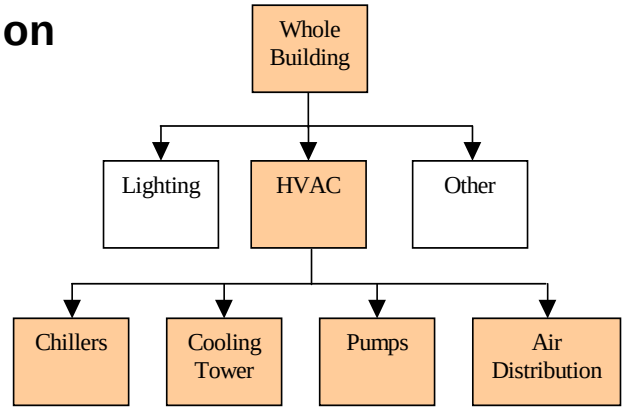
Internet
ISDN Connection

IMDS Remote Archive

- On-Site Electric Eye Software
- Real-time Remote Web Browser
- Public Access

Supersymmetry

LBNL



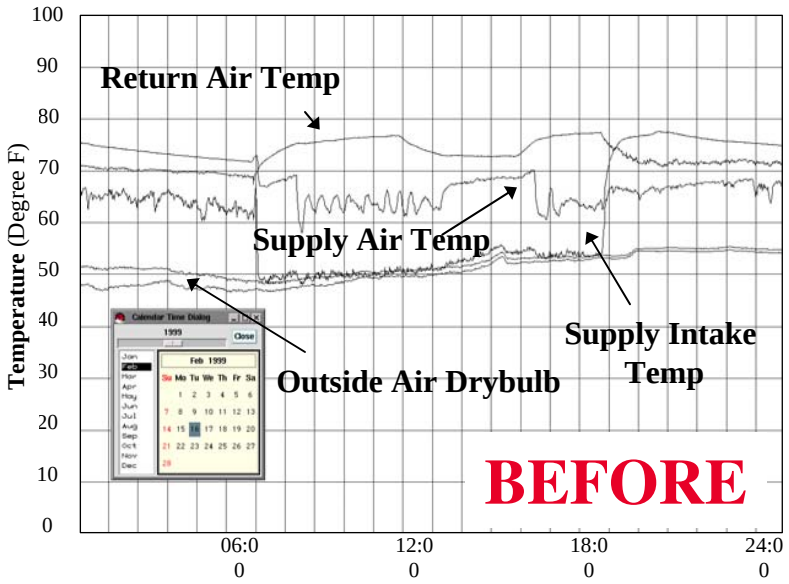
IMDS Evaluation Results

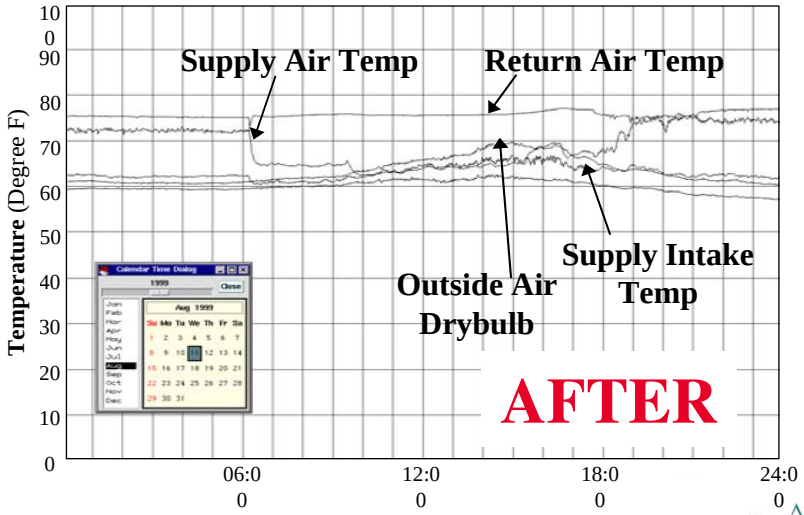
Key Benefits of IMDS

- Dramatic improvement in controls & automation
- Better comfort & reduced complaints
- Extended equipment life

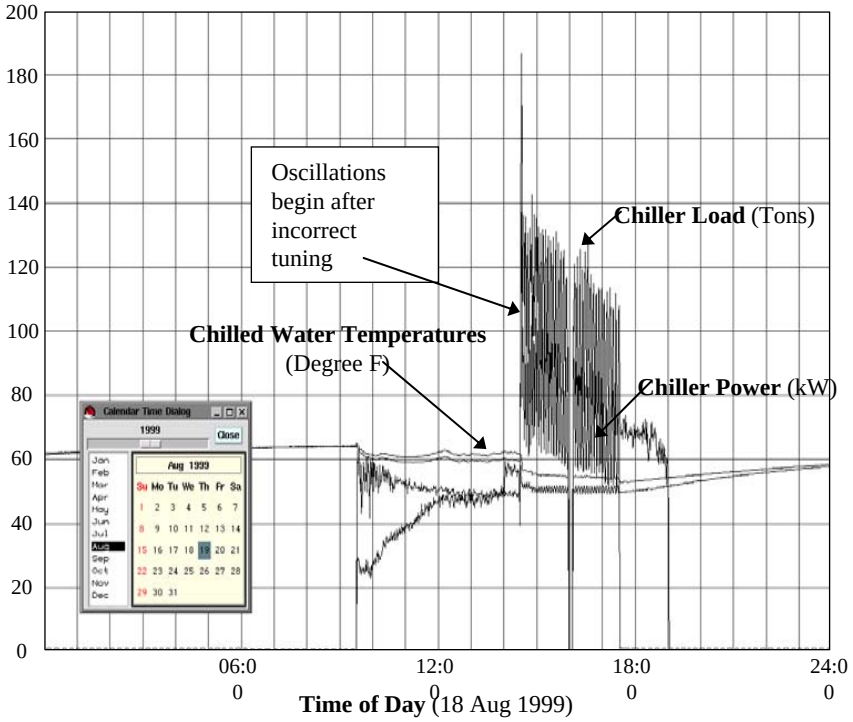
Desire for New Technology

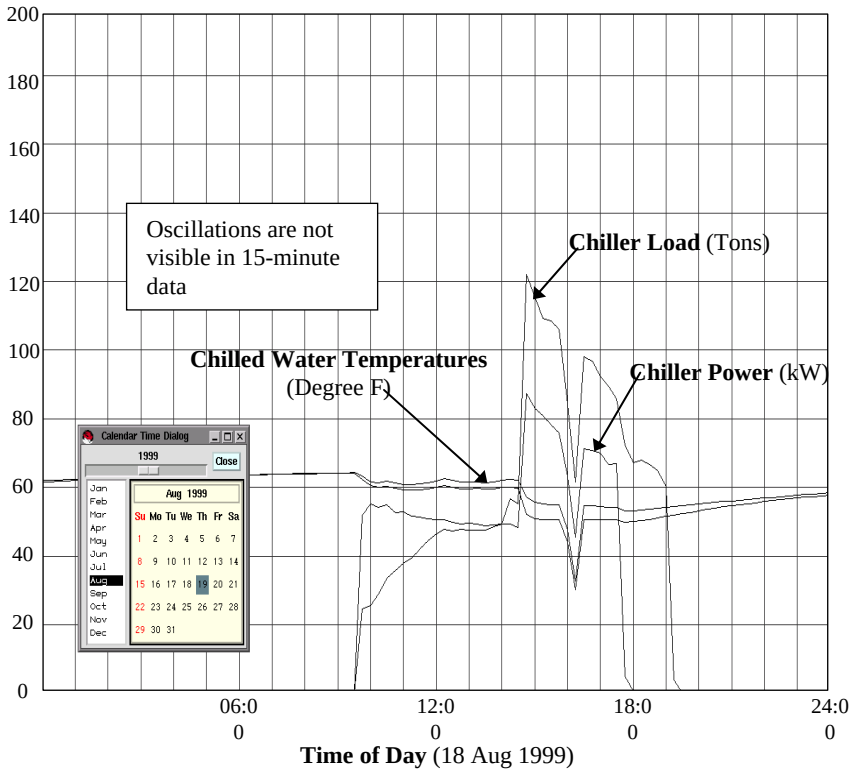
- Continuous archive
- Real-time graphical analysis
- Web-based remote access





Inlet Vane Control Problem





Enterprise Energy Management at UC Santa Barbara

- 5.3 Million Sq. Ft.
- 989 Acres
- 19000 Students
- 900 Faculty
- 3000 Staff

2002 11.5 MW Peak Demand - Down from 15 MW - 1998

EEM·Suite

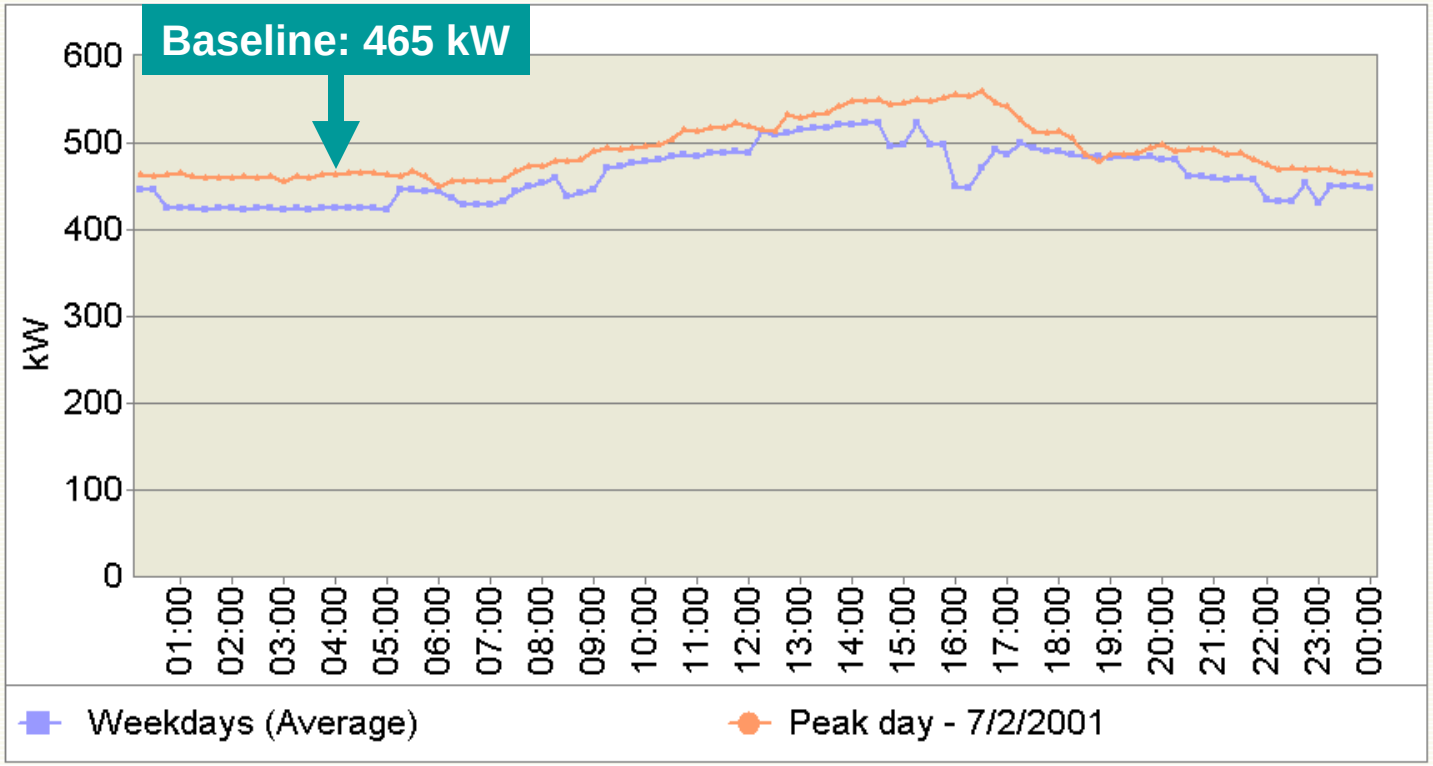
powered by Silicon Energy

24 Hour Line Chart report

24 Hour Line Chart report

Day of week: Weekdays

Report date: 9/30/2003 6:26:41 PM
Report span: 7/1/2001 - 7/31/2001
Total days: 22



Data summary

Point: 45 / pnorth.pw6572.PSB North Electrical Demand					
Minimum	Minimum time stamp	Maximum	Maximum time stamp	Average	Units

EEM·Suite

powered by Silicon Energy

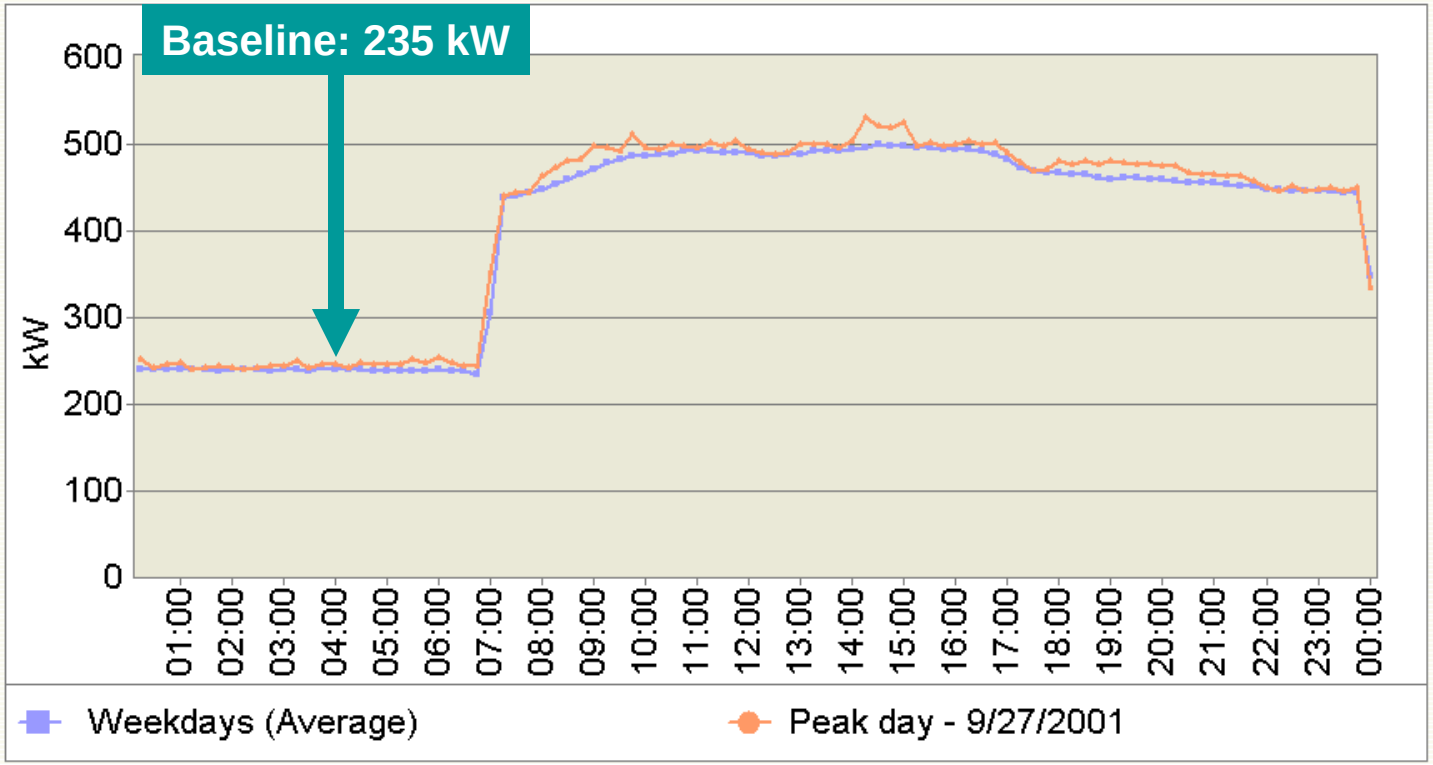
24 Hour Line Chart report

Home
Enterprise Navigator
Alarm Manager
Forecasting
Data Analyst
Single Point Trend
Multi-Point Trend
3D Surface Chart
24 Hour Line Chart
Scatter Plot
Statistical Summary
Histogram
Single Point Digital
Multi-Point Digital
Data View and Export
Energy Analyst
Cost Analyst
System Manager
My Favorite Reports
Point group editor
User preferences
Help
About
Logout

24 Hour Line Chart report

Day of week: Weekdays

Report date: 9/30/2003 6:34:41 PM
Report span: 9/1/2001 - 9/30/2001
Total days: 20



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UCSB Cost Benefit Analysis

Electricity Cost Saving

	Electricity [MWH]	Peak Demand [kW]	Total
May00-April01	83,700	12,742	
May01-April02	75,100	11,362	
Saving	8,600	1,300	
Cost saved	$430,000 (10.3%)	$160,000 (12.4%)	$590,000 (10.8%)
Due to EIS (50%)	$215,000	$80,000	$295,000

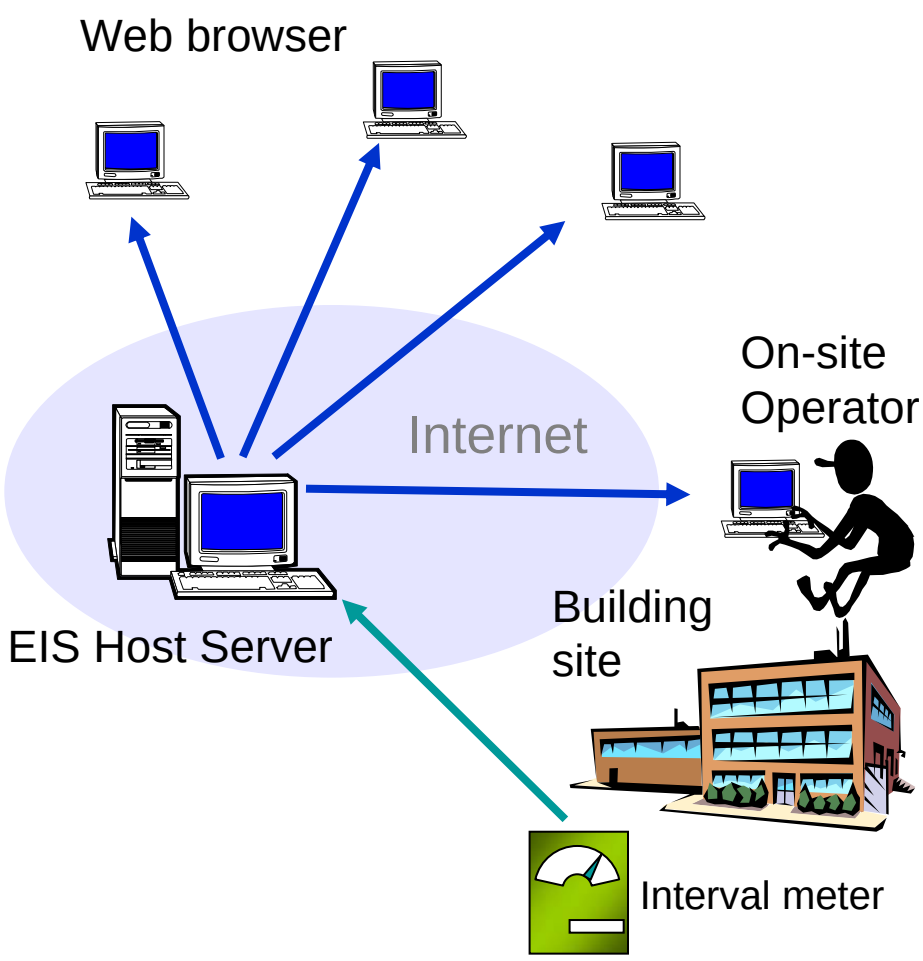
EIS first year cost: $295,000

Payback period: 1.2 year

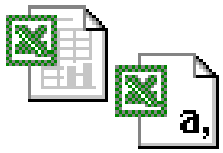
EIS Operations

- **EIS users**: energy manager, facility managers
- **EIS use:** 30 min per day, and often more when operational settings have been changed
- **EIS data**:
  - Time-series energy consumption data as daily routine.
  - Reporting features support participation in energy conservation programs

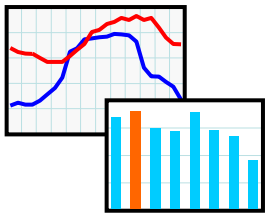
Utility Energy Information Systems



Basic features of EIS



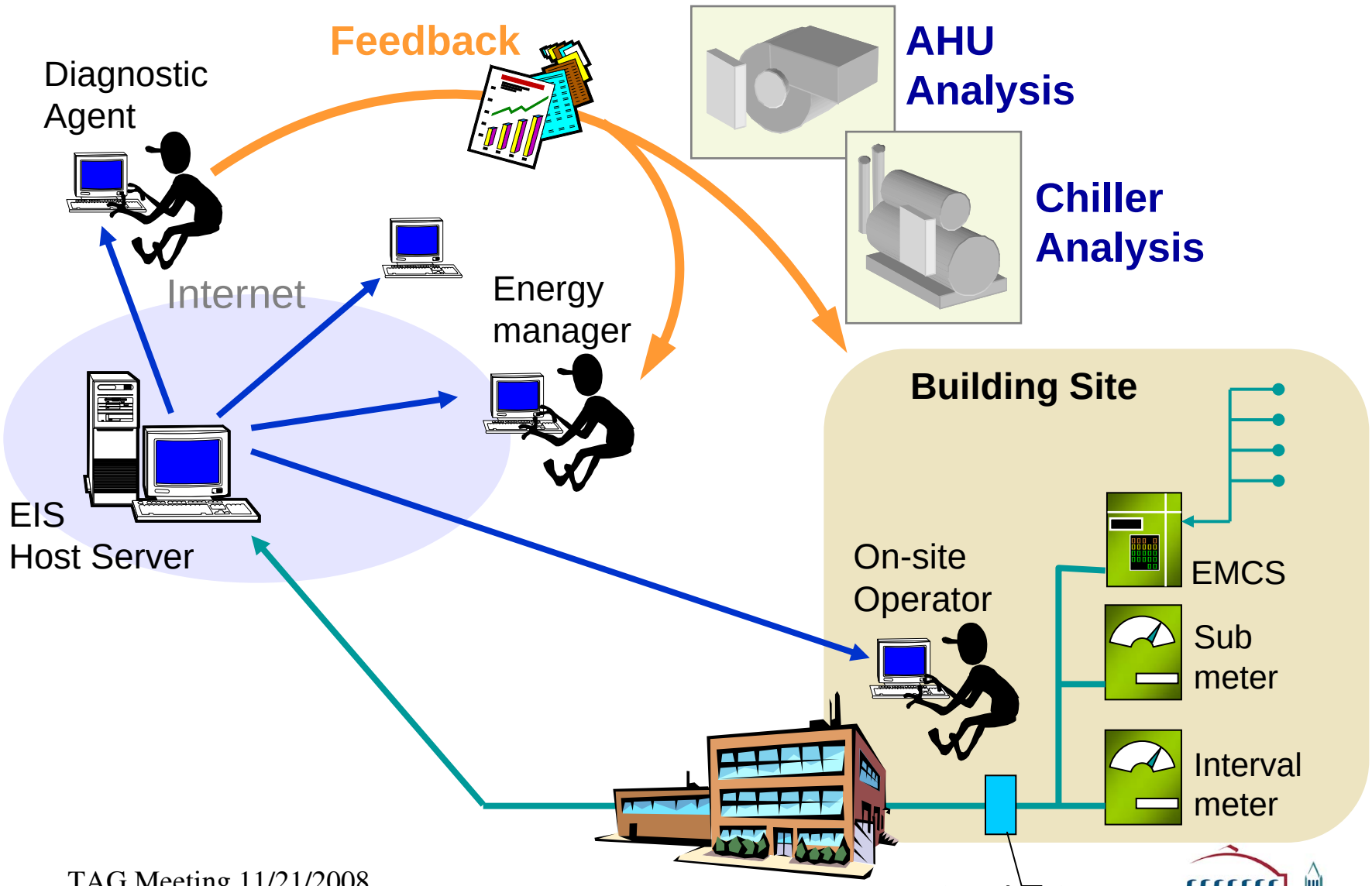
Data Acquisition



Graphical Visualization

Rate Calculation

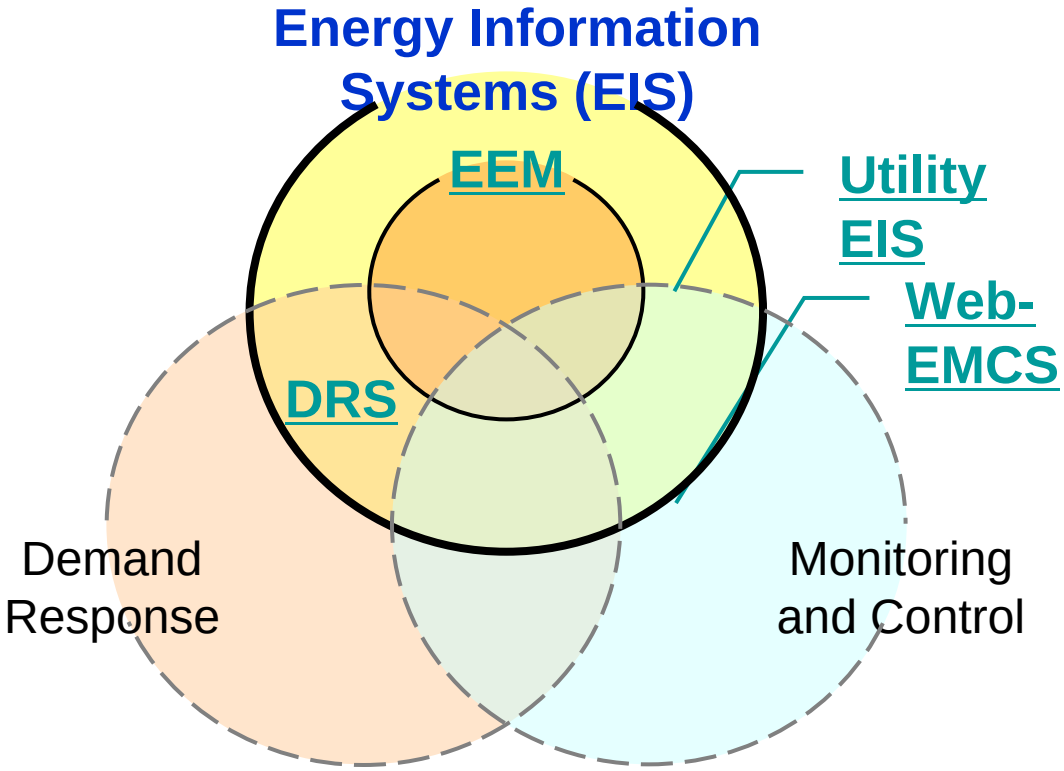
Web-based EMCS Interfaces



Types of EIS

- Utility Energy Information Systems (Utility EIS)
- Demand Response Systems (DRS)
- Enterprise Energy Management (EEM)

- Web-base Energy Management & Control System (Web-EMCS)



EIS Visualization & Analysis Features

Software product	Time series	Day overlay	Average	Highs/lows	Summary	Point overlay	X-Y scatter	3D chart	Load duration	Calendar profile	Aggregation	OAT plot	Per sqft	Forecasting
AMICOS	✓				✓	✓					✓			
Enerlink.net	✓		✓	✓	✓		✓	✓			✓	✓	✓	
Readmeter	✓			✓					✓		✓			
EP Web	✓		✓	✓	✓	✓		✓		✓				
Energy Profiler Online	✓	✓	✓	✓	✓	✓			✓		✓	✓		
Load Profiler	✓				✓	✓					✓	✓		✓
UtilityVison	✓	✓	✓	✓	✓	✓				✓	✓			
EEM Suite	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
EnterpriseOne	✓	✓	✓		✓	✓	✓			✓		✓	✓	
Intelligent Use of Energy	✓	✓			✓	✓			✓		✓	✓		✓
IMDS/Electric Eye	✓	✓				✓	✓	✓				✓		

4. EIS Product Evaluations

- Characterization framework
  - Feature categories
    - Data collection, TX, storage, security
    - Display and visualization
    - Energy, financial, and advanced analysis,
    - Demand Response
    - Control Management (Automated/Remote)
    - “Meta” (general product, cost, and company business model)
  - Feature details
    - Display - XY plots, DR status, trend overlays (day, point)
    - Analysis - normalization, benchmarking, forecasting, FDD, carbon
    - DR - notification, auto/manual, baseline, real-time response
    - Data - archived/exported format, protocols and interoperability, upload frequency, security
    - Meta - cost, target users, upgrades, number of users, browser support

Status of EIS Evaluations

- 40-60 EIS targeted for evaluation
  - To date, ~12 completed or underway
- Evaluation process
  - 1st-pass characterization from public domain info
  - Contact company rep for remaining details, finalization
  - Review company history, goals/mission, future plans
  - Probe for lead users and potential case studies

5. Tools, Products, Companies

- ABB
- Allen Bradley/Rockwell Automation,
- Apogee Interactive, Demand Exchange LLC
- APS Energy Services EIS
- Automated Energy Inc (AEI)
- Automated Logic Corp. (ALC)
- Canon Technologies Dakota Electric
- Chevron Energy Solutions
- Cimetrics
- Comverge
- Elutions
- Energy Connect
- Energy ICT
- Energy Witness
- EnerNOC
- EnFlex
- nnovatis
- EnVINTA
- Genea/InnovoEnergy
- GridLogix
- Honeywell EIS
- Invensys
- Itron Inc. EEM
- Johnson Controls, Inc (JCI) EIS
- Lime Energy
- Matrikon
- MeterSmart
- National Grid
- Natural Step
- NorthWrite
- Novar
- Noveda Technologies
- OSIsoft
- PowerIT
- PowerLogic
- PowerWatch
- Richards Zeta
- Save more Resources (SMR)
- Schnieder Electric/Power Measurement
- Siemens
- Site Controls
- Small Energy Group
- Terradex
- Apogee interactive, Inc.
- Tridium
- Ziphany

6. Case Study Research Questions

- How do people use EIS-PM systems
  - How often do they use them
  - How do they use them
  - What features are most useful Which metrics
  - What kind of operational problems do facility managers evaluate with these data
- What features of EIS make them most successful
  - Internal champion, Good training, Outsourced expert use (services)
- What are the prioritized needs for information systems for energy managers
- What are the costs and benefits of these systems

Case Studies

- 4-6 cases where use of EIS found energy savings
- Look for:
  - Proficient, motivated building operator;
  - Willing to participate in the study;
  - Fairly typical commercial building;
  - Commercially available EIS;
  - At least one full year of data.
- Look at "best practices," not typical practices.

Case Studies

- Evaluate
  - Energy and cost savings attained,
  - Personnel effort expended,
  - Data availability (e.g. level of sub-metering),
  - Level of proficiency with EIS that was required.
- Also, identify
  - Problems with EIS
  - Problems with data
  - Problems with implementing savings efforts

7. Project Timeline and Next Steps

- Tasks 1-4, June-November 2008
  - Finalize scope and initial framework for study
  - Develop and manage TAG
  - Identify products/systems for evaluation
  - Finalize categorization framework
- Next Steps
  - January 2009 evaluate 40-60 IES
  - February 2009 hold second TAG meeting
  - February 2009 conduct selected EIS case studies
  - March 2009 compile findings into final report
  - June 2009 present findings at Natl Conf on Bldg Cx

8. Discussion Questions for TAG

- What other key features should we include
- What other EIS technologies are we missing
- What other case study criteria would you consider
- What possible case study sites would you suggest?

Framework – Feature Details

Data Collection, Transmission and Storage

- What metered energy inputs does the EIS accept? – gas, chilled water, oil, steam …
- Does the EIS accept utility billing data?
- What are the storage limits?
- How often is data retrieved, what is the minimum resolution of interval data, and does the EIS use internet of telecommunication?
- Does the EIS provide component level data or whole-building interval/submeter data?
- How is data archived, and what export formats are supported?
- What security protocols/procedures does the EIS use?

Framework – Feature Details

Display and Visualization

- Is it possible to display an entire month of time series?
- Is it possible to display daily time series in hour-long intervals or less?
- Is it possible to display aggregated usage? – daily, weekly, …
- Is it possible to overlay multiple days' trends, or multiple time series on one plot?
- Is it possible to generate 3-D surface plots, or x-y plots?
- Is it possible to display DR event status and communication details?
- Is it possible to graphically display DR load-shape vs. baseline?

Framework – Feature Details

Energy Analysis

- Does the EIS calculate averages or max/min for a given time period?
- Does the EIS calculate system or component efficiencies?
- Does the EIS calculate load duration?
- Does the EIS estimate consumption by end-use?
- Does the EIS normalize by OAT, CDD, HDD, or sf?
- Is carbon analysis standards-based, or based on a simple energy-carbon relationship, and does it account for time-varying intensity?
- Is it possible to analyze one building's performance vs. another's, or vs. a historic benchmark?
- Does the benchmarking analysis rely upon standards such as Energy Star or Labs 21?

Framework – Feature Details

Advanced Analysis

- Does the EIS forecast near-future load profiles?
- Does the EIS perform FDD, anomaly detection, corrupted data, or gaps in trends?
- Does the EIS calculate percentiles, deviations, or perform regression analysis?
- Are modules/functions provided for renewables, or for on-site generation?
- Does the EIS perform load shape analysis?

Framework – Feature Details

Financial Analysis

- Does the EIS perform simple cost estimates, or include specific rate tariffs?
- Does the EIS validate utility billing and (sub)metering accuracy?
- Does the EIS predict savings from IES use, operational strategies, or retrofits?
- Does the EIS transmit data sufficient to outsource bill processing/payment?
- Does the EIS estimate end-use consumption from whole-building energy?

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Framework – Feature Details

Control and Demand Response

- Is the EIS capable of controlling building systems according to a program, or remotely through the Internet?
- Does the system permit automatic or manual DR, and how is the operator notified of events?
- Does the EIS quantify in RT the load shed?
- Does the EIS calculate or predict energy/$ savings from a DR response?
- Does the EIS calculate a DR baseline according to utility program formulas?
- Can the operator test DR events, opt-out, and specify black-out dates?
- Does the EIS record DR data? – time received, actions performed, load reduction …

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Framework – Feature Details

General

- Are all 3 major browsers supported?
- What are the software and associated hardware costs?
- What are the license/usage fees, or service and maintenance costs?
- What is the expected lifespan before major upgrades, and are modules available (vs. full versions)?
- What market segments does the company traditionally target, and who are the most common end users?
- How is the company characterized (services, software, controls, etc)?
- How many users does the product have?