An Energy Efficiency Workshop & Exposition

Kansas City, Missouri

# *DOE's CHP for Buildings Integration Test Center*

*at the*

*University of Maryland*

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# Outline

- Brief description of CHP
- Chesapeake Building Project sponsored by U.S. DOE's Office of Energy Efficiency and Renewable Energy
- www.enme.umd.edu/ceee/bchp

# CHP Systems Have Great Promise

- Cooling, Heating, and Power systems will efficiently and environmentally:
  - Improve electric grid reliability
  - Improve building energy efficiency
  - Reduce regional and global emissions
  - Improve indoor air environment

# CHP for Buildings Integration Test Center Mission

- This test bed serves as a platform to:
  - Integrate equipment into CHP systems
  - Integrate CHP systems into buildings
  - Test advanced controls systems
  - Provide essential technical knowledge to manufacturing partners

# *The Chesapeake Office Building Provides a Platform for:*

- System Integration
  - packaging
  - sensors and controls
- Performance and Optimization
  - design capacities
  - real-time operating cost and energy savings
- Maintenance and Reliability
  - diagnostician tools
  - internet-based communication
- Energy Storage

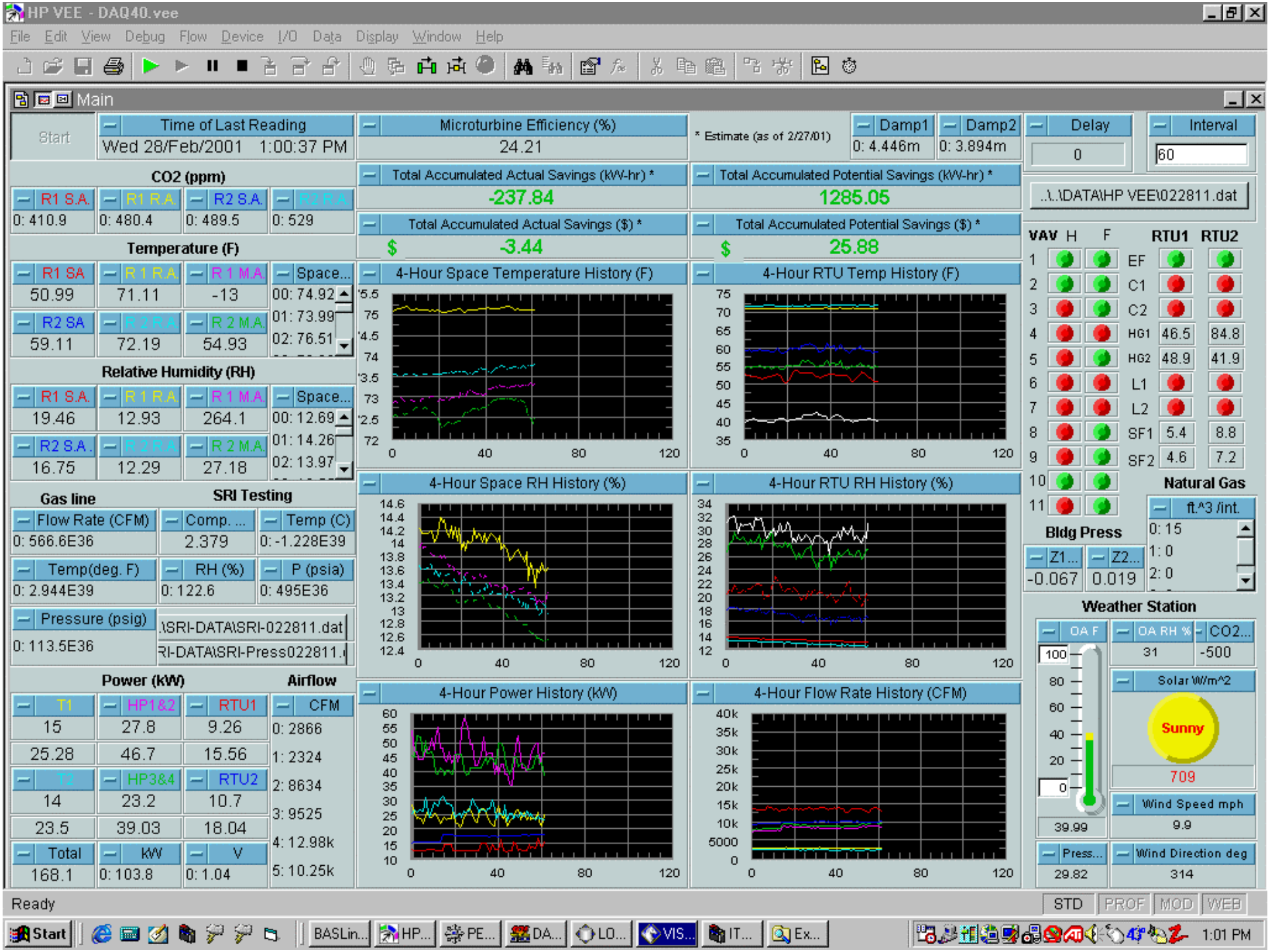
# *Chesapeake Office Building Before Project Inception*

- **Typical medium size office building, 51,000 $Ft^2$,**
- **4 floors, 2 zones**
- **90-ton rooftop unit per zone**
- **Cooling all year**
- **Economizer cycle**
- **VAV with electric reheat**
- **Low level controls**
- **Gas rarely used**
- **Electric peak ~300 kW**
- **10 years old, 200 occupants**

# DATA ACQUISITION SYSTEM

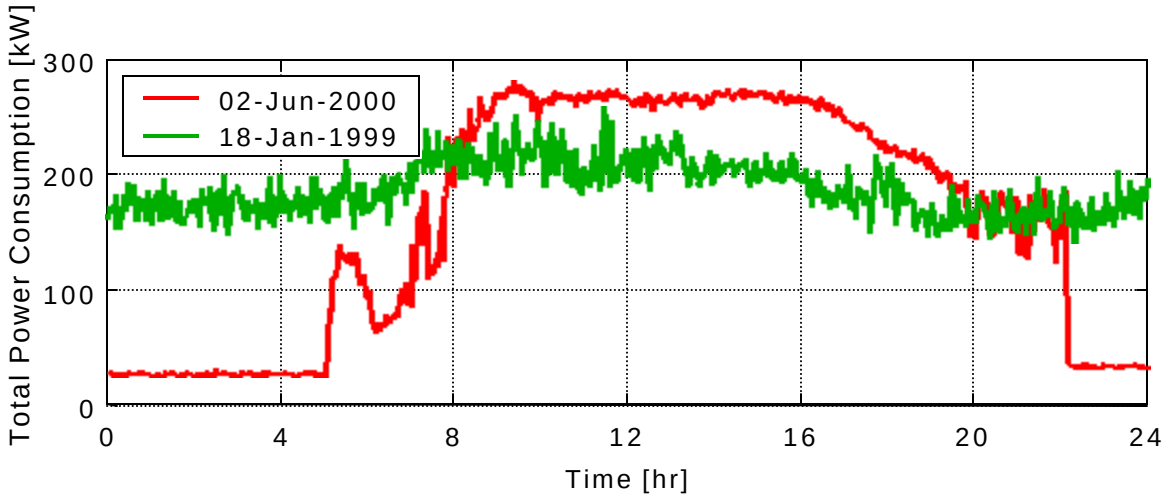
***122 sensors scanned every minute, 1440 readings daily***

- Temperature and Humidity
  - Supply, Mixed, Return, and Space; Hot Gas Bypass
- Power
  - Power and Current Transducers to Measure Load and Equipment Consumption
- Status
  - Compressors, Unloaders, Fans, Dampers, Heaters
- Air Flow Measuring Stations
  - Hot Wire Anemometer Stations
- Gas and Power Utility Meters
  - Gas Meters for Building and Equipment, Electric Utility Meter
- Weather Station
  - Temperature, Humidity, Pressure, Solar Intensity, Wind Speed and Direction
- Building Pressure and $CO_2$ Sensors


HP VEE - DAQ40.vee
File Edit View Debug Flow Device I/O Data Display Window Help
Main
Start
Time of Last Reading
Wed 28/Feb/2001 1:00:37 PM
Microturbine Efficiency (%)
24.21
* Estimate (as of 2/27/01)
Damp1
0: 4.446m
Damp2
0: 3.894m
Delay
0
Interval
60
..\..\DATA\HP VEE\022811.dat
CO2 (ppm)
R1 S.A. 0: 410.9
R1 R.A. 0: 480.4
R2 S.A. 0: 489.5
R2 R.A. 0: 529
Total Accumulated Actual Savings (kW-hr) *
-237.84
Total Accumulated Potential Savings (kW-hr) *
1285.05
Total Accumulated Actual Savings ($) *
$ -3.44
Total Accumulated Potential Savings ($) *
$ 25.88
Temperature (F)
R1 SA 50.99
R1 R.A. 71.11
R1 M.A. -13
Space...
00: 74.92
01: 73.99
02: 76.51
R2 SA 59.11
R2 R.A. 72.19
R 2 M.A. 54.93
4-Hour Space Temperature History (F)
4-Hour RTU Temp History (F)
Relative Humidity (RH)
R1 S.A. 19.46
R1 R.A. 12.93
R1 M.A. 264.1
Space...
00: 12.69
01: 14.26
02: 13.97
R2 S.A. 16.75
R2 R.A. 12.29
R 2 M.A. 27.18
4-Hour Space RH History (%)
4-Hour RTU RH History (%)
Gas line
SRI Testing
Flow Rate (CFM) 0: 566.6E36
Comp. ... 2.379
Temp (C) 0: -1.228E39
Temp(deg. F) 0: 2.944E39
RH (%) 0: 122.6
P (psia) 0: 495E36
Pressure (psig) 0: 113.5E36
\SRI-DATA\SRI-022811.dat
RI-DATA\SRI-Press022811.
Power (kW)
Airflow
T1 15 25.28
HP1&2 27.8 46.7
RTU1 9.26 15.56
CFM
0: 2866
1: 2324
2: 8634
3: 9525
4: 12.98k
5: 10.25k
T2 14 23.5
HP3&4 23.2 39.03
RTU2 10.7 18.04
Total 168.1
kW 0: 103.8
V 0: 1.04
4-Hour Power History (kW)
4-Hour Flow Rate History (CFM)
VAV H F
RTU1 RTU2
1 EF
2 C1
3 C2
4 HG1 46.5 84.8
5 HG2 48.9 41.9
6 L1
7 L2
8 SF1 5.4 8.8
9 SF2 4.6 7.2
10
11
Natural Gas
ft.^3 /int.
0: 15
1: 0
2: 0
Bldg Press
Z1... -0.067
Z2... 0.019
Weather Station
OA F 39.99
OA RH % 31
CO2... -500
Solar W/m^2
Sunny
709
Wind Speed mph 9.9
Press... 29.82
Wind Direction deg 314
Ready
STD PROF MOD WEB
Start
BASLin... HP... PE... DA... LO... VIS... IT... Ex...
1:01 PM

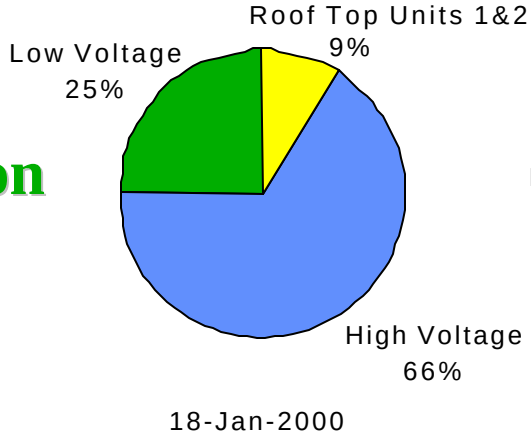
# Baseline Data

## Electric Load Profile

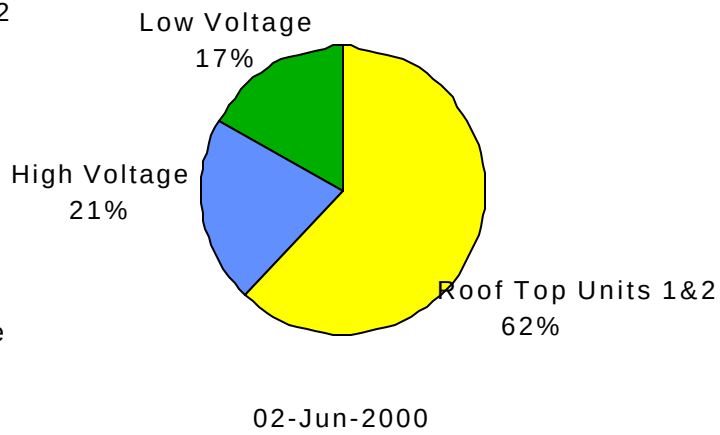



## Power Consumption by Type

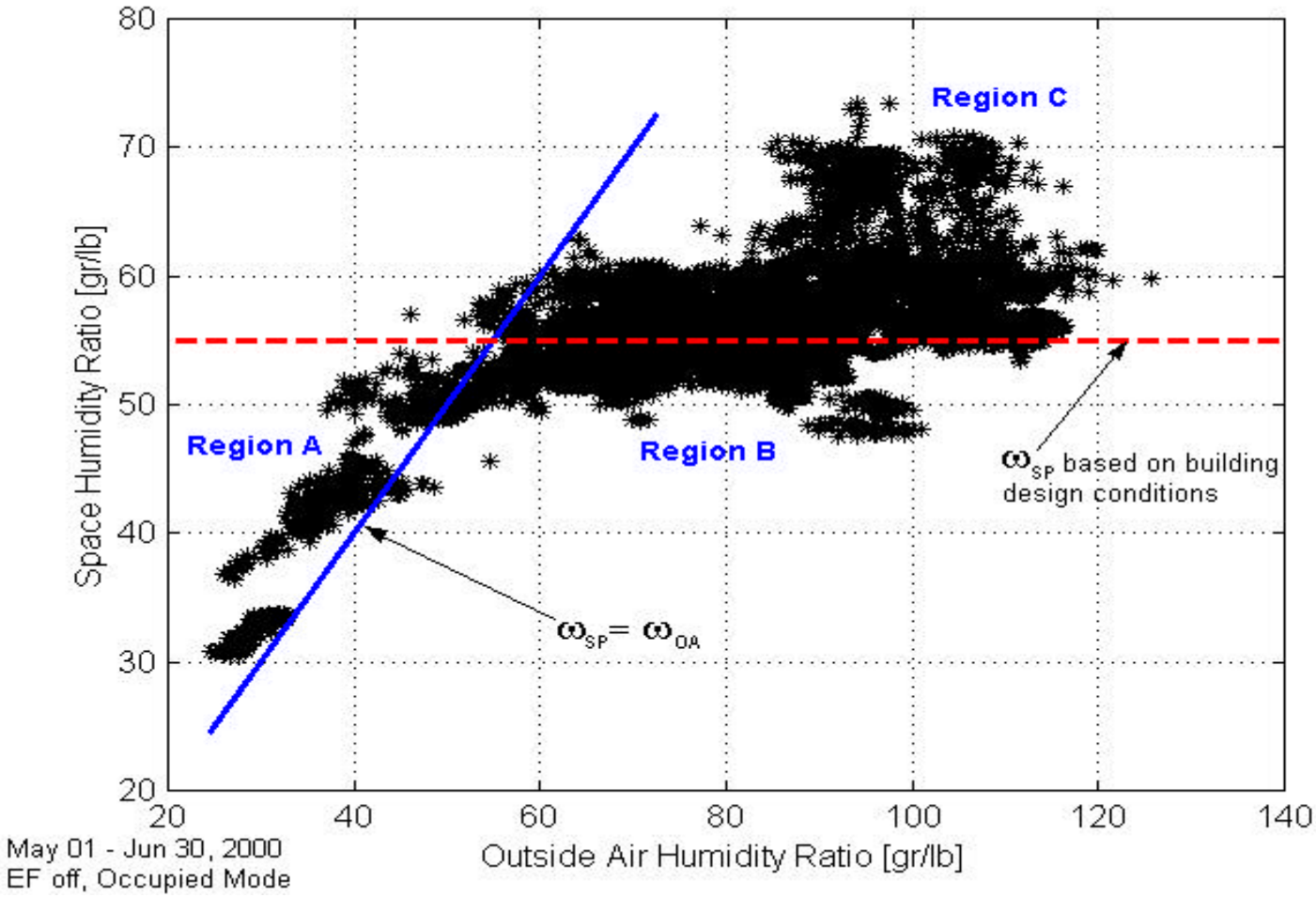
**Winter**



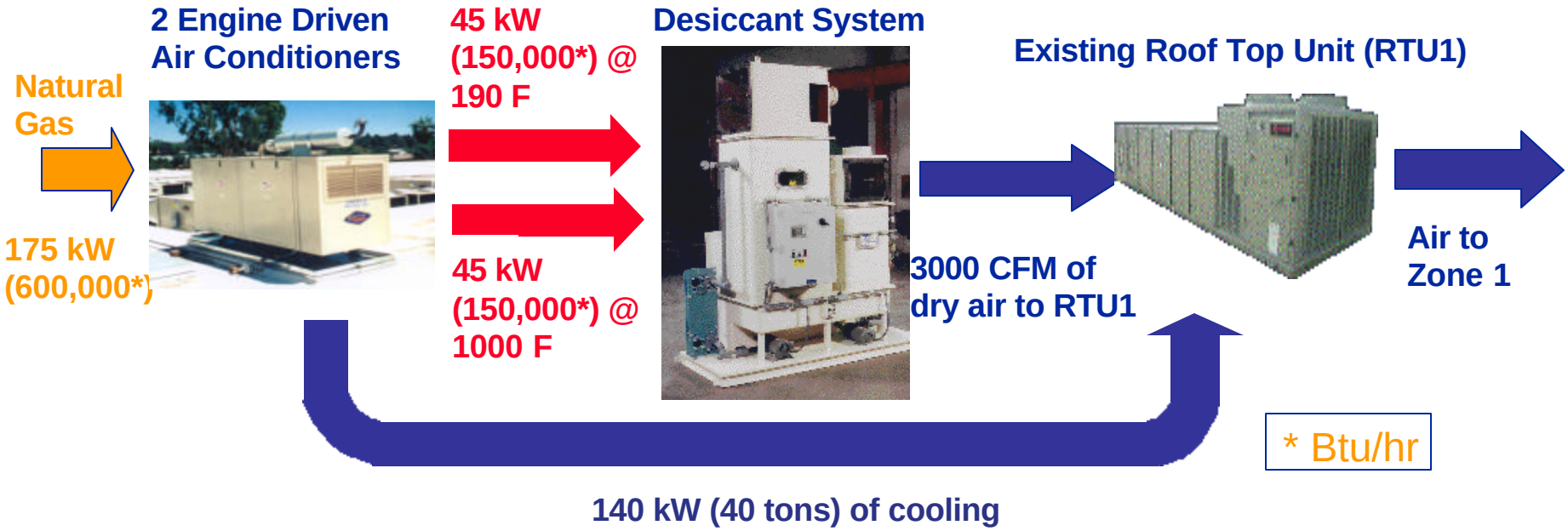

**Summer**



# Baseline Data: Building Humidity

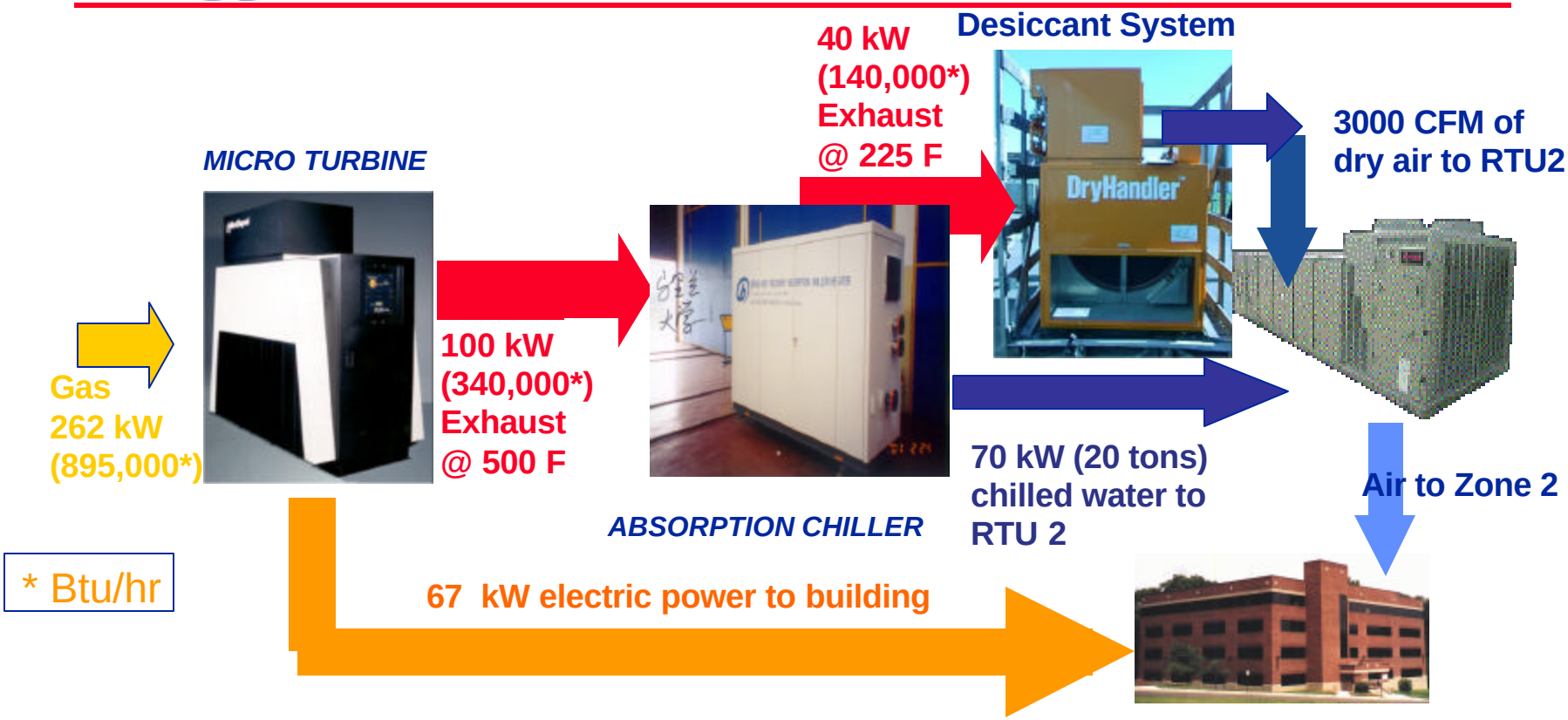


# 1st Integrated System




- **Engine jackets' water & exhausts' regenerate desiccant**
- **Desiccant keeps DX coil dry and controls humidity in zone**
- **Overall efficiency up to 80 %**

# 2nd Integrated System




- **Turbine efficiency 25.6 %, with chiller 63.5 %, and with desiccant 79.2%**
- **Single effect absorption chiller with COP of 0.7**
- **Desiccant keeps DX coil dry and controls humidity (exhaust provides 2/3 of heat load)**

# Project Status

- Building baseline data collected
- Data acquisition systems operational
- Integrated systems designed, installed and near operational
  - micro-turbine operating since summer 2000
  - gas-air conditioners operating since summer 2000
  - absorption chiller commissioned May 2001
  - desiccant units to be commissioned in June 2001
- Control systems being upgraded
- Partnership between National Labs, UMD CEEE, and manufacturers established

# Professional Collaboration

- ORNL – Sensors ($CO_2$ and Humidity)
- PNNL – Whole Building Diagnostician
- NREL – Liquid Desiccant Components
- Energy Storage
- Energetics, NRECA, Sandia – Distributed Energy Technology Simulator
- Southern Research Institute, EPA, Honeywell – Independent Verification of Micro-Turbine Performance and Emissions
- ORNL – Integrated System Performance Evaluation

*Visit web site: www.enme.umd.edu/ceee/bchp*

# Project Sponsors

- U.S. Department of Energy EERE
- UMD CEEE and Physical Plant
- Capron Controls
- PEPCO
- Broad
- Air Technology Systems
- Honeywell
- Tridium Controls
- Washington Gas
- RMF Engineering
- Goettl, Daikin, Baltimore Gas & Electric
- Kathabar Dehumidification Systems