



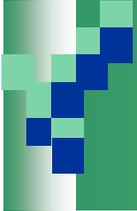
Demand Response Quick Assessment Tool (DRQAT) Large commercial buildings

Peng Xu

July 9th, 2007

Sponsored by the California Energy
Commission through the Demand
Response Research Center



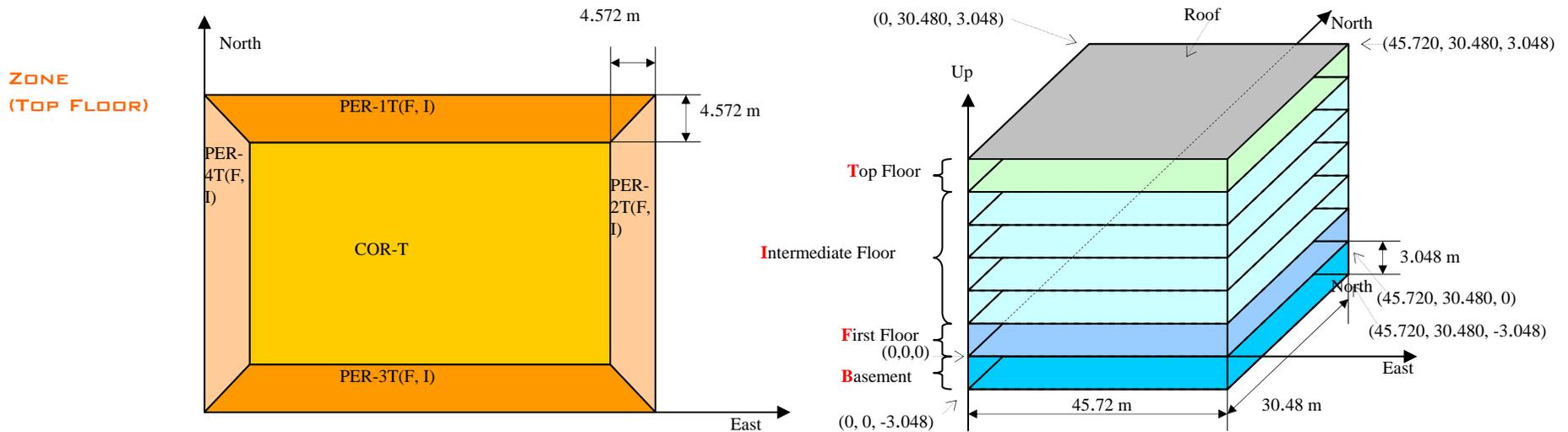


“Quick” Assessment Tool

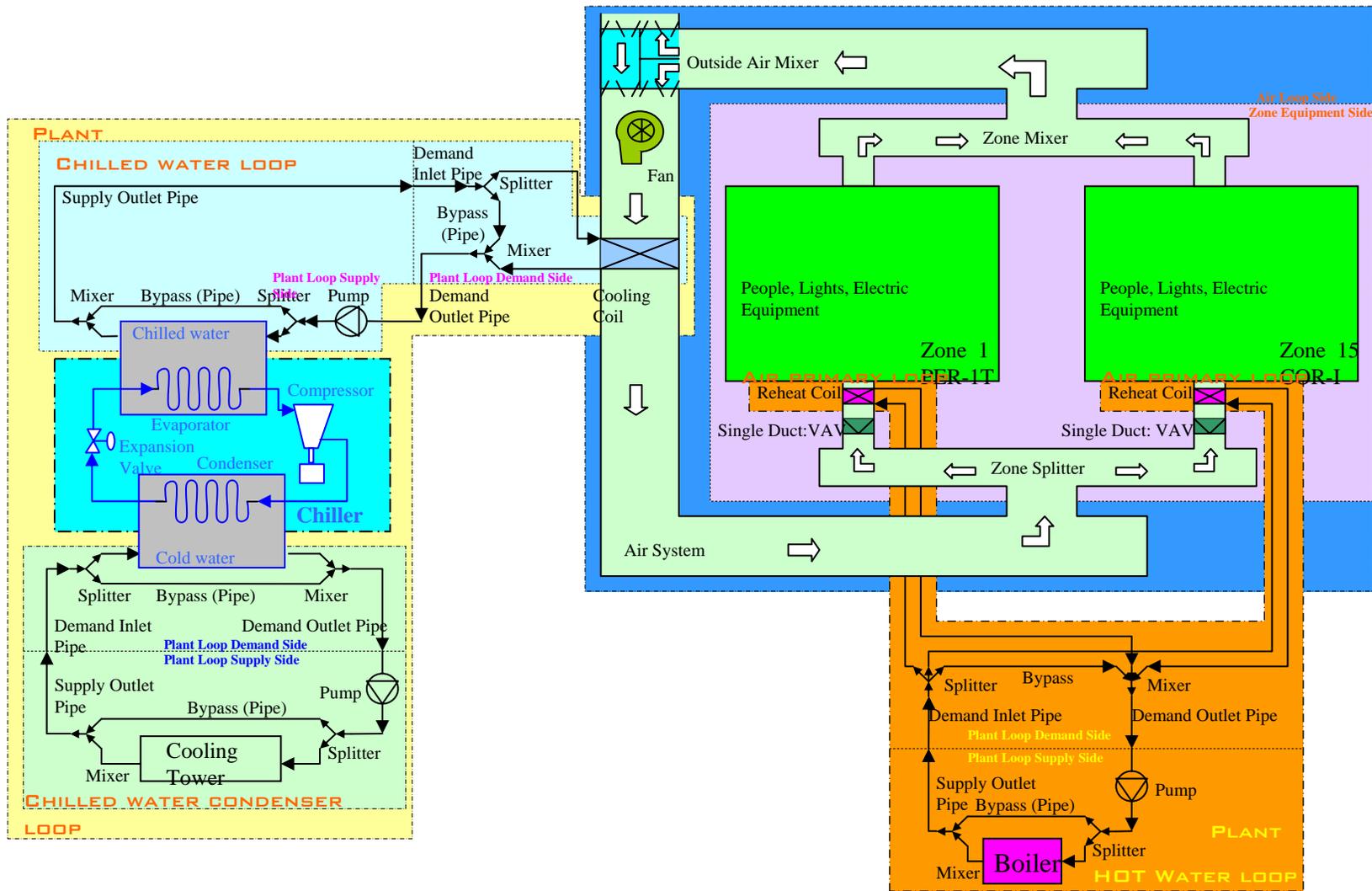
- Evaluate demand reduction and cost savings for large commercial buildings
 - Predict peak load reduction
 - Compare demand shed strategies
 - Predict comfort
 - Analyze energy cost

DRQAT Methodology

EnergyPlus prototypical office building model (Joe Huang's model)



HVAC systems





Demand Response Quick Assessment Tool

Project Advanced Input/Output Printer Setup About

Building Basic Inputs	●
Utility Inputs	●
Baseline Schedules	●
Run Baseline Simulation	●
DR Strategies	●
Run DR Simulation	●
Reports	●

Status:

Building Basic Input Completed
Utility Input Completed
Project DemoProject1 Baseline Input Completed
Project DemoProject1 Baseline Calculation Completed
DR Strategies DemoDR1 Input Completed
DR Strategies DemoDR1 Calculation Complete
Not Saved

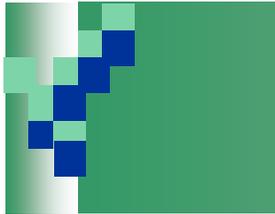
Simulation Period: From **MAY-01** To **OCT-31**
[Click here to change simulation period](#)



Demand Response Quick Assessment Tool

Project Advanced Input/Output Printer Setup About

Building Basic Inputs	●	<p>Status:</p> <p>Building Basic Input Completed Utility Input Completed Project DemoProject1 Baseline Input Completed Project DemoProject1 Baseline Calculation Completed DR Strategies DemoDR1 Input Completed DR Strategies DemoDR1 Calculation Complete Not Saved</p> <p>Simulation Period: From MAY-01 To OCT-31 Click here to change simulation period</p>
Utility Inputs	●	
Baseline Schedules	●	
Run Baseline Simulation	●	
DR Strategies	●	
Run DR Simulation	●	
Reports	●	



Building Basic Input Form

Location:
Zip Code:
City:

Building Information:
Building Name:
North Axis:
Terrain:

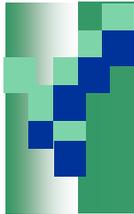
Building Geometry
Stories:
Length: ft
Width: ft
Height: ft

Window to Wall Ratio
East:
West:
South:
North:

Internal loads:
of People:
Equipment: W/Sq ft
lighting: W/Sq ft
Mass Level:

[Click here to change Mass Level Value](#)

Working Hours:
Weekday: Begin Hour Lasting
Holidayday: Begin Hour Lasting



Advanced Input form

E+ Version:

Perimeter Zone Depth: Ft

E+ Run Control:

Loads Convergence Tolerance Value:

Maximum Number of Warmup Days:

Temperature Convergence Tolerance Value:

Run Period Setup

Begin Month:

Begin Day of Month:

End Month:

End Day of Month:

Day of Week for Start Day:

System convergence limits

Minimum System Time Step:

Maximum HVAC Iterations:

Internal Surface Mass Level Setup:

	Area Multiplier	Thickness (m)	Conductivity (W/m-K)	Density (kg/m3)	Specific Heat (J/kg-K)
High					
Medium					
Low					

Save

Load Current

Load Default

Done

Energy and Demand Charges

RATE	TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13
RATE-1	ENERGY	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.13055	0.13055	0.13055	0.13055	0.14108
RATE-1	DEMAND	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25
RATE-2	ENERGY	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613
RATE-2	DEMAND	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25
RATE-3	ENERGY	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.10613	0.25621

RATE-1 Energy Charge Demand Charge
 Start Hour: 1 End Hour: 1 Value: \$

Customer Charge: 63.71 \$

Monthly Energy and Demand Charge Schedules

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15
January															
February															
March															
April															
May	RATE-1														
June	RATE-1														
July	RATE-1														
August	RATE-2	RATE-1													
September	RATE-1	RATE-1	RATE-1	RATE-1	RATE-1	RATE-1	RATE-2	RATE-2	RATE-1						
October	RATE-1														
November															
December															

Simulation Period is from MAY-01 to OCT-31

Start Month: 1 Start Day: 1 Value: RATE-1

End Month: 1 End Day: 1

Baseline Input Form

Project Description | **Baseline Schedules**

HVAC Equipment Schedule | Zone Temp Setpoint (cooling) | Chilled/Condenser Water Setpoint | Supply Air Temp Setpoint

Workdays and Holidays Schedules

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Workday Value	Red	Red	Red	Red	Red	Red	Green	Red																
Holiday Value	Red	Red	Green	Green	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red						


ON


OFF

Save
Load Default
Load Current
Done

Baseline Input Form

Project Description | **Baseline Schedules**

HVAC Equipment Schedule | **Zone Temp Setpoint (cooling)** | Chilled/Condenser Water Setpoint | Supply Air Temp Setpoint

Zone Temp Setpoints (Cooling-Weekday)—Degree F

Zone Temp Setpoints (Cooling-Holiday)— Degree F

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Workday Value	80.00	80.00	80.00	80.00	79.70	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	79.50	79.80	79.80	79.40	80.00	79.90	79.90	
Holiday Value	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00

Workday ▾ Start Hour ▾ End Hour ▾ Value Degree F

Baseline Input Form

Project Description | **Baseline Schedules**

HVAC Equipment Schedule | Zone Temp Setpoint (cooling) | Chilled/Condenser Water Setpoint | **Supply Air Temp Setpoint**

Supply Air Temp Setpoint—Unit (Degree F)

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Value	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00

Start Hour: End Hour: Value: Degree F



Run Control Form

Run Show details Terminate Done

Calculation failed

Time consumed: 4seconds

Notes: Simulation will take about 5 minutes on a Pentium 2.0 GHZ computer.

Error Report:

```
the current running file is "main.bat"
Thu 07/05/2007
12:06 PM
!
Beginning of running file "C:\DRQAT\Weather\Weather.bat"
!
Beginning of running file "C:\DRQAT\Weather\Weather.awk"
!
End of running file "C:\DRQAT\Weather\Weather.awk"
!
Beginning of running file "C:\DRQAT\Weather\hottestdays12.awk"
!
End of running file "C:\DRQAT\Weather\Weather.awk"
!
End of running file "C:\DRQAT\Weather\Weather.bat"
!
Beginning of running file "C:\DRQAT\simulate\simulate.bat"
!
Beginning of running file "C:\DRQAT\simulate\simulate.awk"
```

Simulate Input Form

DR Strategies Description | **DR Strategies**

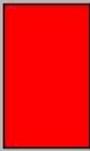
HVAC Equipment Schedule | Zone Temperature Setpoint (Cooling) | Chilled/Condenser Water Setpoint | Supply Air Temp Setpoint

Workdays and Holidays Schedules

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
workday value	ON	ON	ON	ON	ON	ON	OFF																	
holiday value	ON	ON	OFF	OFF	OFF	OFF	ON																	

Baseline

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
workday value	ON	ON	ON	ON	ON	ON	OFF																	
holiday value	ON	ON	OFF	OFF	OFF	OFF	ON																	

 ON
  OFF

Simulate Input Form

DR Strategies Description | **DR Strategies**

HVAC Equipment Schedule | **Zone Temperature Setpoint (Cooling)** | Chilled/Condenser Water Setpoint | Supply Air Temp Setpoint

Zone Temp Setpoint (Cooling-Weekday)—Degree F

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
workday val	80.00	80.00	80.00	80.00	79.70	70.30	70.20	70.30	70.30	70.00	70.40	75.30	75.60	75.50	75.50	75.60	75.70	79.50	79.80	79.80	79.40	80.00	79.90	79.90
holiday val	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75

Zone Temp Setpoint (Cooling-Holiday)—Degree F

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
holiday val	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75

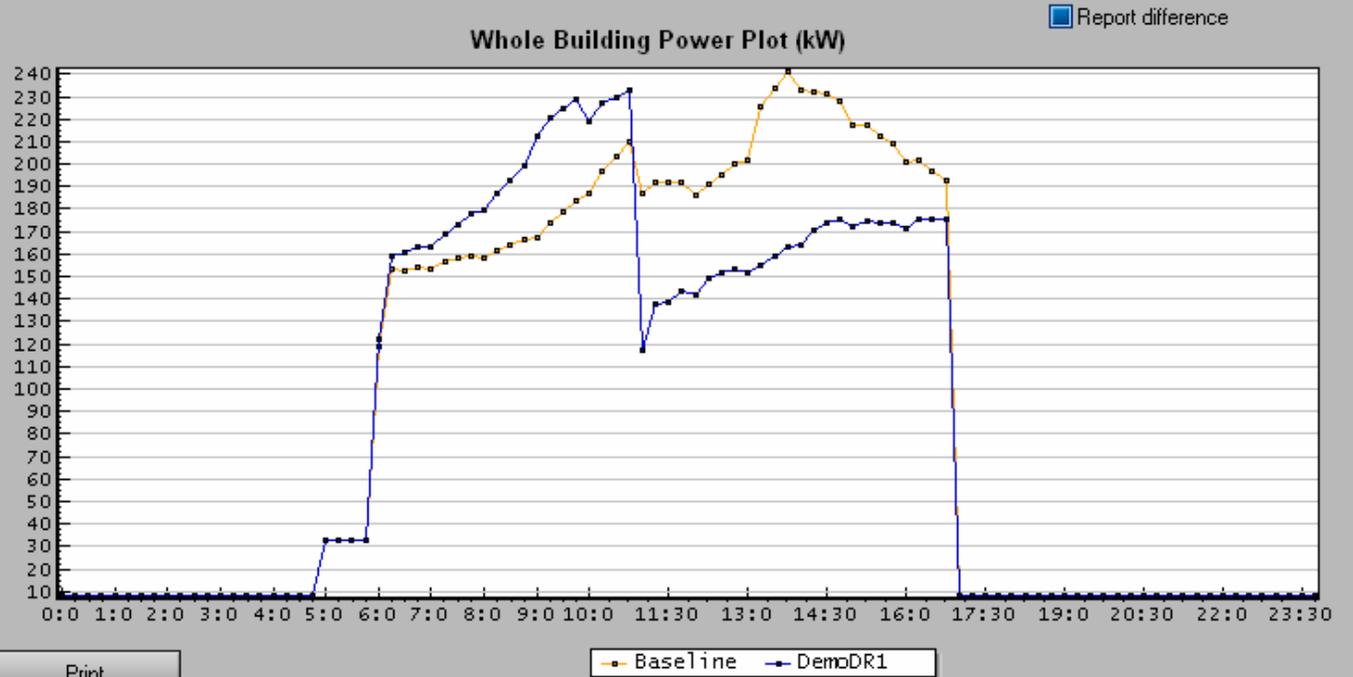
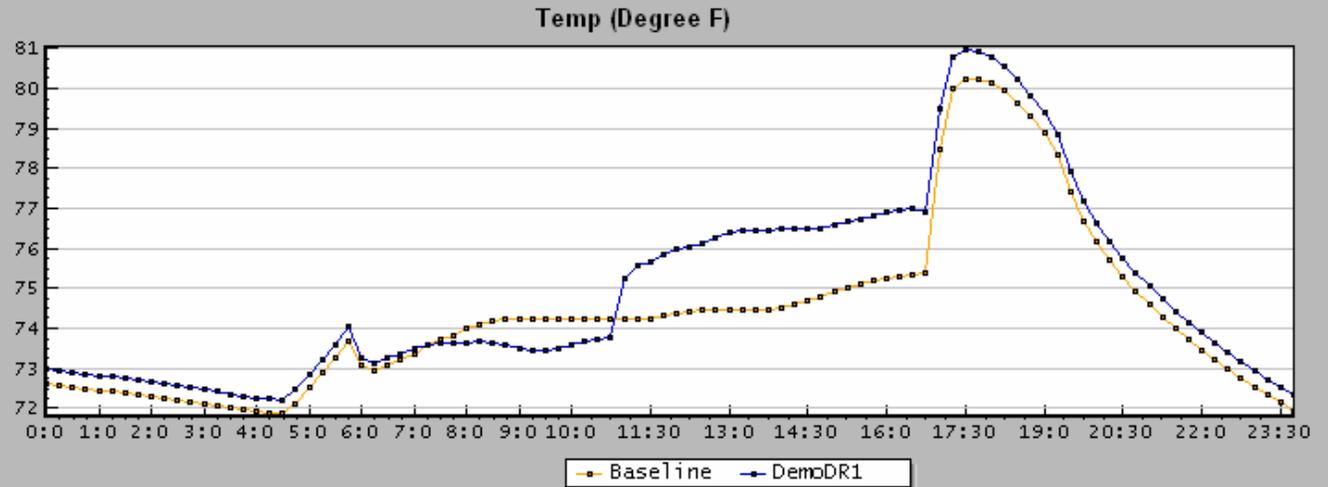
Workday Start Hour End Hour Value F

The Following Days are CPP Days:

Month	Day	Hour	Temp (F)
4	13	16	71.6
6	23	13	72.5
7	19	13	71.96
7	20	13	72.32
7	21	10	74.12
8	1	15	74.48
8	22	15	72.5
8	29	12	72.32
8	30	17	72.5
8	31	16	71.06
9	7	13	75.38
9	8	10	78.8

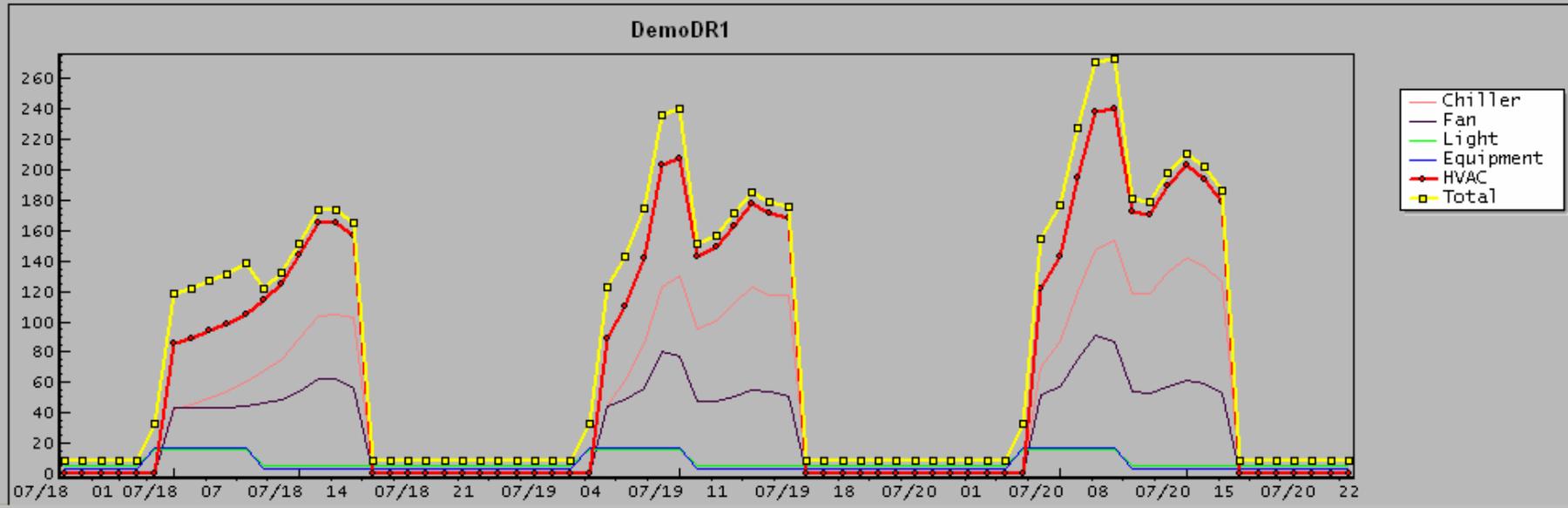
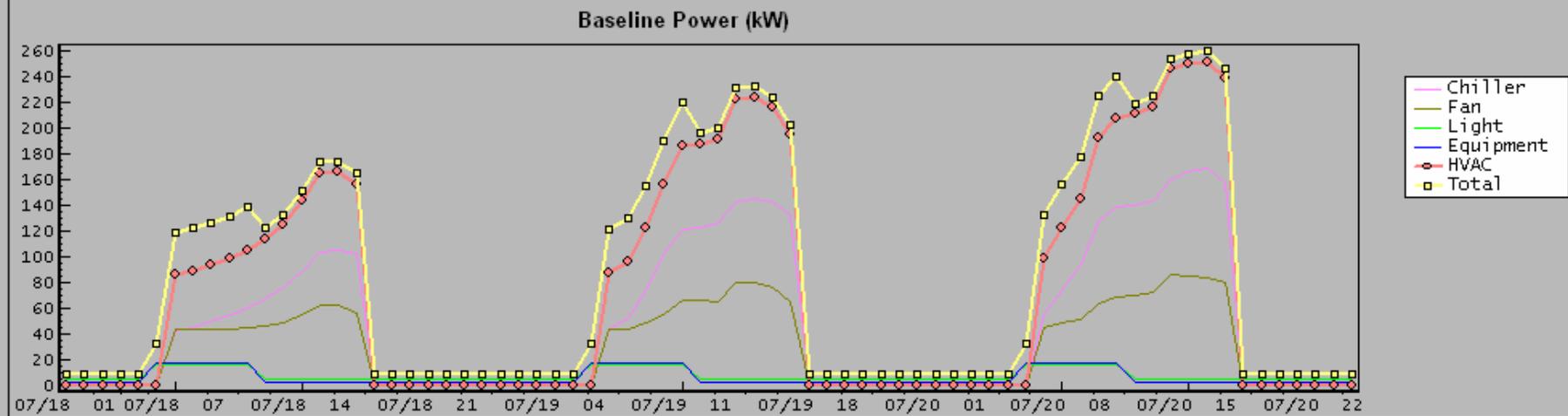
CPP Days Available

Month	Day	Hour	Temp (F)
6	23	13	72.5
7	19	13	71.96
7	20	13	72.32
7	21	10	74.12
8	1	15	74.48
8	22	15	72.5
8	29	12	72.32
8	30	17	72.5
8	31	16	71.06
9	7	13	75.38
9	8	10	78.8

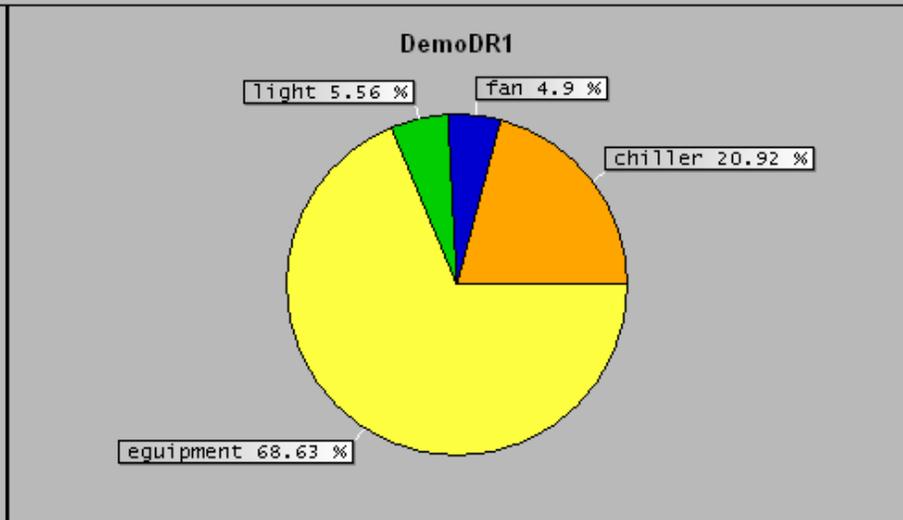
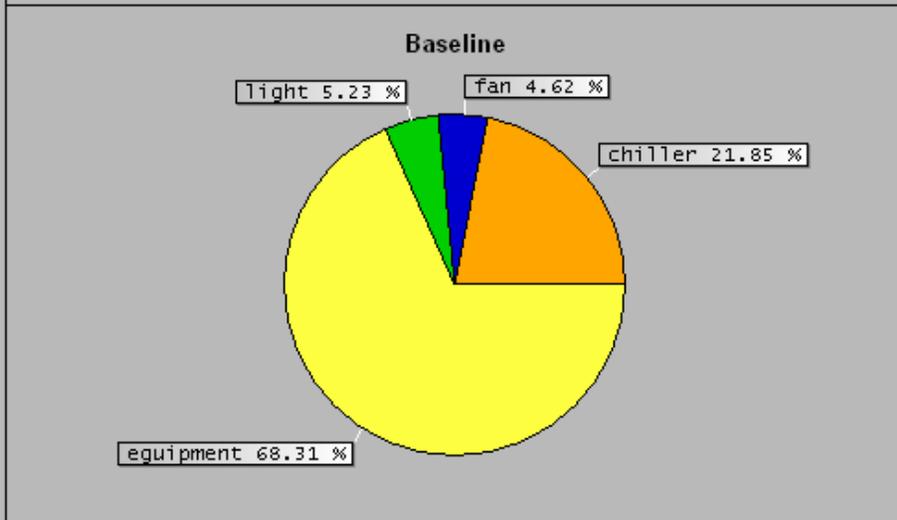
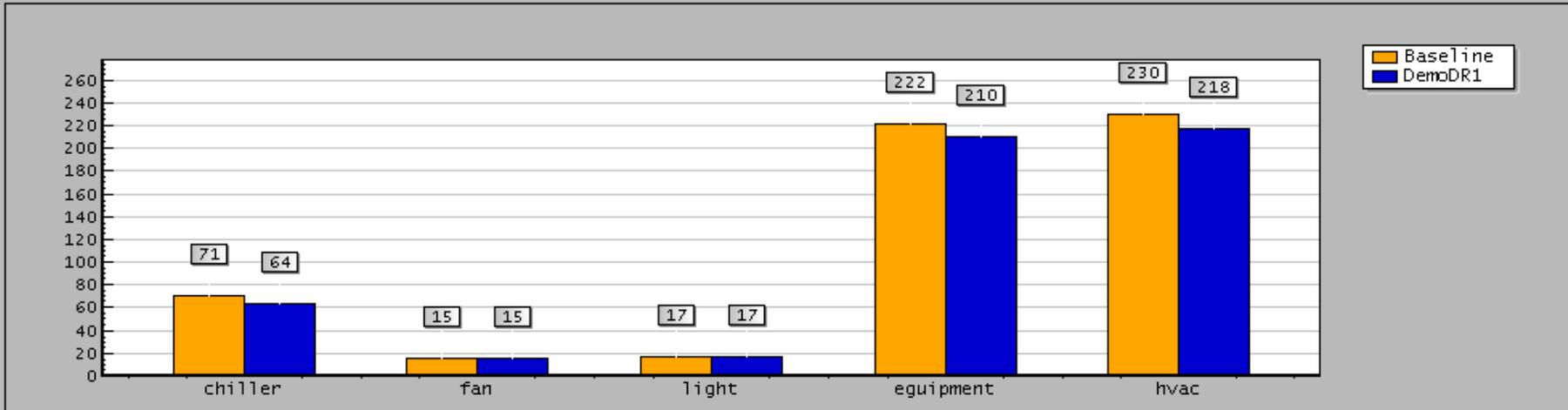


Print

Date: Jul 18 Start hour 1 Lasting hours 72 Report Difference [Show](#) [Print](#)



Month: Aug Day: 22

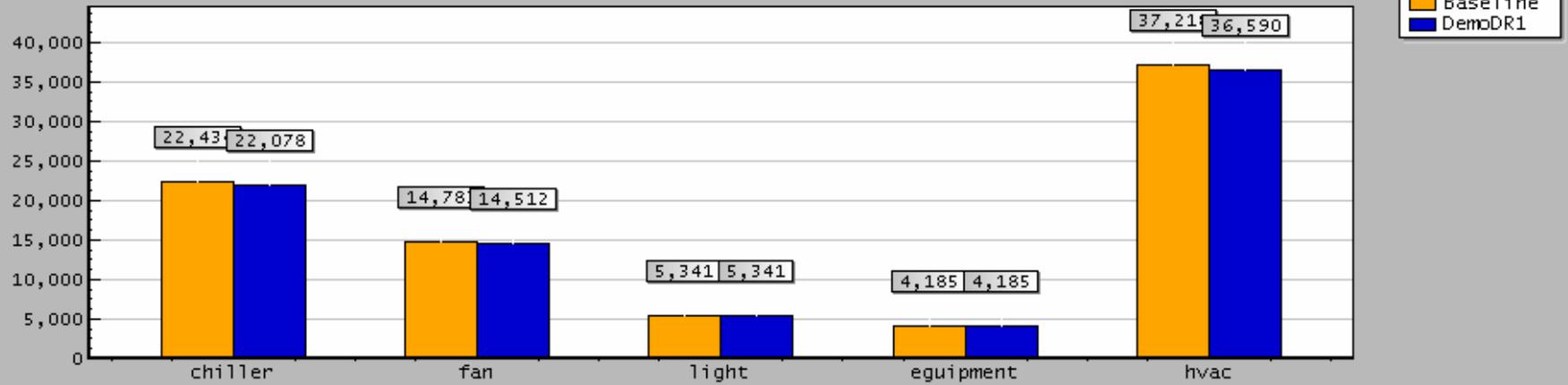


Aug

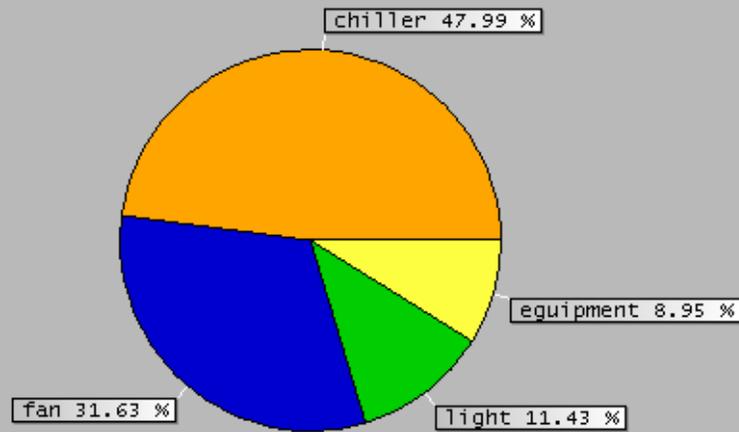
Show

Print

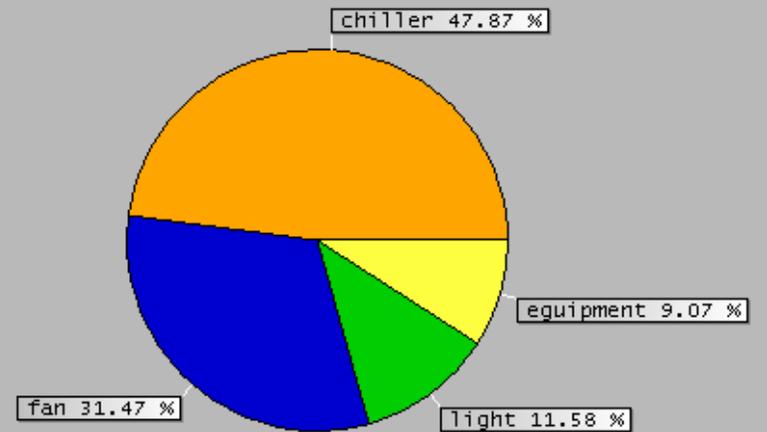
Monthly Electric (kWh)



Baseline



DemoDR1

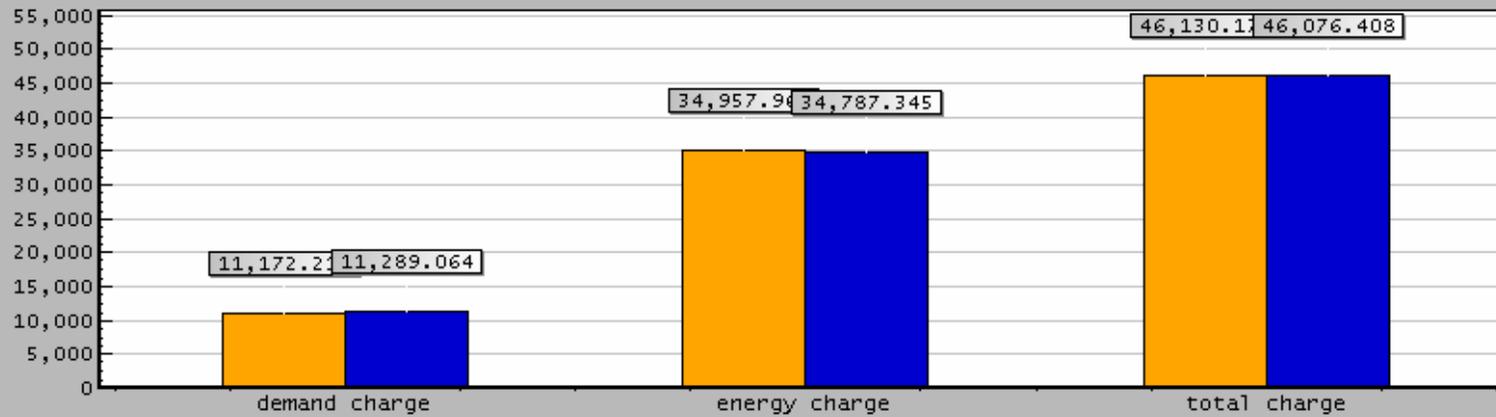


The Season You Want To See: Summer

show

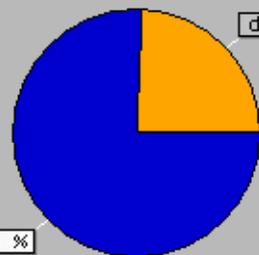
Print

Cost of Summer



Baseline
DemoDR1

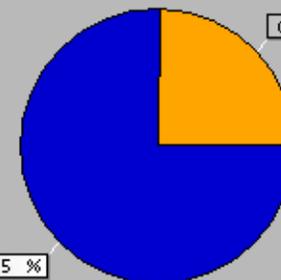
Baseline



demand charge 24.22 %

energy charge 75.78 %

DemoDR1



demand charge 24.5 %

energy charge 75.5 %