UC/CSU/IOU Energy Efficiency Partnership Monitoring-Based Commissioning (MBCx) Program

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Monitoring-Based Commissioning (MBCx)
UC/CSU/IOU Energy Efficiency Partnership

Outline

Background for Monitoring-Based Commissioning (MAP)

UC/CSU/IOU Energy Efficiency Partnership Program (JMN)

UC/CSU/IOU Monitoring-Based Commissioning Program

2004-05 Preliminary Case Studies

Cx Training and Education in UC/CSU/IOU Partnership

MBCx Team and Support Organizations

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Funding for:

Permanent Monitoring

Meters
Telemetry
Trending Software

Whole-Building Energy
Sub-System

Commissioning Consultants

Emphasis on Training for Campus Staff

In-House Staff (Limits)

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Key Program Features

Improved Operation of Existing Equipment/Systems
(as opposed to retrofit equipment upgrades)

Permanent Monitoring with Trending Capability
identifies dysfunction
assures verification and persistence of savings

Savings opportunities identified by combination of:
monitoring
test protocol-based methods

Benchmarking

Identification of Future Retrofit Projects

Best Practices Report for Future Planning

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Typical Targets

Reheat Systems
(minimize simultaneous heating and cooling)

Chilled/Hot Water Pump Systems

Variable Frequency Drives (VFD)

District Cooling Systems
(e.g. delta T issues)

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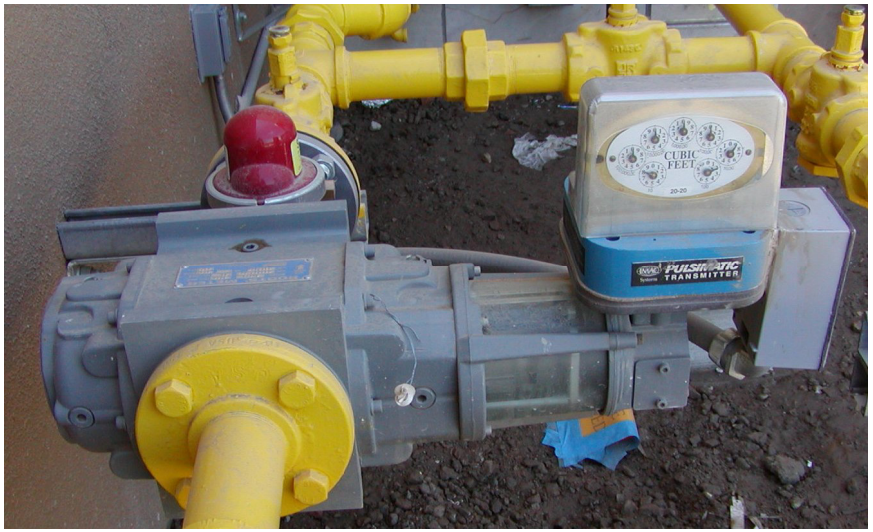
2004-05 Program Statistics (1 of 2):



25 Campuses

9 Plant Systems

40+ Buildings

over 5 million gross square feet

~ half laboratory or other energy intensive buildings

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2004-05 Program Statistics (2 of 2):

$5 Million Total Funding
- Project Size $25k - $350k
- $0.30 - $1.75 per gsf for buildings

Savings Estimates (Conservative for Pilot Program)
- 1 MW peak demand
- 9,000,000 kWh per year
- 500,000 therms per year

2 -15% of current building or plant system use

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Case Study #3 Library Building (original Cx in 1999)

Building Floor Area	**215,000 gsf**	
Project Budget	**$83,500**	
Monitoring Equipment	$16,500	
Prep by Staff	$14,000	
Commissioning Provider	$46,500	
Staff Training for Ongoing Cx	$ 6,500	
Savings Target	**125,250**	**kWh/yr**
	2	**kW**
	2,279	**therms/yr**

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Case Study #3: Library Building Benchmarking (215,000 gsf)

(Preliminary)	Electricity Annual Use	Maximum Power	Chilled Water Annual Use	Maximum
Historical	**n/a**	**n/a**	**n/a**	**n/a**
Revised	**3,747,600 kWh/yr**	**730 kW**	**11 kton-hr/yr**	**74 tons**
Index	**17 kWh/yr/gsf***	**3.4 W/gsf***	**0.05 ton-hr/yr/gsf**	**0.3 tons/kgsf**
Typical UC/CSU Non-Lab Building (climate normalized)	**~11 kWh/yr/gsf***	**~2.7 W/gsf***	**n/a**	**~1.5 tons/kgsf**

* Not Including Chilled Water Production
(Thermal/Gas Benchmark Data Under Review)

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Case Study #3: Library Building

Initial Cx Measures:

Identified primary/secondary CHW loop imbalance
(revealed by two days of warm weather monitoring)
Adjusted controls to allow adequate CHW flow to coils
Observed Fan Speed Reduction from 100% to 40%
(any corresponding increase in chiller load incurred at night)

Savings:

Overall Targets		Preliminary Savings Measurements	
125,250	kWh/yr	500,000	kWh/yr
2	kW	100	kW
2,279	therms/yr	TBD	therms/yr

(Project Budget: $83,500)

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Case Study #4: Lab Building Benchmarking (176,000 gsf)

(Preliminary)	**Electricity** (including chilled water production) Annual Use
Historical	**9,113,440 kWh/yr**
Revised	(in documentation)
Index	**52 kWh/yr/gsf**
Typical UC/CSU Lab Building (climate normalized)	**~37 kWh/yr/gsf**

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Case Study #4: Lab Building Benchmarking (176,000 gsf)

(Preliminary)	**Thermal / Natural Gas** Annual Use
Historical	**452,204 therms/year**
Revised	(in documentation)
Index	**~2.6 therms/year/gsf**
Typical UC/CSU Lab Building (climate normalized)	**~1.8 therms/year/gsf**

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Case Study #4: Lab Building

Building Floor Area (gsf)	**176,000**
Project Budget	**$270,000**
Monitoring Equipment	$130,000
Monitoring/EMCS Integration & Prep by Staff	$ 75,000
Cx Provider	$ 50,000
Staff Training for Ongoing Cx	$ 15,000
Savings Target	**409,260 kWh/yr**
	47 kW
	13,100 th/yr

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Case Study #4: Lab Building (176,000 gsf)

Initial Cx Measures:

(In documentation)

Savings:

Overall Targets	Savings Measurements
409,260 kWh/yr	720,000 kWh/yr
47 kW	117 kW
13,100 therms/yr	94,700 therms/yr

(Project Budget: $270,000)

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(Preliminary Summary)		Target Savings	Actual Savings		Project Budget
Case Study #1:	**Laboratory Building**				
Electricity	(annual kWh)	N/A**	N/A**		$ 67,500
	(kW*)	N/A**	N/A**		
Gas	(annual therms)	13,292	43,000	(+224%)	
Case Study #2:	**Laboratory Building**				
Electricity	(annual kWh)	369,559	500,000	(+35%)	$114,000
	(kW*)	27	TBD		
Gas	(annual therms)	3,000	TBD		
Case Study #3:	**Library**				
Electricity	(annual kWh)	125,250	450,000	(+259%)	$ 83,500
	(kW*)	2?	100		
Gas	(annual therms)	13,100	TBD		
Case Study #4:	**Laboratory Building**				
Electricity	(annual kWh)	409,260	720,000	(+76%)	$270,000
	(kW*)	47	117	(+149%)	
Gas	(annual therms)	13,100	94,700	(+622%)	

* Annual peak kWh reported as average kW

** Savings target combined with district CHW project

UC/CSU/IOU Energy Efficiency Partnership

Training and Education Element

New Construction/Major Renovation
Tailored for UC/CSU Project Managers
(usually architects)

Commissioning Certification

Monitoring-Based Commissioning

Building Operator Certification Courses

Sustainability Conferences

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Monitoring-Based Commissioning (MBCx) Partner Team

Mark Bramfitt, Pacific Gas and Electric (PG&E, Co-chair)
Karl Brown, UCOP (Co-chair)
Ryan Stroup, PG&E (Lead for MBCx Training and Education)
Aaron Klemm, CSU
Paul Kyllo & Tony Pierce, Southern California Edison
Randall Higa & Guy Hansen, Sempra
Keith Marchando, Sonoma State University
Jim Dewey, UC Santa Barbara

MBCx Team Consultants

Richard Sterrett, Alternative Energy Systems Consulting
Mike Anderson & Matt Sullivan, Newcomb Anderson McCormick
Ziyad Awad, Awad & Singer

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Support Organizations

Portland Energy Conservation, Inc (PECI)
- Project Scoping Consultant to Campuses
- MBCx Curriculum Development & Lead Instructor(s)

California Energy Commission

Public Interest Energy Research (PIER) Program
- Technical Support (LBNL)
  - MBCx Case Studies and Needs Assessment
  - Monitoring (EIS) System Architecture
  - Benchmarking
- MBCx Curriculum Development (PECI thru New Buildings Institute)

Commissioning Providers

Monitoring-Based Commissioning
UC/CSU/IOU Energy Efficiency Partnership

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MBCx Task Categories

- **Planning**
- **Background Information**
- **Pre-Investigation**
  - Monitoring Installation/Upgrade
- **Investigation**
  - Baseline
  - Diagnostics on Trended Data
  - Functional Performance Testing
- **Initial Implementation**
  - Operational Changes, Maintenance and Repair
  - Document Remaining Opportunities incl. Retrofit
- **Handoff**
- **Ongoing**

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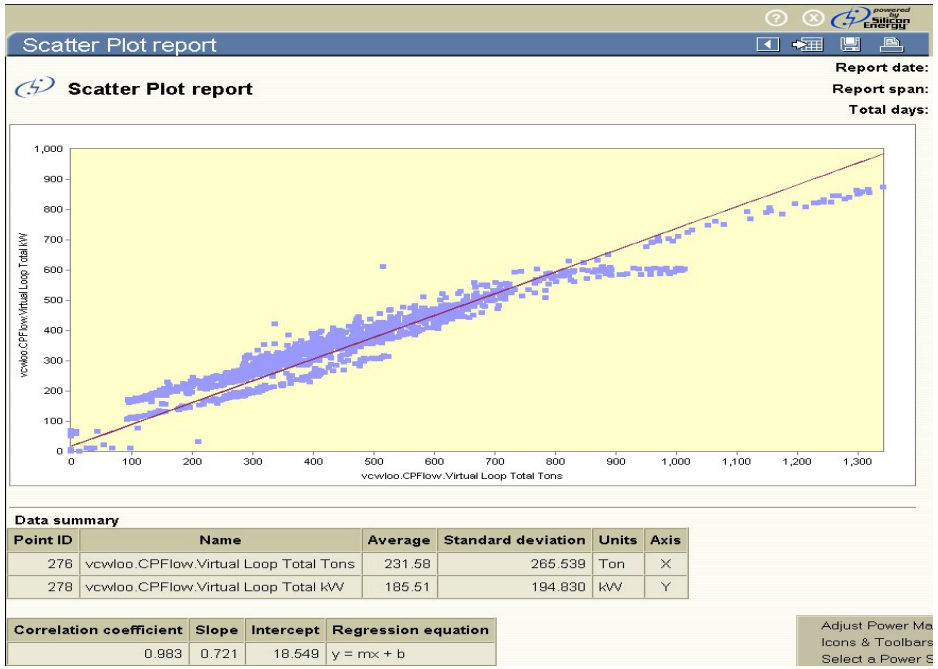
Documents

- **MBCx Task List**
  - Project-Specific Check List of Tasks for Cx Consultants:
    - Lead?
    - Support?
    - N/A
- **Findings Log**
- **MBCx Plan**
- **"M&V" Plan**
- **Systems Manual**

- **Summary Report**



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Key UC Green Building and Clean Energy Policy Provisions

- 10% energy use reduction through energy efficiency measures by 2014
- 20% better than Title 24 for new buildings
- LEED™ Existing Building (EB) approach under assessment—pilot projects encouraged
- Partner with others to speed development of technologies that improve energy efficiency

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CSU Related Activities

2005/06 Commissioning Required MCO

Mechanical Review Board (MRB) Developing

- Commissioning Guidelines New & Existing Buildings
- Utility Infrastructure Guidelines
- Controls Guidelines

Recommission 1 Building/Campus/Year

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New CSU Policy on Energy Efficiency & Sustainability

- **15% energy use reduction by 2010**
- **15% better than Title 24 for new buildings**
- **10% better than Title 24 for EB & R**
- **2006/07 new buildings LEED Silver or CSU equivalent**
- **2005/06 Savings by Design Strongly Encouraged**
- **MRB Review Required**

Brief History of Monitoring-Based Commissioning (MBCx)

1993	SMUD/PECI	1st National Conference on Building Cx
1994-1999	California Utilities/CIEE	"Diagnostics for Cx & Operations"
		IMDS 160 Sansome Street
	CEC/CIEE	IMDS 925 L Street
	Texas A&M	~ 100 Buildings
	California Cx Collaborative	
2000-03	SMUD/CIEE	IMDS 925 L Street
		Persistence of Retro-Cx
	PIER	
	UC Santa Barbara	
	CSU Long Beach	
	Central Florida State University	
	UC Merced	Planning and Design
2004-05	**UC/CSU/IOU Partnership**	**CSU/UC Campuses**
	PIER	

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Case Study #1: Lab Building (original Cx in 1996) plus District Chilled Water Pumping

	Lab Building	District System	Overall Project
Building Floor Area (gsf)	**113,000**	**n/a**	
Project Budget	**$ 67,500**	**$161,500**	**$239,000**
Engineering		$ 15,000	
Monitoring Equipment	$ 10,000	$ 89,000	
Prep by Staff	$ 7,500	$ 7,500	
Cx Provider	$ 50,000	$ 50,000	
Savings Target			**1,241,310 kWh/yr**
			90 kW
			13,292 th/yr

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Case Study #1: Lab Building Benchmarking (113,000 gsf)

(Preliminary)	Electricity Annual Use	Electricity Maximum Power	Chilled Water Annual Use	Chilled Water Maximum
Historical	**2,417,000 kWh/yr***	n/a	n/a ton-hr/yr	n/a tons
Revised	n/a	**364 kW***		
Index	**21 kWh/yr/gsf***	**3.2 W/gsf***		
Typical UC/CSU Lab Building (climate normalized)	**~35 kWh/yr/gsf***	**~5 W/gsf***		

* Not Including Chilled Water Production

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Case Study #1: Lab Building Benchmarking (113,000 gsf)

(Preliminary)	**Thermal / Natural Gas** Annual Use
Historical	n/a
Revised	**~135,000 therms/year**
Index	**~1.2 therms/year/gsf**
Typical UC/CSU Lab Building (climate normalized)	**~1.8 therms/year/gsf**

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Case Study #1: Lab Building (original Cx in 1996) plus District Chilled Water Pumping

Initial Lab Building Cx:

12 VAV Fume Hood Valves Re-Commissioned
53 CV Exhaust Valves Re-Commissioned
3 Valves Failed Fully Open
1 Valve Failed Fully Closed
1 Temperature Control Adjustment
Minimum Air Change Rates Reduced to Code Levels

Savings:

Overall Targets	(Lab Only) Preliminary Savings Measurements
1,241,310 kWh/yr	150,000 kWh/yr
90 kW	17 kW
13,292 therms/yr	43,000 therms/yr

(Lab Only Project Budget: $67,500)

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Case Study #2: Lab Building

Building Floor Area (gsf)	**100,800**
Project Budget	**$114,140**
Monitoring Equipment	$ 52,780
Prep by Staff	$ 7,500
Cx Provider	$ 51,360
Staff Training for Ongoing Cx	$ 2,500
Savings Target	**369,559 kWh/yr**
	27 kW
	3,000 th/yr

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Case Study #2: Lab Building Benchmarking (100,800 gsf)

(Preliminary)	Electricity Annual Use	Maximum Power	Chilled Water Annual Use	Maximum
Historical	**7,391,185 kWh/yr***	**1,101 kW***	**182 kton-hr/yr**	**543 tons**
Revised	n/a	n/a	n/a	n/a
Index	**73 kWh/yr/gsf***	**11 W/gsf***	**1.8 ton-hr/yr/gsf**	**5 tons/kgsf**
Typical UC/CSU Lab Building (climate normalized)	**~35 kWh/yr/gsf***	**~5.5 W/gsf***	**n/a**	**~3 tons/kgsf**

* Not Including Chilled Water Production
(Thermal/Gas Benchmark Data Under Review)

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Case Study #2: Lab Building

Initial Cx Measures:

(In documentation)

Savings:

Overall Targets	Preliminary Savings Measurements
369,559 kWh/yr	(Partial) 500,000 kWh/yr
27 kW	TBD kW
3,000 therms/yr	TBD therms/yr

(Project Budget: $114,100)