University of Iowa's PI Powered Energy Control Center

Presented by **George Paterson**

George Paterson

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- Senior Utilities Systems Specialist
- University of Iowa

Agenda

- Background on University of Iowa

- 2020 Energy Goal

- PI System Role in Meeting Energy Goal

Facilities Management
THE UNIVERSITY OF IOWA

University of Iowa

1. Fall 2013 student enrollment: 31,065
2. Main campus square footage: ~15,000,000
3. Annual utilities budget: ~$90,000,000
4. Annual "fuels" (fuels & purchased electricity): ~$30,000,000
5. More than 120 major buildings.

Notable Alumni

- **James Van Allen** — World famous physicist and discoverer of two radiation belts (the Van Allen Belts) that surround the earth. Emeritus Carver Professor of Physics at the University of Iowa. MS, 1936; PhD, 1939, Physics

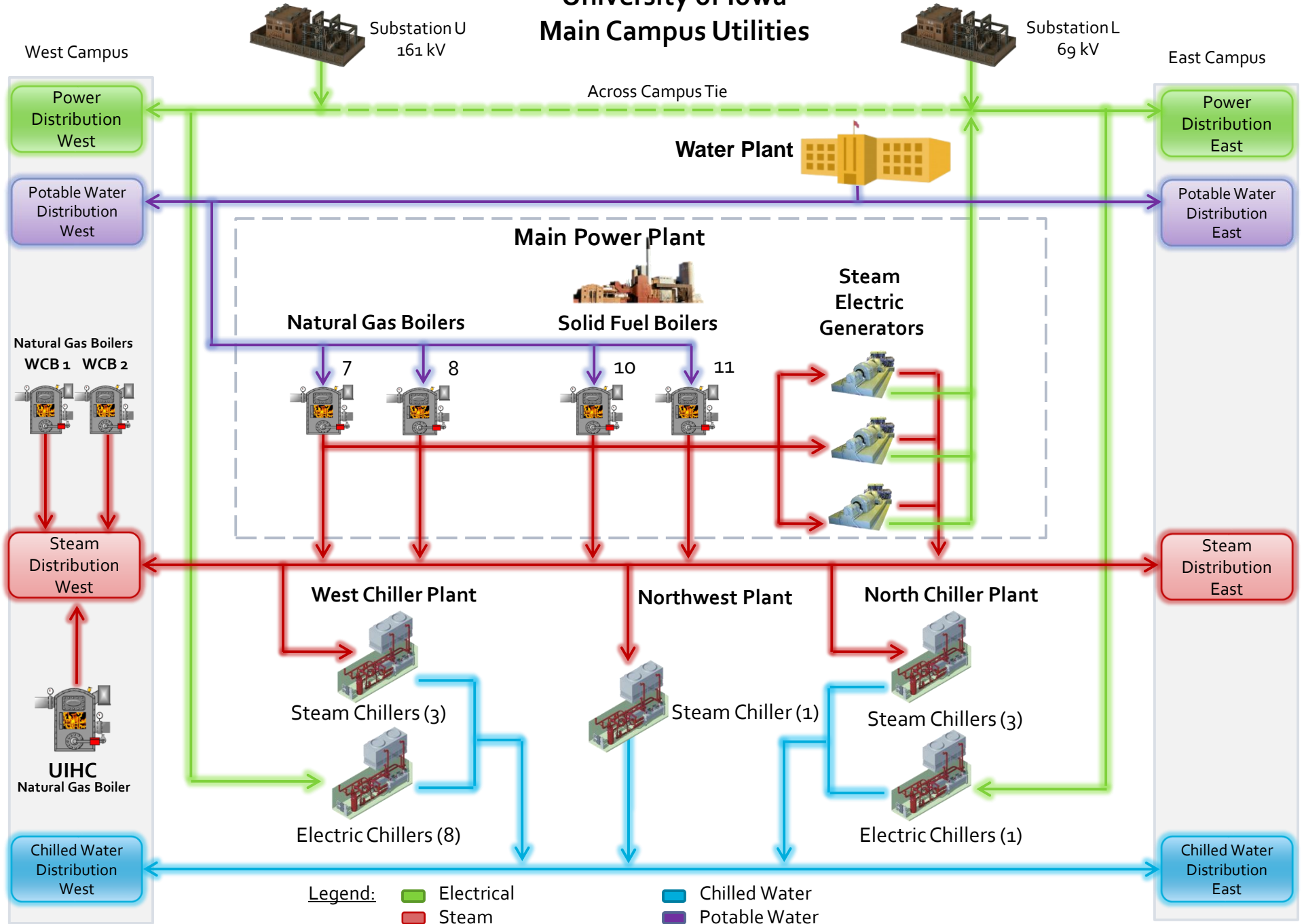- **George Gallup** — Founder of the Gallup Poll. BA, 1923.

Favorite Alumni

- **Gene Wilder** — Comedic film and television actor whose credits include "Silver Streak," "Young Frankenstein," and "Stir Crazy." BA, 1955, Communication and Theatre Arts

University of Iowa
Main Campus Utilities

Legend:
- Electrical
- Steam
- Chilled Water
- Potable Water

2020 "Net-Negative" Energy Goal

- Goal is to use no more energy in 2020 than in 2010 despite a billion dollars of new construction on campus.

Facilities Management
THE UNIVERSITY OF IOWA

2020 Energy Goal Progress

Chart with x-axis labels: Dec-10, Apr-11, Aug-11, Dec-11, Apr-12, Aug-12, Dec-12, Apr-13, Aug-13, Dec-13, Apr-14, Aug-14, Dec-14, Apr-15, Aug-15, Dec-15, Apr-16, Aug-16, Dec-16, Apr-17, Aug-17, Dec-17, Apr-18, Aug-18, Dec-18, Apr-19, Aug-19, Dec-19, Apr-20, Aug-20, Dec-20

Y-axis labels: 10.00%, 5.00%, 0.00%, -5.00%, -10.00%

Annotations on chart: ITF and CoPH; Demo. Art and Hancher/Voxman; IBDB; -1.4%; West Campus Residence Hall; Biomedical Research Support Facility; Hancher/Art/Music; UIHC Children's Hospital; Demo. Quadrangle; Seamans Center Expansion; New Pharmacy Building; Demo. Old Pharmacy Building

Legend: % Projected from Baseline — % Actual from Baseline ---- Linear (% Projected from Baseline) ---- Linear (% Actual from Baseline)
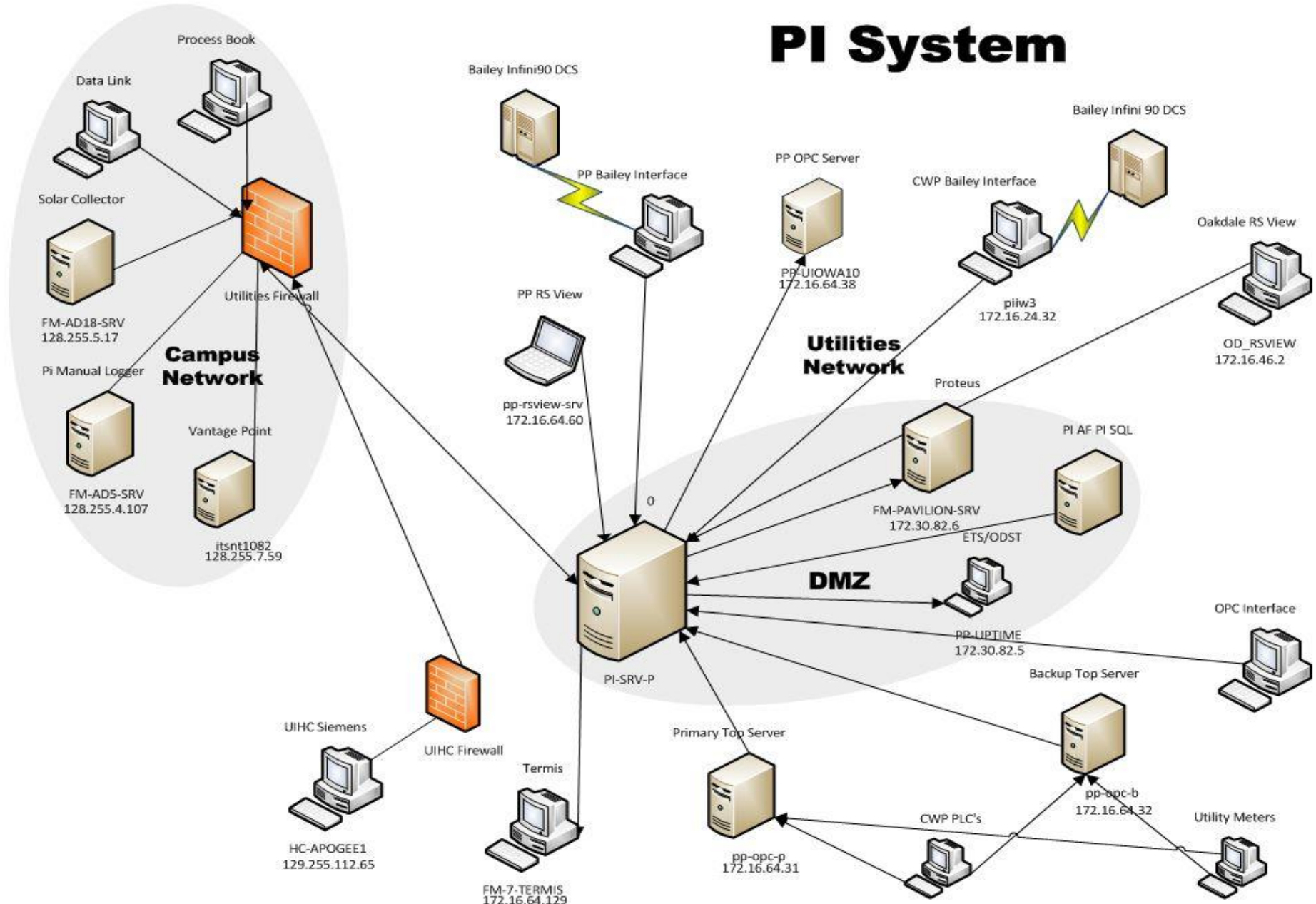
Energy Control Center (ECC)

- Purpose - Use real-time and historical information to optimize energy supply and consumption at the University of Iowa

PI System

Process Book

Data Link

Solar Collector

FM-AD18-SRV
128.255.5.17

Pi Manual Logger

FM-AD5-SRV
128.255.4.107

Vantage Point

itsnt1082
128.255.7.59

Campus Network

Utilities Firewall

Bailey Infini90 DCS

PP Bailey Interface

PP RS View

pp-rsview-srv
172.16.64.60

PP OPC Server

PP-UIOWA10
172.16.64.38

CWP Bailey Interface

Bailey Infini 90 DCS

piiw3
172.16.24.32

Oakdale RS View

OD_RSVIEW
172.16.46.2

Utilities Network

Proteus

PI AF PI SQL

FM-PAVILION-SRV
172.30.82.6

ETS/ODST

DMZ

PP-UPTIME
172.30.82.5

OPC Interface

PI-SRV-P

Backup Top Server

UIHC Siemens

UIHC Firewall

Termis

Primary Top Server

pp-opc-p
172.16.64.31

CWP PLC's

pp-opc-b
172.16.64.32

Utility Meters

HC-APOGEE1
129.255.112.65
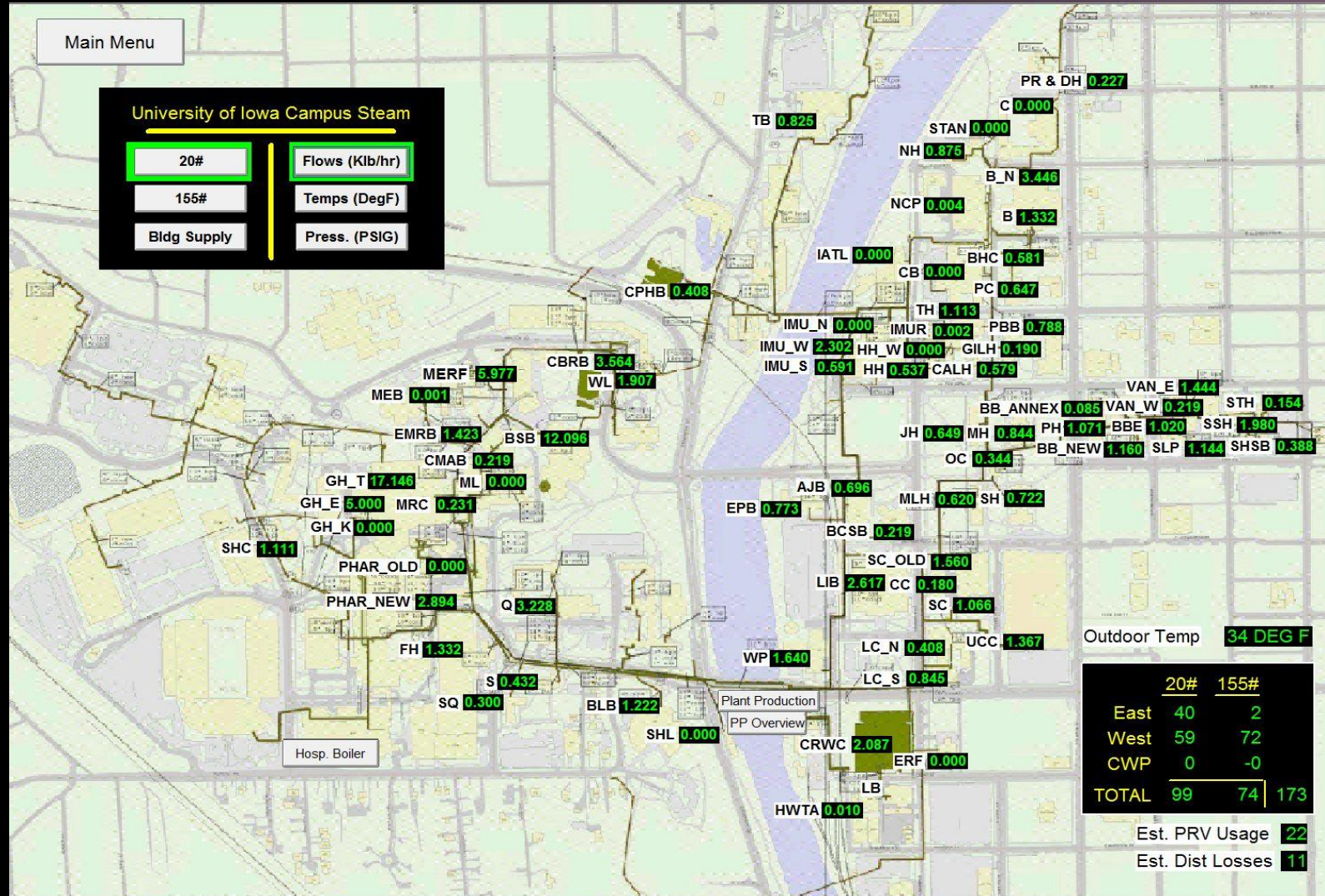
FM-7-TERMIS
172.16.64.129

PI System is the backbone of the ECC

- Monitoring and visualization

- Analysis

- Benchmarking

- Demand management

- Link optimization models to live data

Facilities Management
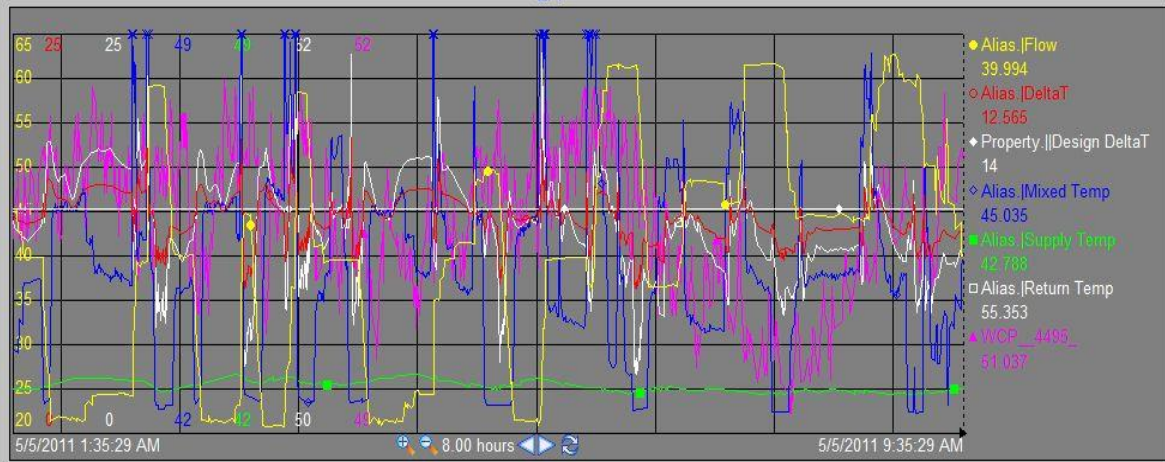THE UNIVERSITY OF IOWA
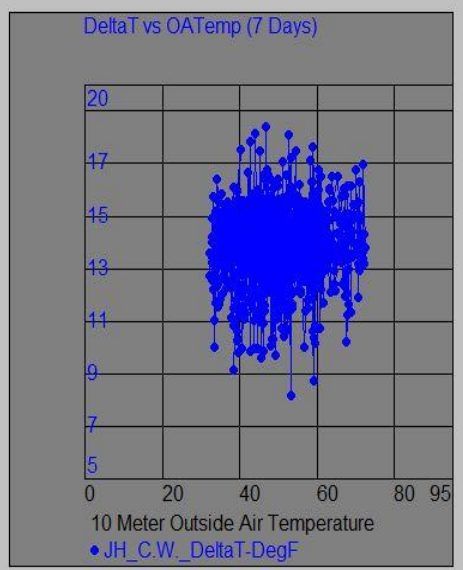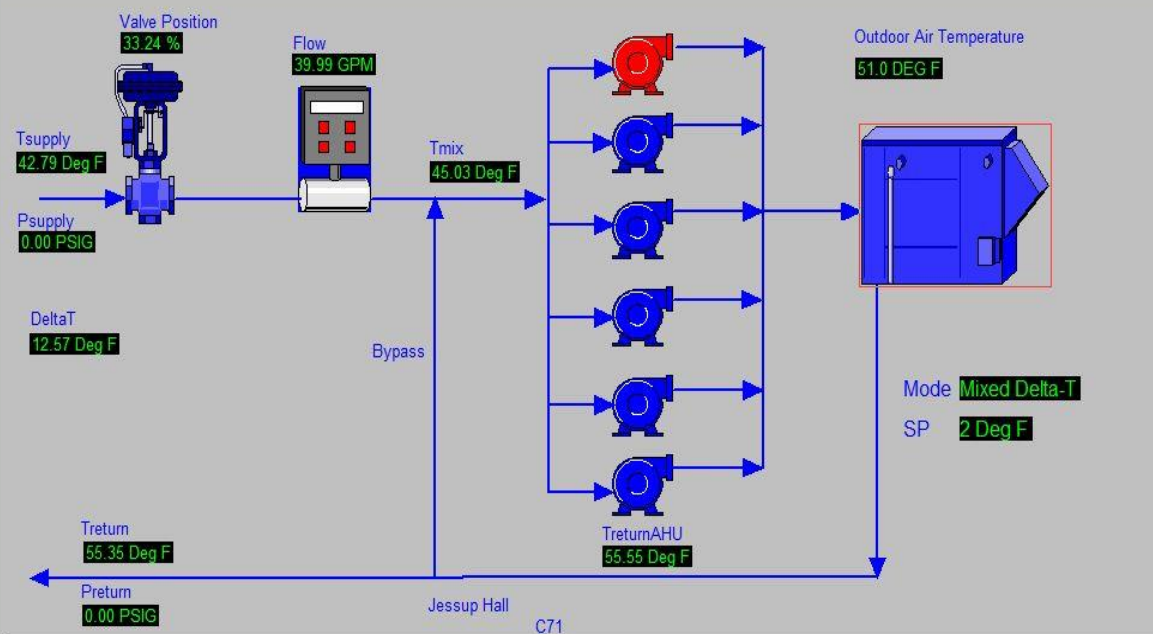
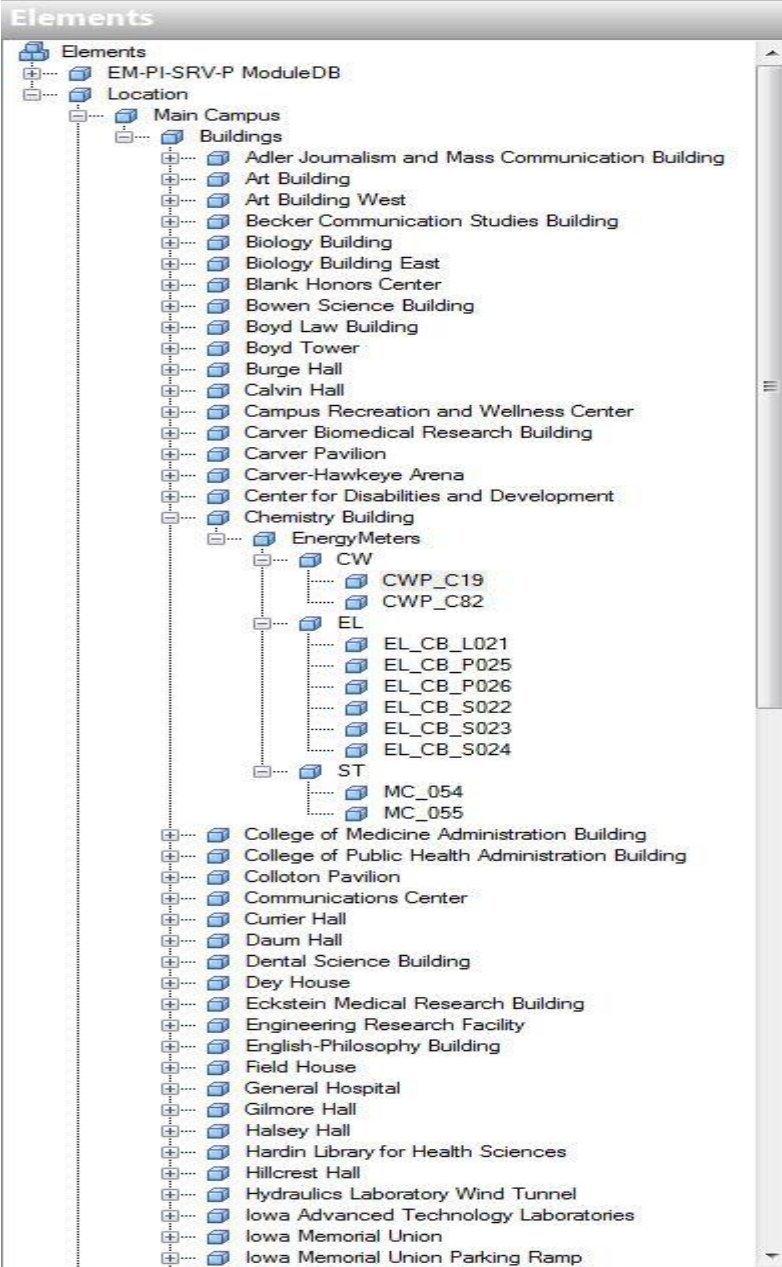# Power Plant Overview
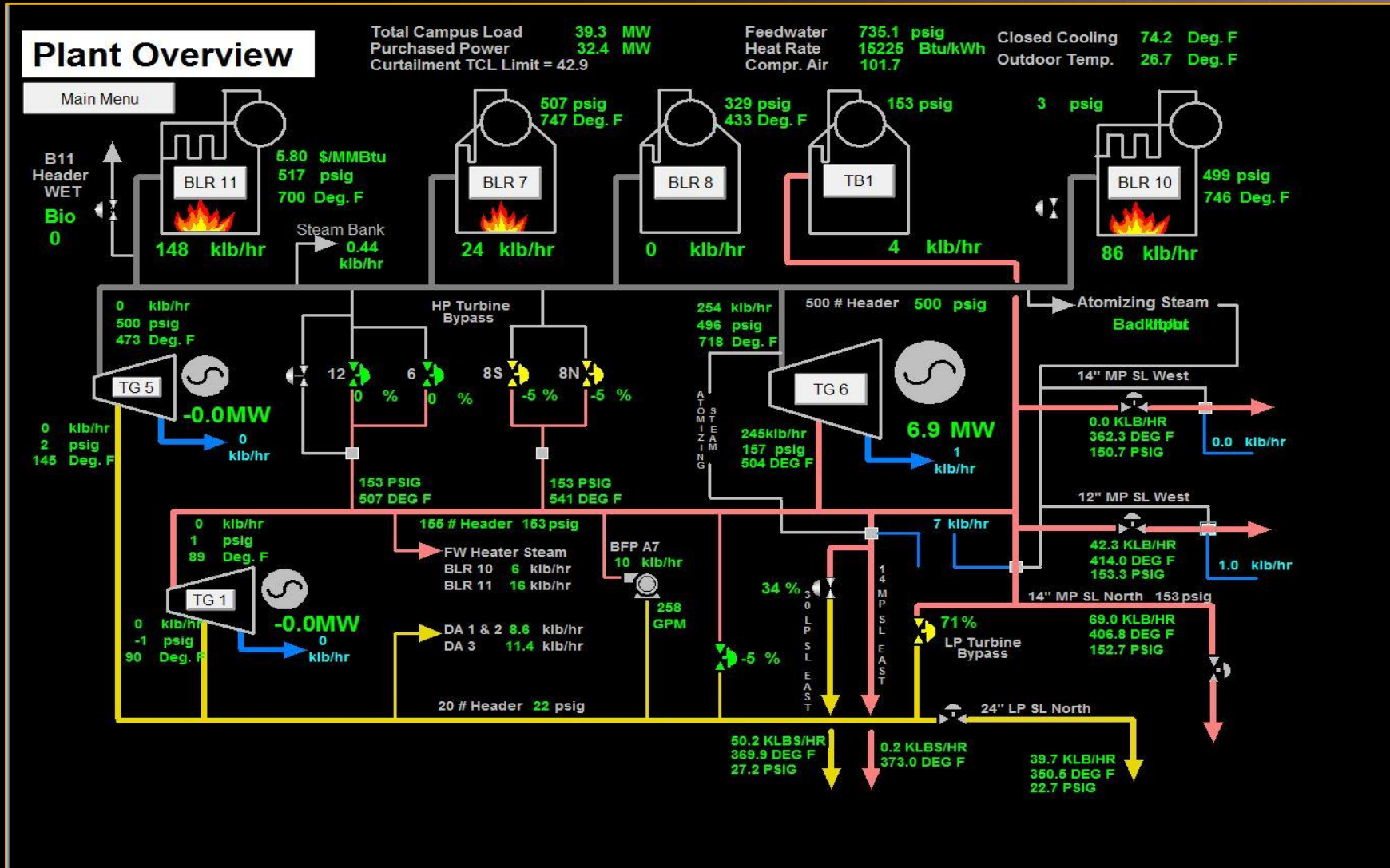
Geographical Displays of Steam, Chilled Water and Electricity Consumption

Available Modules

- Interface1
- John Colloton Pavilio
  - Chilled Water
    - Interface1
- John Pappajohn Pav
  - Chilled Water
    - Interface1
- Kinnick Stadium
  - Chilled Water
    - Interface1
    - Press Box
- Library
  - Chilled Water
    - Interface1
- Lindquist Center
  - Chilled Water
    - North
    - South
    - South2
- Macbride Hall
  - Chilled Water
    - Interface1
    - Winter Interfa
- Maclean Hall
  - Chilled Water
    - Interface1
    - Winter Interfa
- Medical Education B
  - Chilled Water
    - Interface1
    - Winter Interfa
- Medical Education an
  - Chilled Water
    - Interface1
    - Interface2
- Medical Library
  - Chilled Water
    - Courtyard
    - Interface1
- Medical Research Ce
  - Chilled Water
    - Interface1
- Medical Research Fa
  - Chilled Water
    - Interface1
- Museum of Art
  - Chilled Water
    - Interface1
- North Hall
  - Chilled Water
    - Interface1
    - Winter Interfa
- Nursing Building
  - Chilled Water
    - Interface1
- Old Capitol
  - Chilled Water
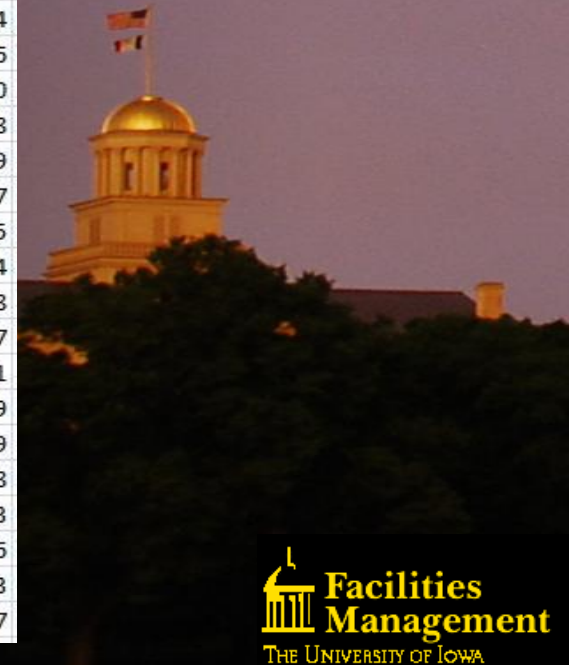   - Interface1
- Pappajohn Business

\\172.26.24.14\Campus\t
Hall\Chilled
Water\Interface1

Valve Position
33.24 %

Flow
39.99 GPM

Tsupply
42.79 Deg F

Psupply
0.00 PSIG

Tmix
45.03 Deg F

Outdoor Air Temperature
51.0 DEG F

DeltaT
12.57 Deg F

Bypass

Mode Mixed Delta-T
SP 2 Deg F

Treturn
55.35 Deg F

TreturnAHU
55.55 Deg F

Preturn
0.00 PSIG

Jessup Hall
C71

DeltaT vs OATemp (7 Days)

20
17
15
13
11
9
7
5

0   20   40   60   80 95

10 Meter Outside Air Temperature
● JH_C.W._DeltaT-DegF

● Alias.|Flow
39.994
○ Alias.|DeltaT
12.565
♦ Property.||Design DeltaT
14
◇ Alias.|Mixed Temp
45.035
■ Alias.|Supply Temp
42.788
□ Alias.|Return Temp
55.353
▲ WCP__4495_
51.037

5/5/2011 1:35:29 AM   8.00 hours   5/5/2011 9:35:29 AM

Elements

- Elements
  - EM-PI-SRV-P ModuleDB
  - Location
    - Main Campus
      - Buildings
        - Adler Journalism and Mass Communication Building
        - Art Building
        - Art Building West
        - Becker Communication Studies Building
        - Biology Building
        - Biology Building East
        - Blank Honors Center
        - Bowen Science Building
        - Boyd Law Building
        - Boyd Tower
        - Burge Hall
        - Calvin Hall
        - Campus Recreation and Wellness Center
        - Carver Biomedical Research Building
        - Carver Pavilion
        - Carver-Hawkeye Arena
        - Center for Disabilities and Development
        - Chemistry Building
          - EnergyMeters
            - CW
              - CWP_C19
              - CWP_C82
            - EL
              - EL_CB_L021
              - EL_CB_P025
              - EL_CB_P026
              - EL_CB_S022
              - EL_CB_S023
              - EL_CB_S024
            - ST
              - MC_054
              - MC_055
        - College of Medicine Administration Building
        - College of Public Health Administration Building
        - Colloton Pavilion
        - Communications Center
        - Currier Hall
        - Daum Hall
        - Dental Science Building
        - Dey House
        - Eckstein Medical Research Building
        - Engineering Research Facility
        - English-Philosophy Building
        - Field House
        - General Hospital
        - Gilmore Hall
        - Halsey Hall
        - Hardin Library for Health Sciences
        - Hillcrest Hall
        - Hydraulics Laboratory Wind Tunnel
        - Iowa Advanced Technology Laboratories
        - Iowa Memorial Union
        - Iowa Memorial Union Parking Ramp

- Elements
- Event Frames
- Library
- Unit of Measure

CWP_C19

Tabs: General | Child Elements | **Attributes** | Ports | Version

Filter

Name	Value
AHURetTemp	49.9337310791016 °F
BldgDeltaT	4.87809896469116 °F
D_Gallons	0 US gal
Deduct	False
DeltaT	7.34057760238647 delta °F
DeltaT_HAvg	7.32837200164795 delta °F
Flow	0.881630897521973 US gal/min
Flow_HAvg	2.51170539855957 US gal/min
M_Gallons	0 US gal
M_MMBTU	0 MM Btu
MixTemp	45.1555023193359 °F
Multiplier	1
Power	0.00323842868196881 MM Btu/h
Power_HAvg	0.00921071844420366 MM Btu/h
RetPress	57.5731735229492 psi
RetTemp	49.7053756713867 °F
Station_CO	0 %
Station_Local_Remote	Remote
Station_Mode	Mixed Delta-T
Station_PV	2.6490273475647 °F
Station_SP	3 °F
SupPress	106.992134094238 psi
SupTemp	42.3294830322266 °F

AF Organizes Energy Data by Buildings

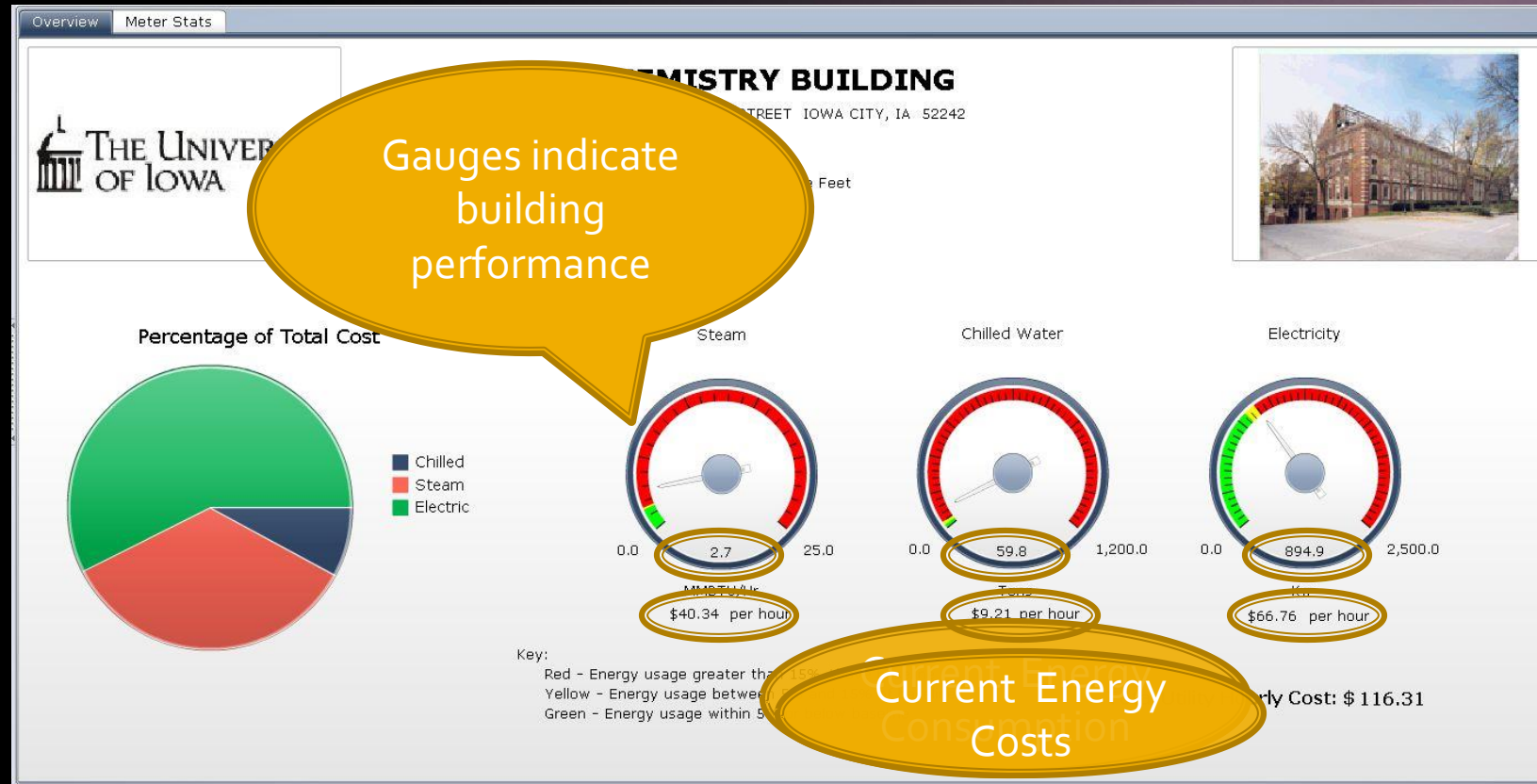| \\EM-AF-SRV\PIDB-AF\Location\Main Campus\Buildings	Start	3/1/2013
	End	3/1/2014
		Hourly Peak (KW)
Adler Journalism and Mass Communication Building\EnergyMeters\EL|Power_Havg	04-Mar-13 14:00:01	357
Art Building West\EnergyMeters\EL|Power_Havg	11-Feb-14 15:00:01	231
Becker Communication Studies Building\EnergyMeters\EL|Power_Havg	22-Apr-13 14:00:01	63
Biology Building East\EnergyMeters\EL|Power_Havg	10-Feb-14 15:00:01	373
Biology Building\EnergyMeters\EL|Power_Havg	09-Apr-13 15:00:01	617
Blank Honors Center\EnergyMeters\EL|Power_Havg	17-Jun-13 15:00:01	121
Bowen Science Building\EnergyMeters\EL|Power_Havg	26-Aug-13 14:00:01	1578
Boyd Law Building\EnergyMeters\EL|Power_Havg	27-Aug-13 16:00:01	401
Boyd Tower\EnergyMeters\EL|Power_Havg	10-Sep-13 12:00:01	992
Burge Hall\EnergyMeters\EL|Power_Havg	30-Aug-13 14:00:01	994
Calvin Hall\EnergyMeters\EL|Power_Havg	09-Apr-13 15:00:01	86
Campus Recreation and Wellness Center\EnergyMeters\EL|Power_Havg	03-Oct-13 17:00:01	1060
Carver Biomedical Research Building\EnergyMeters\EL|Power_Havg	19-Sep-13 14:00:01	738
Carver Pavilion\EnergyMeters\EL|Power_Havg	08-Jan-14 12:00:01	2109
Carver-Hawkeye Arena\EnergyMeters\EL|Power_Havg	28-Jan-14 17:00:01	927
Center for Disabilities and Development\EnergyMeters\EL|Power_Havg	01-May-13 11:00:01	155
Chemistry Building\EnergyMeters\EL|Power_Havg	29-Aug-13 15:00:01	1094
College of Public Health Administration Building\EnergyMeters\EL|Power_Havg	08-Apr-13 13:00:01	348
Colloton Pavilion\EnergyMeters\EL|Power_Havg	12-Aug-13 11:00:01	3227
Communications Center\EnergyMeters\EL|Power_Havg	10-Sep-13 14:00:01	61
Currier Hall\EnergyMeters\EL|Power_Havg	30-Aug-13 15:00:01	489
Daum Hall\EnergyMeters\EL|Power_Havg	30-Aug-13 14:00:01	269
Dental Science Building\EnergyMeters\EL|Power_Havg	02-Jan-14 13:00:01	1128
Eckstein Medical Research Building\EnergyMeters\EL|Power_Havg	09-Aug-13 12:00:01	823
English-Philosophy Building\EnergyMeters\EL|Power_Havg	22-Oct-13 13:00:01	106
Field House\EnergyMeters\EL|Power_Havg	21-Nov-13 12:00:01	343
General Hospital\EnergyMeters\EL|Power_Havg	11-Jun-13 13:00:01	1377

Click the building icon to get information in detail

Energy Intensity

MMBTU/h/1000Sq.Ft. e-3

- 0 - 3
- 3 - 12
- 12 - 17
- 17 - 22
- 22 - 26
- 26 - 33
- 33 - 40
- 40 - 45
- 45 - 56
- 56 - 71

Facilities Management
The University of Iowa
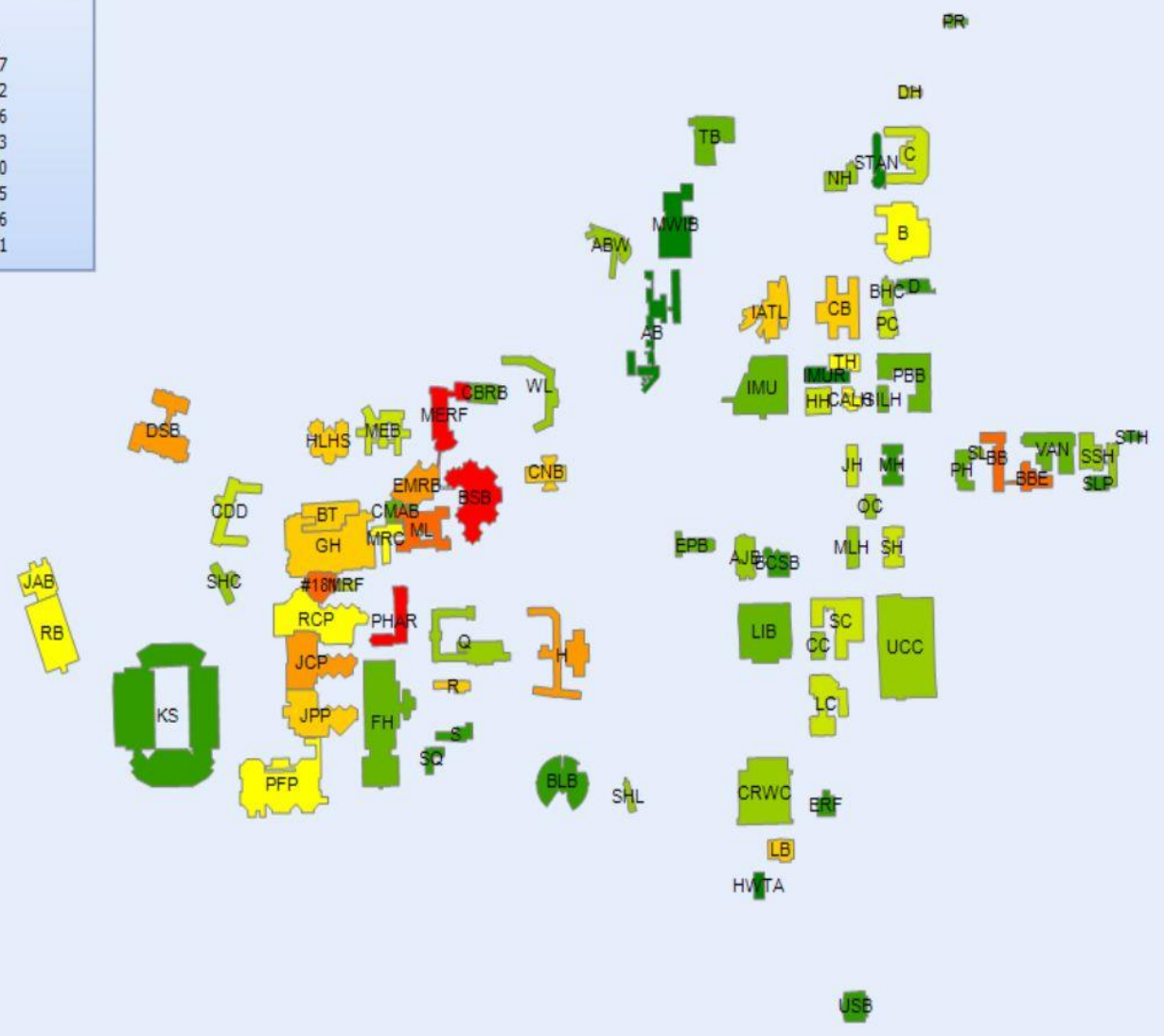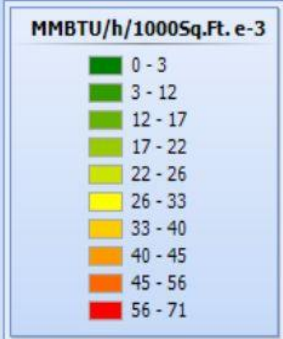
Building Energy Dashboard

- Building dashboards monitor the demand for steam, chilled water and electricity in all buildings.

Building Matrix

Daily Utilities — Below / Baseline / Above

Data from 03/06/2010 23:05 to 03/07/2010 23:05

MAIN CAMPUS (WEST)	Consumed			units per k-Sq Ft			Dollars			Total	
Building Name	Ton-Hours	mmBtu	KW	Ton-Hours	mmBtu	KW	Ton-Hours	mmBtu	KW	$/day	$/ksq ft
ART BUILDING				-	-	-	$0.00	$0.00	$0.00	$0.00	$0.00
ART BUILDING WEST				-	-	-	$0.00	$0.00	$0.00	$0.00	$0.00
BOWEN SCIENCE BUILDING	135.42	329.99	18,643.04	0.42	1.01	57.19	$22.36	$4,953.68	$1,390.77	$6,366.82	$19.53
BOYD LAW BUILDING		46.38	1,407.21	-	0.24	7.42	$0.00	$696.28	$104.98	$801.26	$4.22
CARVER BIOMEDICAL RESEARCH BUILDIN		72.86	12,595.43	-	0.54	93.56	$0.00	$1,093.68	$939.62	$2,033.30	$15.10
CARVER-HAWKEYE ARENA		56.13		-	0.26	-	$0.00	$842.54	$0.00	$842.54	$3.95
COLLEGE OF MEDICINE ADMINISTRATION	213.33	6.44		6.17	0.19	-	$32.71	$96.67	$0.00	$129.38	$3.74
DENTAL SCIENCE BUILDING	159.72	118.74	5,845.74	0.80	0.59	29.11	$21.12	$1,782.44	$436.09	$2,239.65	$11.15
ECKSTEIN MEDICAL RESEARCH BUILDING	518.19	134.17	14,676.79	3.77	0.98	106.72	$79.45	$2,014.14	$1,094.89	$3,188.48	$23.18
FIELD HOUSE		94.36	6,051.30	-	0.28	18.10	$0.00	$1,416.47	$451.43	$1,867.90	$5.59
HARDIN LIBRARY FOR HEALTH SCIENCES		49.26	7,809.25	-	0.56	89.34	$0.00	$739.41	$582.57	$1,321.98	$15.12
HILLCREST		86.62		-	0.32	-	$0.00	$1,300.30	$0.00	$1,300.30	$4.86
HYDRAULICS LABORATORY		0.47	1,507.63	-	0.01	44.36	$0.00	$7.07	$112.47	$119.54	$3.52
KINNICK STADIUM		35.22		-	0.09	-	$0.00	$528.72	$0.00	$528.72	$1.39
MEDICAL EDUCATION BUILDING	18.45	35.85	1,302.76	0.22	0.42	15.21	$2.85	$538.17	$97.19	$638.20	$7.45
MEDICAL EDUCATION RESEARCH FACILIT		138.51	17,703.24	-	0.65	82.52	$0.00	$2,079.32	$1,320.66	$3,399.98	$15.85
MEDICAL LABORATORIES	406.85	137.74	17,406.21	2.07	0.70	88.36	$62.59	$2,067.72	$1,298.50	$3,428.81	$17.41
MEDICAL RESEARCH CENTER	664.04		4,476.66	6.97	-	47.00	$102.44	$0.00	$333.96	$436.40	$4.58
MEDICAL RESEARCH FACILITY	118.46	7.19	1,804.67	3.45	0.21	52.60	$18.23	$107.93	$134.63	$260.80	$7.60
MUSIC WEST - INTERIM BUILDING	438.56	2.39	674.55	6.00	0.03	9.22	$72.33	$35.94	$50.32	$158.59	$2.17
NURSING BUILDING	6.79	28.35	1,647.40	0.09	0.37	21.27	$1.20	$425.53	$122.90	$549.62	$7.10
PHARMACY BUILDING	1,842.94	146.77	12,108.33	12.89	1.03	84.69	$283.59	$2,203.19	$903.28	$3,390.06	$23.71
QUADRANGLE		145.59		-	1.05	-	$0.00	$2,185.45	$0.00	$2,185.45	$15.80
RECREATION BUILDING	0.08	36.72	3,051.11	0.00	0.24	19.81	$0.00	$551.28	$227.61	$778.89	$5.06
RIENOW HALL				-	-	-	$0.00	$0.00	$0.00	$0.00	$0.00
SLATER HALL		48.16		-	0.41	-	$0.00	$722.90	$0.00	$722.90	$6.19
SOUTH QUAD		3.33	463.38	-	0.12	16.56	$0.00	$49.98	$34.57	$84.54	$3.02
THEATRE BUILDING	23.68	18.10	1,747.72	0.29	0.22	21.57	$3.75	$271.72	$130.38	$405.85	$5.01
WENDELL JOHNSON SPEECH AND HEARI		16.22	1,500.40	-	0.25	22.92	$0.00	$243.43	$111.93	$355.36	$5.43
WESTLAWN	437.79	34.29	2,828.71	3.09	0.24	19.97	$67.13	$514.73	$211.02	$792.88	$5.60
Totals ------>	4984	1830	135252	3.30	0.42	45.12	$769.77	$27,468.71	$10,089.76	$38,328.23	$9.01

Analysis re: Electrical Contract

Summer Average Daily Electrical Load Profiles
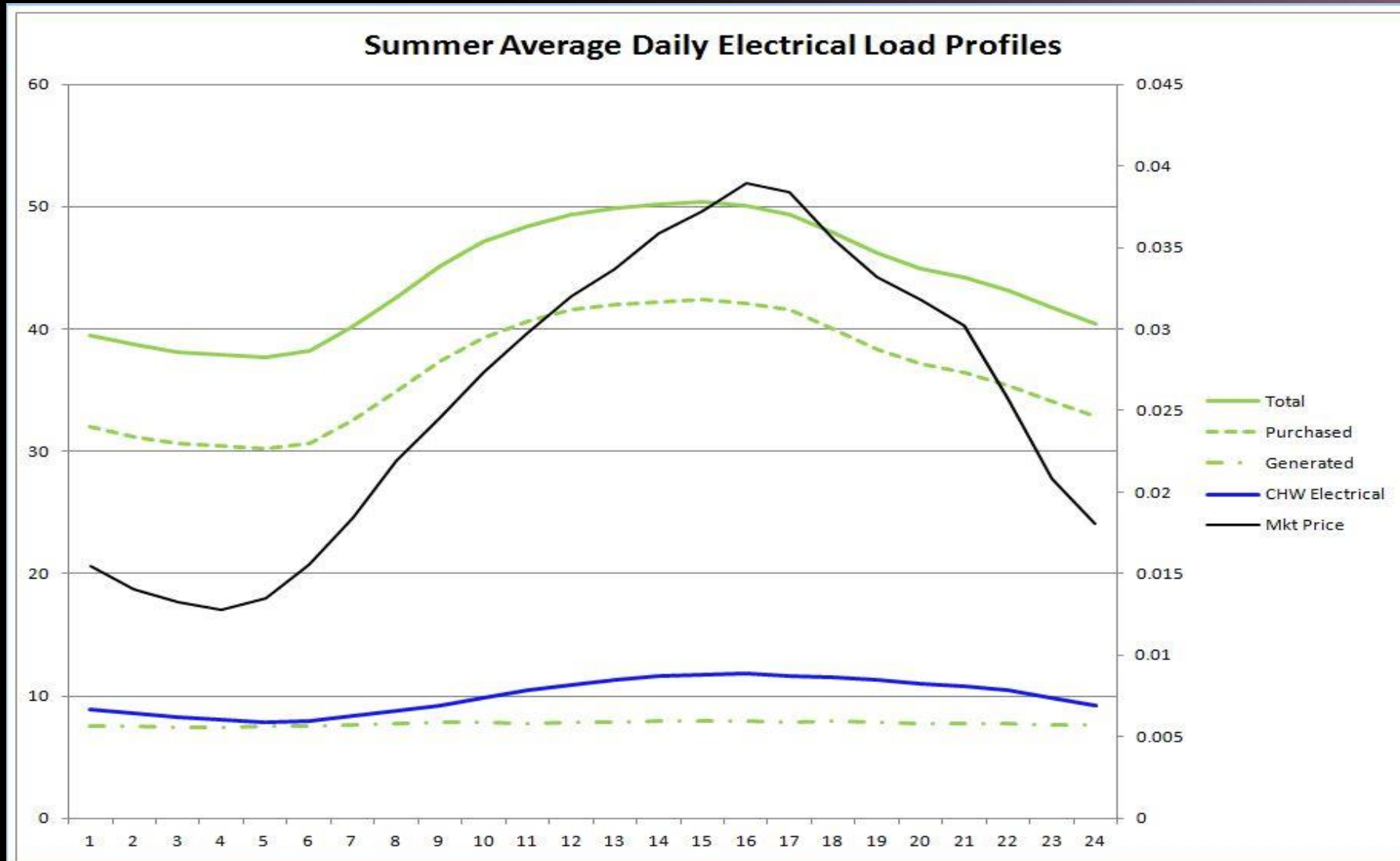
Purchased Electricity Costs

August 30, 2013
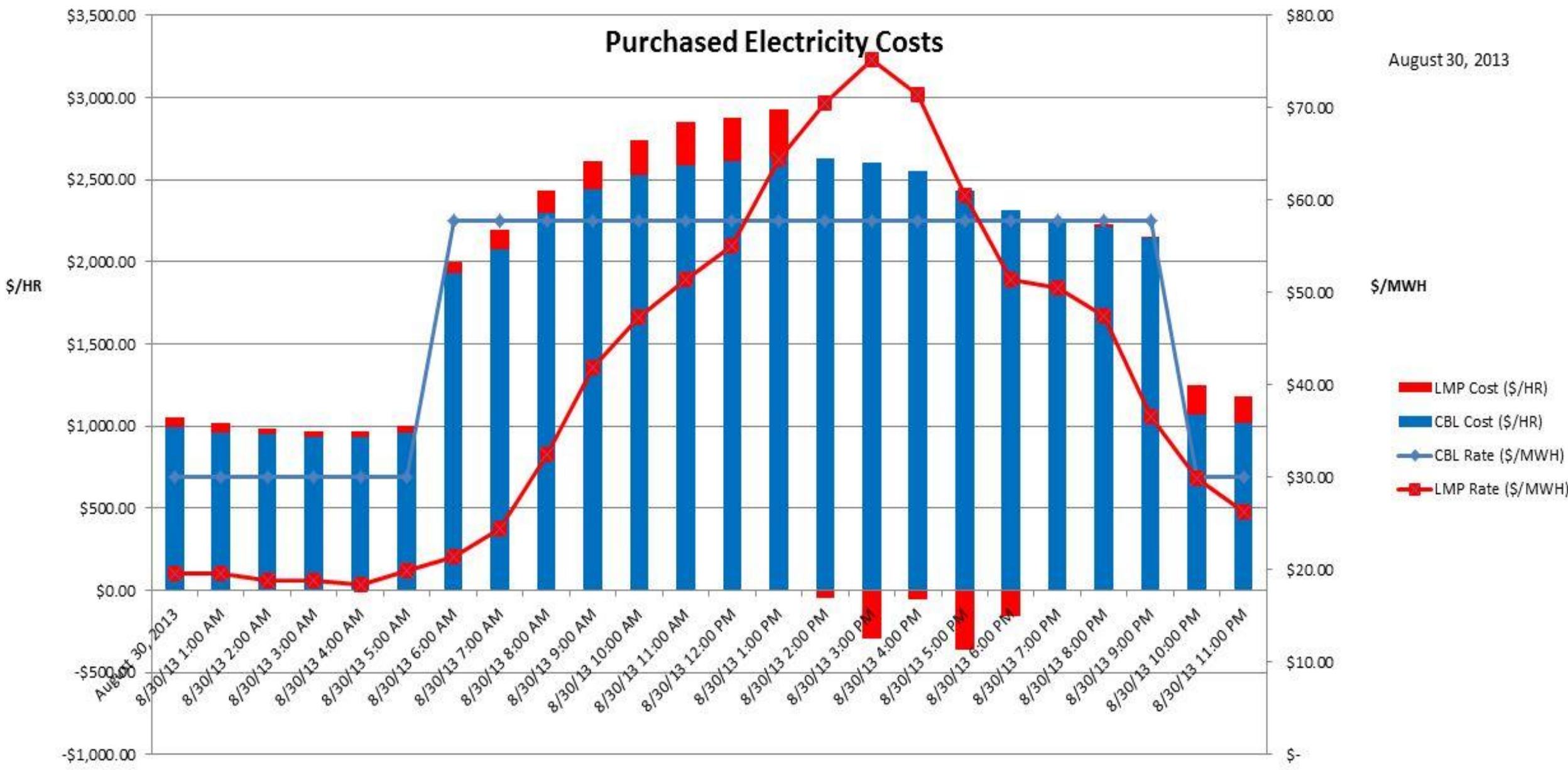
Legend:
- LMP Cost ($/HR)
- CBL Cost ($/HR)
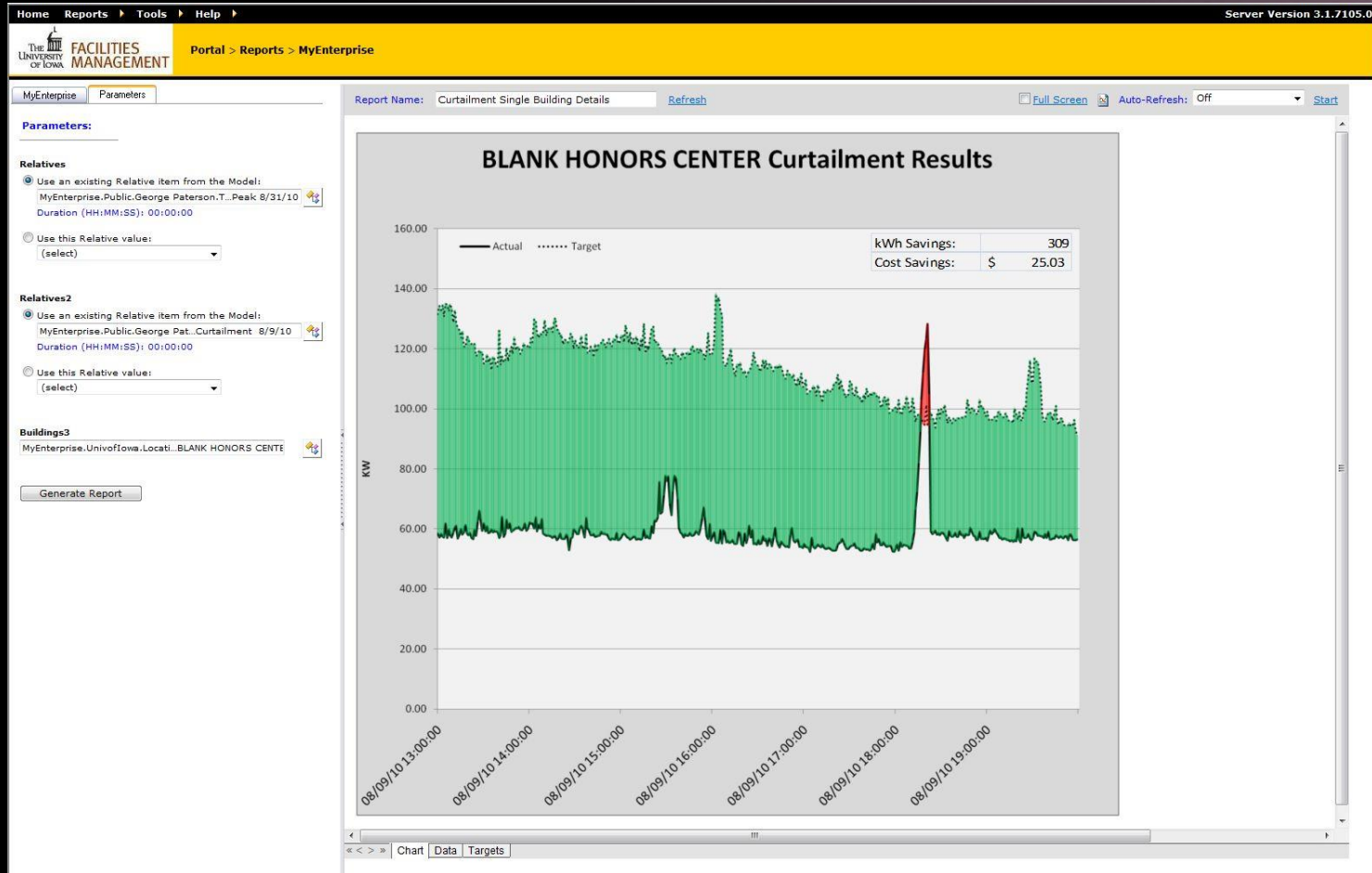- CBL Rate ($/MWH)
- LMP Rate ($/MWH)

Benchmarking
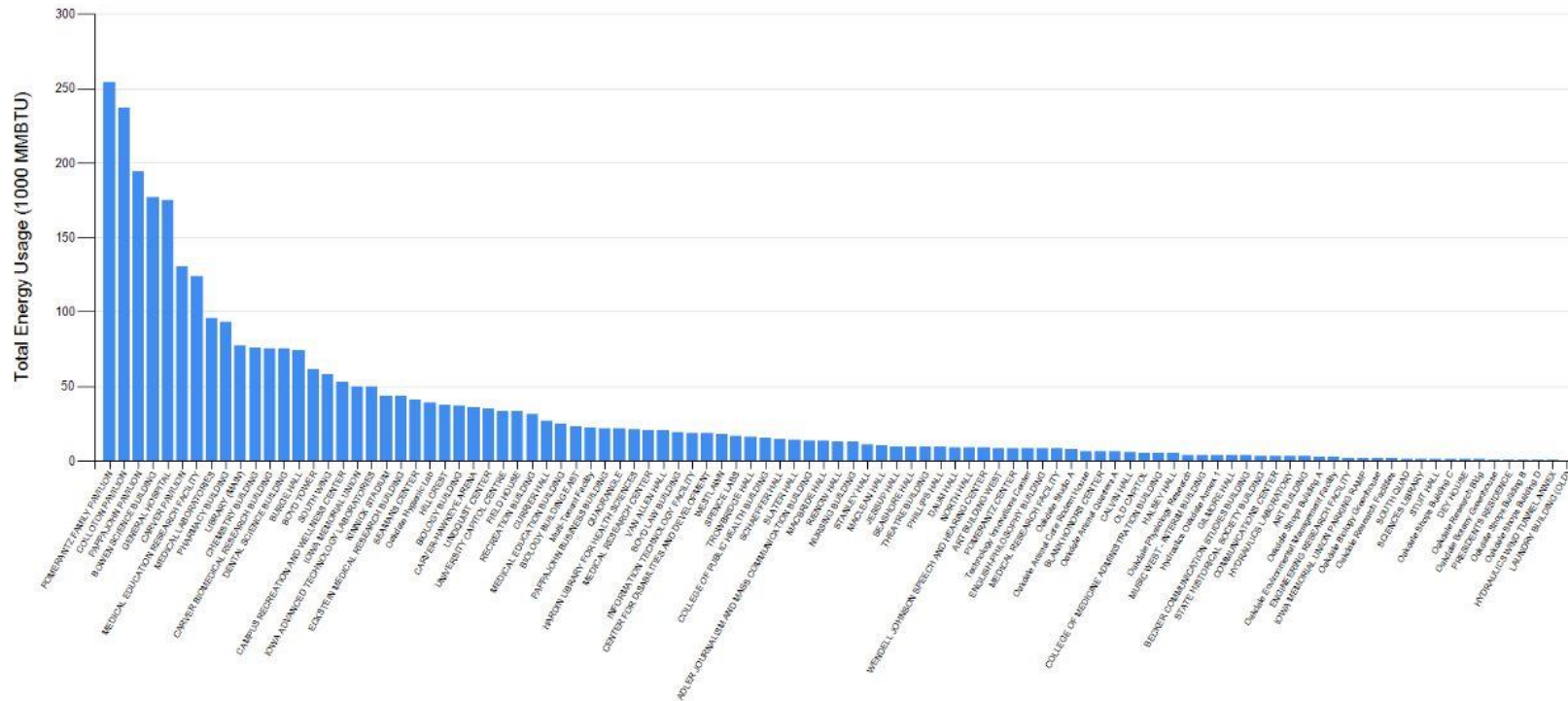
Demand Management

Curtailment Summary

EAST CAMPUS	Start	8/29/13 3:00 PM	8/30/13 3:00 PM			
	End	8/29/13 6:00 PM	8/30/13 6:00 PM			
	Peak Day (KWH)	Curtailment (KWH)	Avg KW Savings	Avg KW Savings Target	Target Savings %	Actual Savings %
ADLER JOURNALISM AND MASS COMMUNICATION BUILDING	818	583	78	170	62%	29%
BECKER COMMUNICATION STUDIES BUILDING	126	94	11		0%	25%
BIOLOGY BUILDING	1,480	1,601	(40)		0%	-8%
BIOLOGY BUILDING EAST	994	939	18		0%	6%
BLANK HONORS CENTER	-	-	-	112	0%	0%
BURGE HALL	2,850	2,872	(7)		0%	-1%
CALVIN HALL	191	103	30	54	84%	46%
CAMPUS RECREATION AND WELLNESS CENTER	2,927	2,948	(7)	116	12%	-1%
CHEMISTRY BUILDING	3,249	3,119	43		0%	4%
COMMUNICATIONS CENTER	159	117	14		0%	26%
CURRIER HALL	1,401	1,441	(13)		0%	-3%
DAUM HALL	731	762	(10)		0%	-4%
DEY HOUSE	-	-	-	49	0%	0%
ENGLISH-PHILOSOPHY BUILDING	410	285	42		0%	31%
GILMORE HALL	172	156	5		0%	9%
HALSEY HALL	253	217	12	50	60%	15%
IOWA ADVANCED TECHNOLOGY LABORATORIES	1,236	1,117	40	245	59%	10%
IOWA MEMORIAL UNION	1,500	1,419	27		0%	5%
IOWA MEMORIAL UNION PARKING RAMP	96	98	(0)		0%	-1%
JESSUP HALL	-	-	-	287	0%	0%
MADISON STREET SERVICES BUILDING	-	-	-	183	0%	0%
LIBRARY (MAIN)	2,193	1,506	229		0%	31%
LINDQUIST CENTER	1,619	1,332	96	101	19%	18%
MACBRIDE HALL	560	507	18	22	12%	9%
MACLEAN HALL	527	360	56		0%	32%
NORTH HALL	347	229	39	168	145%	34%
OLD CAPITOL	173	155	6	90	157%	10%
PAPPAJOHN BUSINESS BUILDING	1,561	1,138	141		0%	27%
PHILLIPS HALL	-	-	-	148	0%	0%
POMERANTZ CENTER	-	-	-		0%	0%
SCHAEFFER HALL	620	239	127		0%	61%
SCIENCES LIBRARY	56	32	8	84	446%	43%
SEAMANS CENTER	1,696	1,573	41	48	9%	7%
SEASHORE HALL	617	494	41		0%	20%
SPENCE LABS	464	353	37		0%	24%
STANLEY HALL	770	799	(10)		0%	-4%
STUIT HALL	44	32	4		0%	26%
TROWBRIDGE HALL	341	291	17	118	104%	15%
UNIVERSITY CAPITOL CENTRE	4,263	3,825	146		0%	10%
UNIVERSITY SERVICES BUILDING	1,126	258	289		0%	77%
VAN ALLEN HALL	986	857	43		0%	13%
EAST CAMPUS TOTALS	36,558	31,853	1,568		17%	13%
EAST and WEST CAMPUS COMBINED	69,827	62,977	2,283		12%	10%
EAST, WEST and UIHC COMBINED TOTALS	110,032	102,111	2,641		8%	7%
CHILLED WATER PLANTS	46,173	34,990	3,727			24%

Facilities Management
The University of Iowa

Chilled Water Dispatch
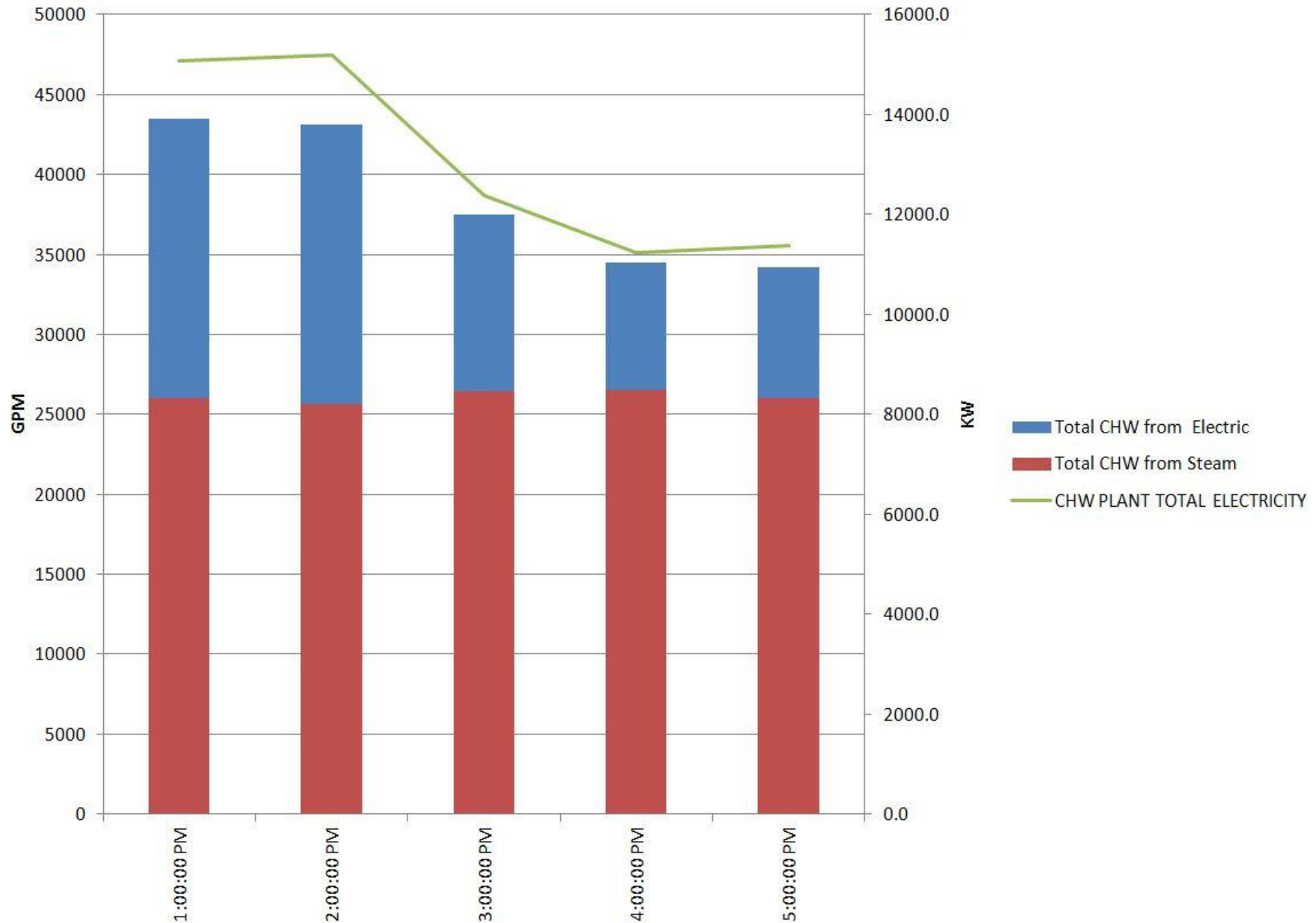
Optimization Models with Live Data

- Steam Distribution Model using Termis by 7 Technologies

- Optimized dispatch of steam, electric and chilled water production equipment using Proteus by Rockwell Automation.

Future

- Use ESRI with PI System for all of our maps

- Add building automation data hierarchy in AF and build fault detection system for building systems.

- Use Microsoft Business Intelligence Tools to analyze our data more quickly and completely.
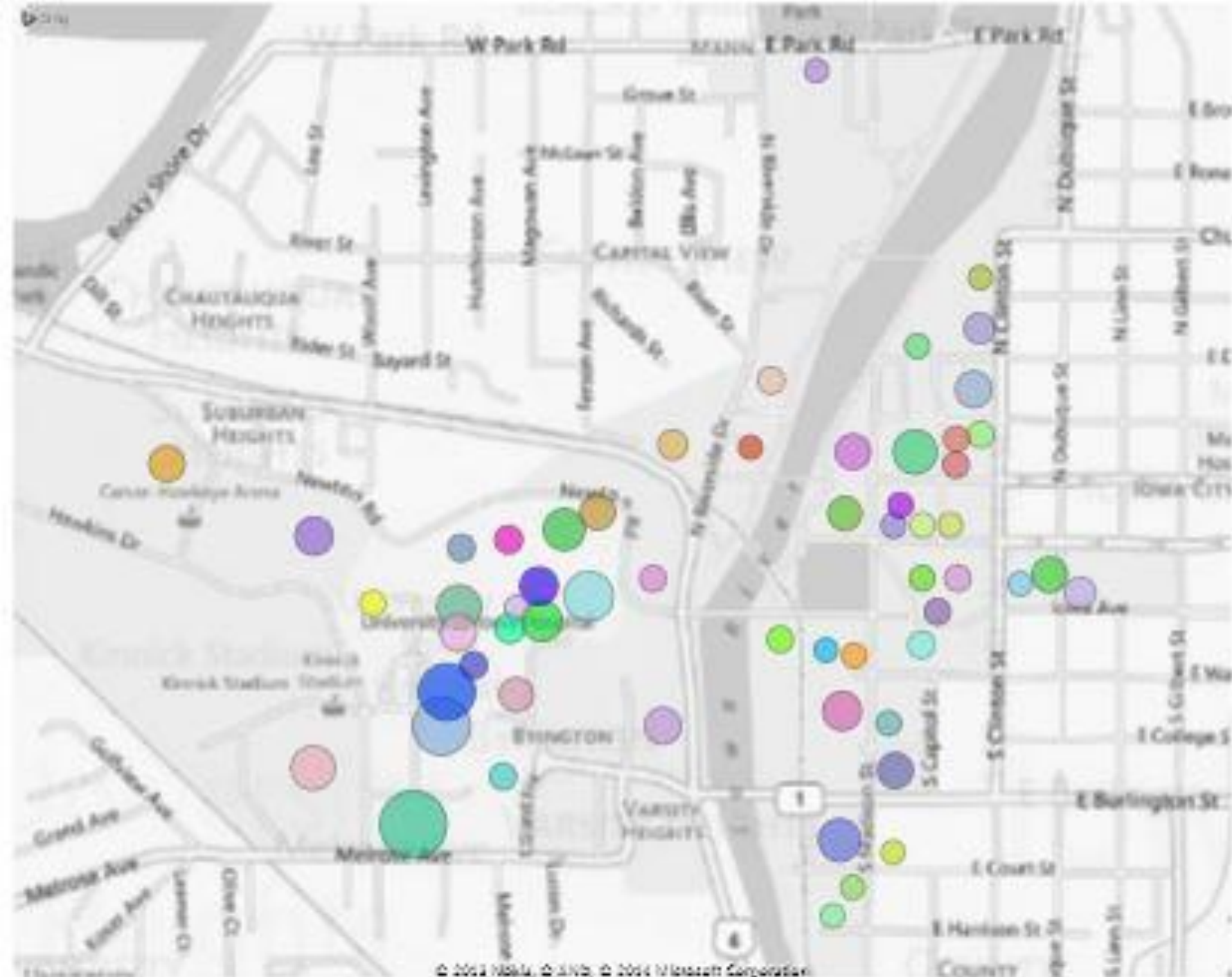
Building Name

- Adler Journalism and Mass Communication
- Art Building
- Becker Communication Studies Building
- Biology Building
- Biology Building East
- Blank Honors Center
- Bowen Science Building
- Boyd Tower
- Burge Hall
- Calvin Hall
- Campus Recreation and Wellness Center
- Carver Biomedical Research Building
- Carver Pavilion
- Carver-Hawkeye Arena
- Center for Disabilities and Development
- Chemistry Building
- College of Medicine Administration Building
- College of Public Health Administration Building
- Colloton Pavilion
- Communications Center
- Currier Hall
- Daum Hall
- Dental Science Building
- Dey House
- Eckstein Medical Research Building
- Engineering Research Facility
- English-Philosophy Building
- Field House
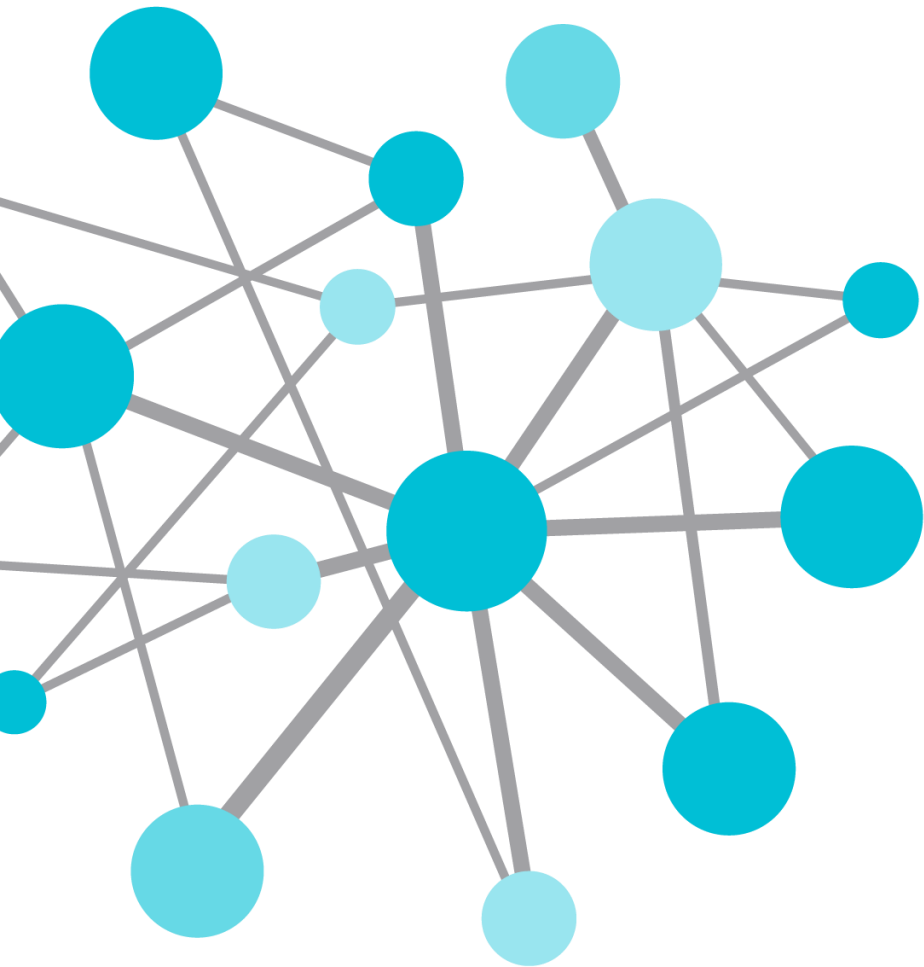
THANK YOU

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