Cool Technologies

August 20, 2008
ENERGY STAR Monthly Partner
Web Conference

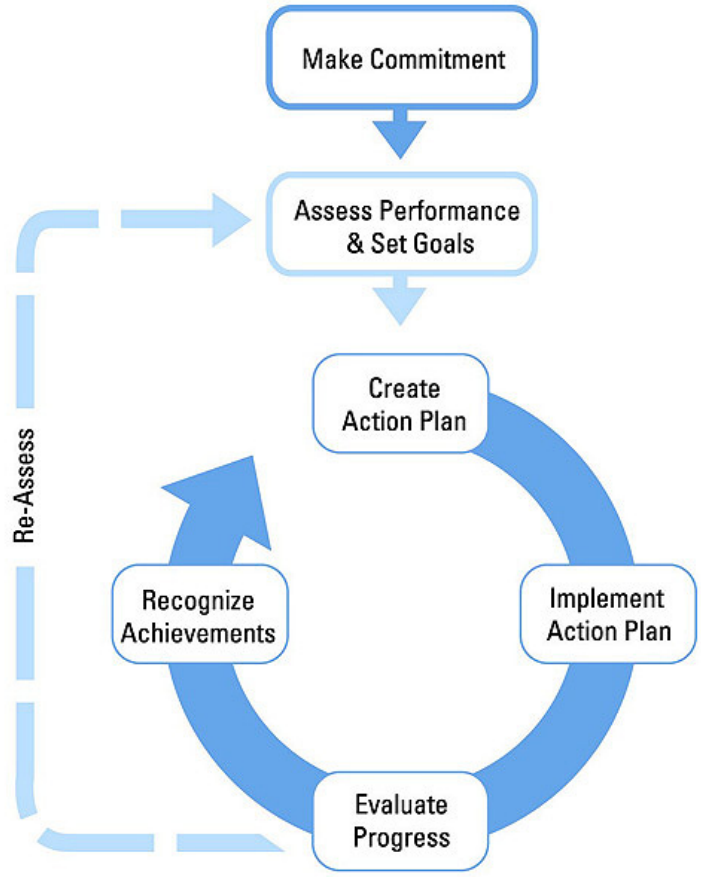
Call-in Number: 1-866-299-3188
Conference Code: 202 343 9965

EPA

Learn more at **energystar.gov**

About The Web Conferences

- Monthly
- Topics are structured on a strategic approach to energy management
- Opportunity to share ideas with others
- Slides are a starting point for discussion
- Open & Interactive



Web Conference Tips

- Mute – To improve sound quality, all phones but the presenters will be muted.
- Use # 6 to un-mute and * 6 – to mute
- Presentation slides will be sent by email to all participants following the web conference.

Today's Web Conference

- Cooling and conditioning is one the largest energy loads in most buildings and facilities.
- Commercial buildings in the US will use over 800 trillion Btus for cooling alone!

Agenda:

- **Mark MacCracken**, **CALMAC** – Thermal Energy Storage
- **Dan Thatcher, Danfoss Turbocor** – Frictionless Compressor Technology
- **Discussion**
- **Announcements**

Thermal Energy Storage: A Vital Ingredient in a Low Carbon Future

Mark M. MacCracken, PE, LEED^{AP}, Pte
CALMAC Mfg. Corp.
Fair Lawn, NJ
Calmac.com

8-20-08

Benefits of Thermal Energy Storage

Reduces Peak Demand at most critical time	20-40%
Reduces consumer's energy costs	10-20%
May reduce energy usage at the building	up to 14%
Reduces source energy usage at power plant	8-34%
Reduces emissions	up to 50%
Increases Load Factor of Generation	up to 25%
Provides operational flexibility	

Cool Storage

What is it?

Why is it Vital for a Low Carbon Future?

How does it work?

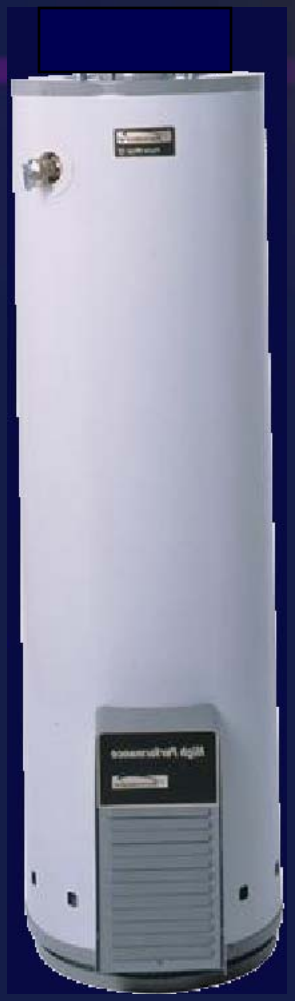
Why is it Green?

Other “Green” Advantages

Applications/Case Studies

Storage is Natural

Most common TES System



4.5 kW Heater

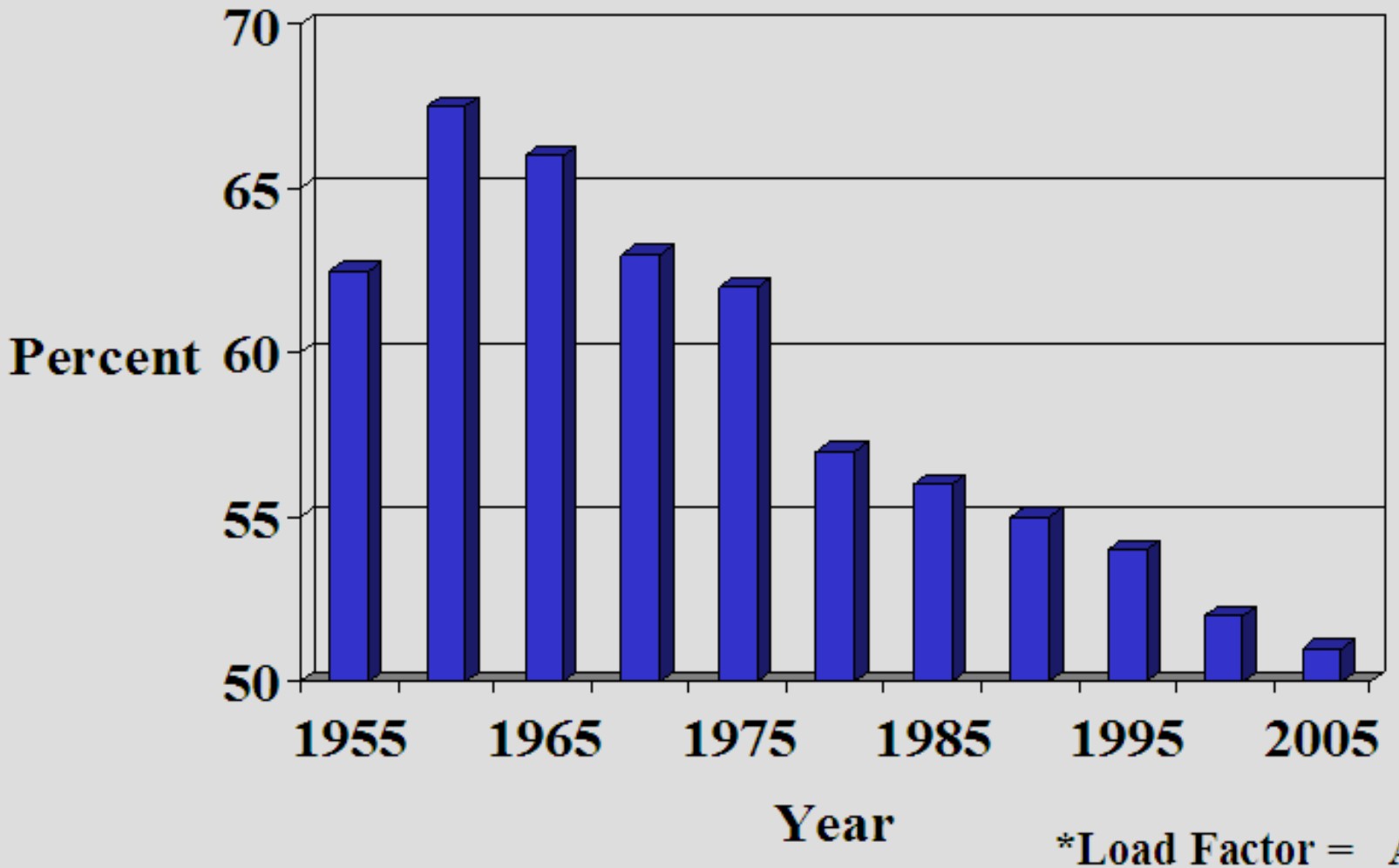
Water Heater (Electric)

Assume one low-flow shower

((2.5gpm x 8.33 lb/gal x (110-60))

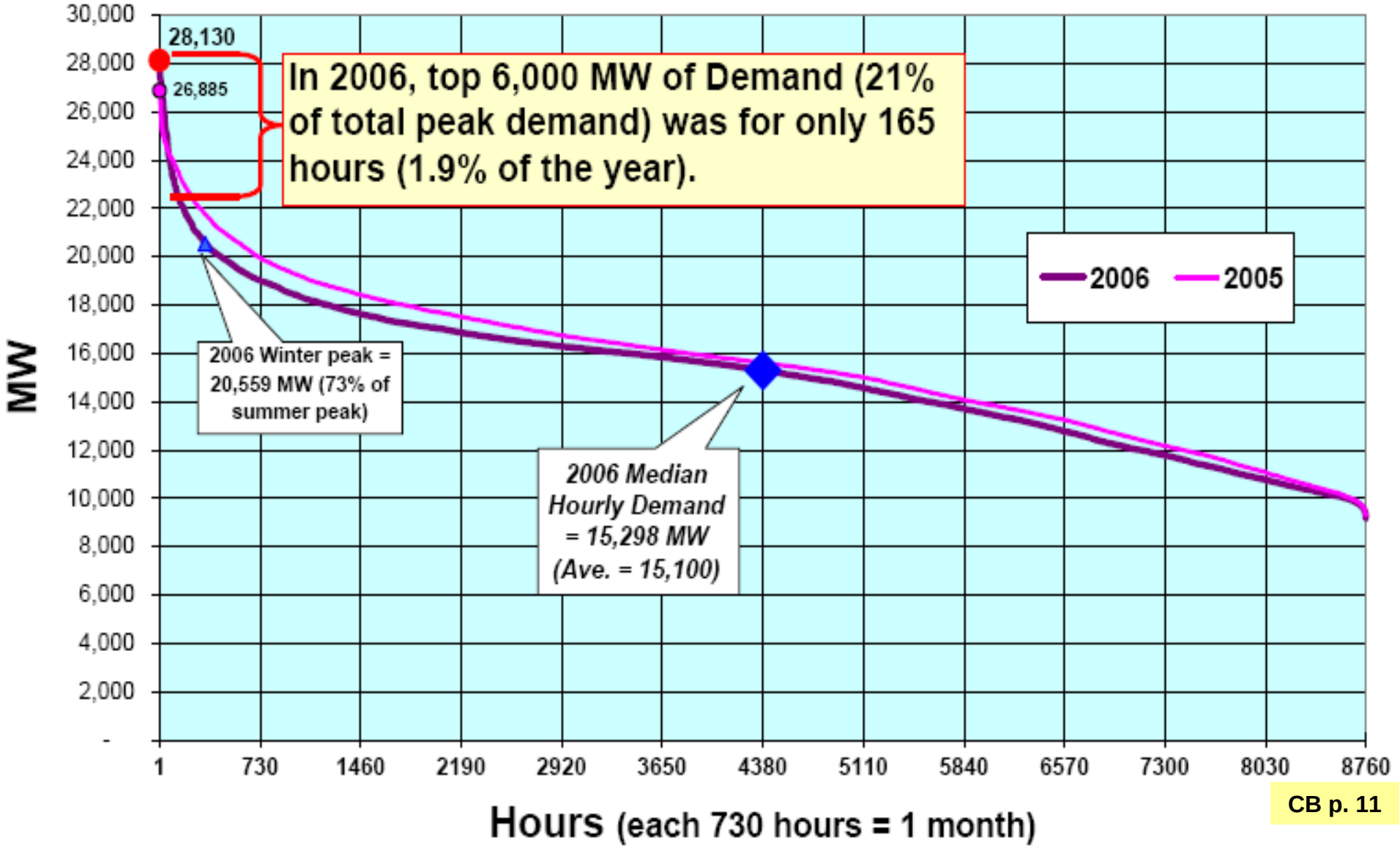
x 60 minutes/hr / 3,414 Btu/kW = 18.3 kW

Utility Load Factors* in the USA



*Load Factor = $\frac{\text{Avg. Load}}{\text{Peak Load}}$

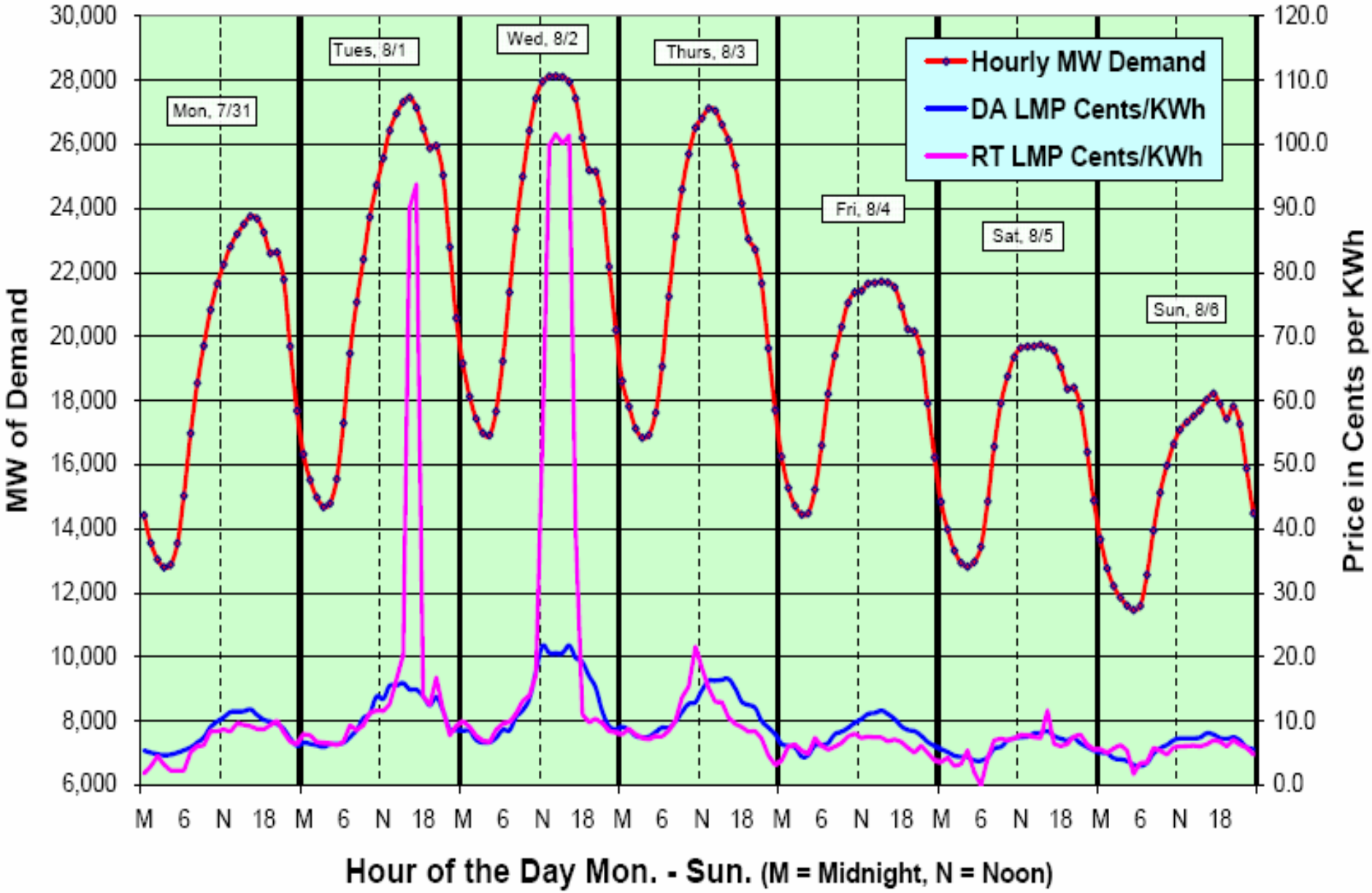
ISO-New England 2005 & 2006 Hourly MW Load Duration Curve



CB p. 11

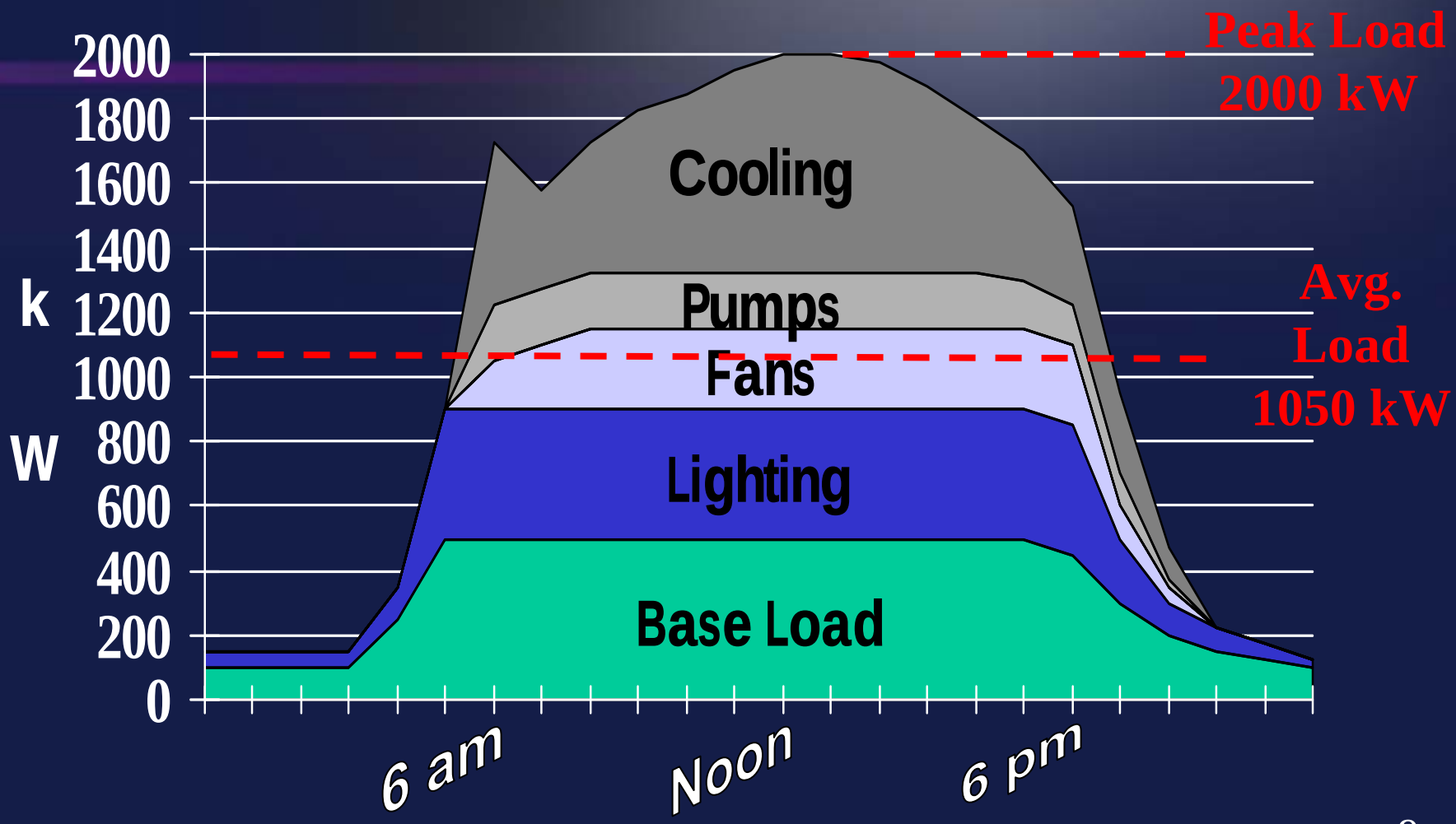
Graph by Clifton Below, NHPUC, from: 2006_smd_hourly.xls and 2005_smd_hourly.xls available at: http://www.iso-ne.com/markets/hstdata/znl_info/hourly/index.html

ISO-NE Hourly Demand & Price Week of 7/31-8/6/06



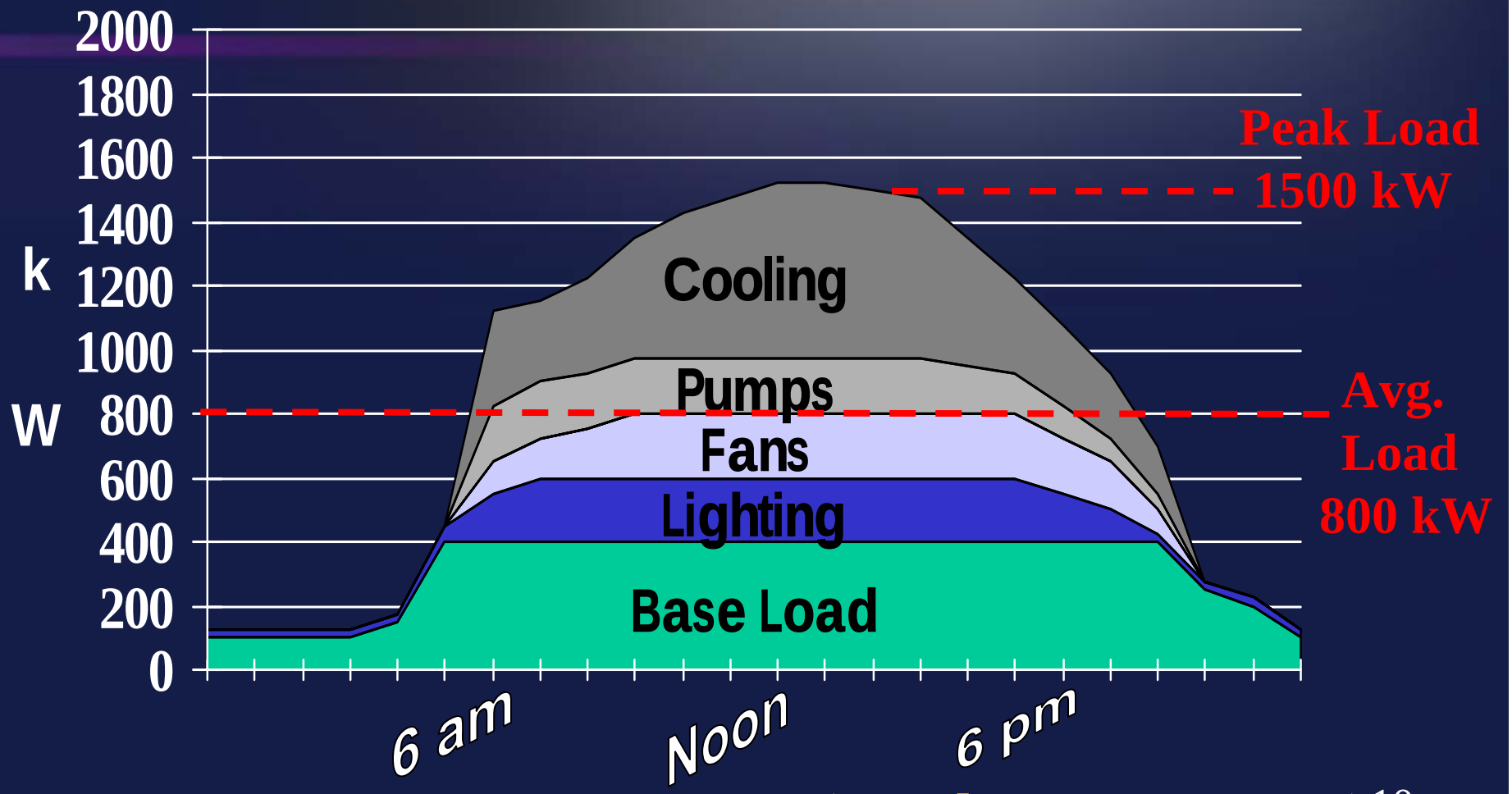
Graph by Clifton Below, NHPUC, from: 2006_smd_hourly.xls, available at: http://www.iso-ne.com/markets/hstdata/znl_info/hourly/index.html

ASHRAE 90.1 Base Building
Non-Storage Electrical Profile



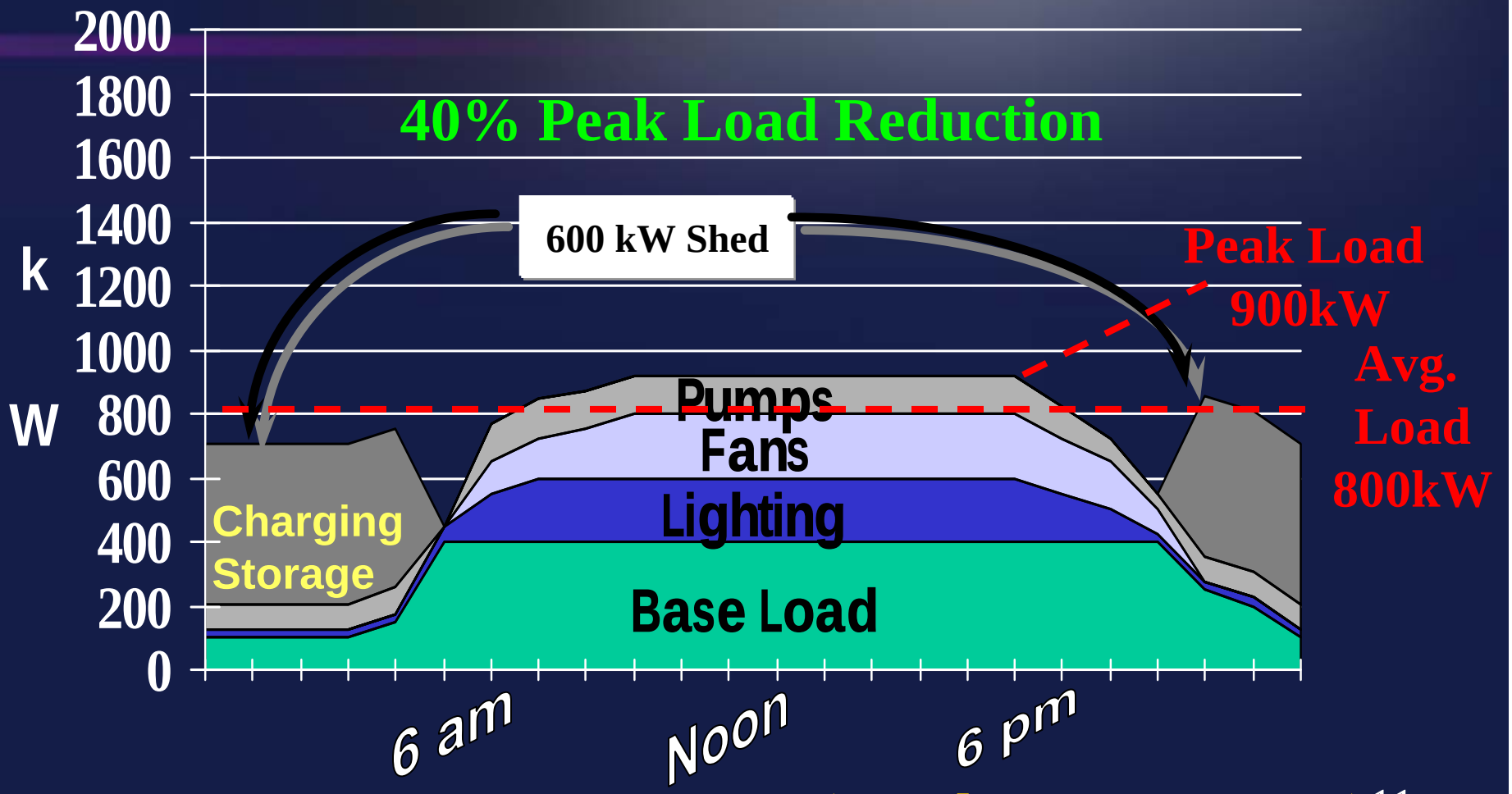
Total kWh = 28,000/day **(Load Factor = 53%)**

Design 30% better than 90.1
Non-Storage Electrical Profile



Total kWh = 19,200/day **(Load Factor = 53%)**

Off Peak Cooling (OPC) Electrical Profile



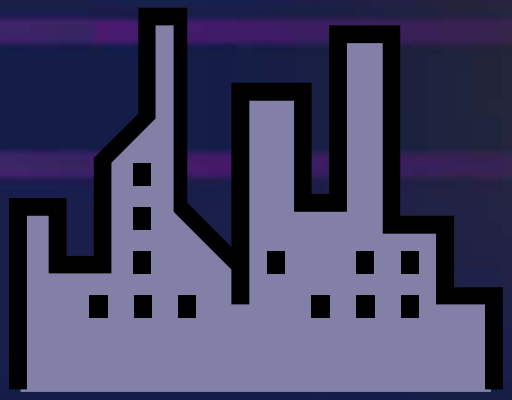
Total kWh = 19,200/day **(Load Factor = 88%)**

Stable Electric Rates

Edison Electric Institute stated that the only form of Energy that has stayed the same cost or gone down in last 30 to 40 years has been

Off-Peak Electricity

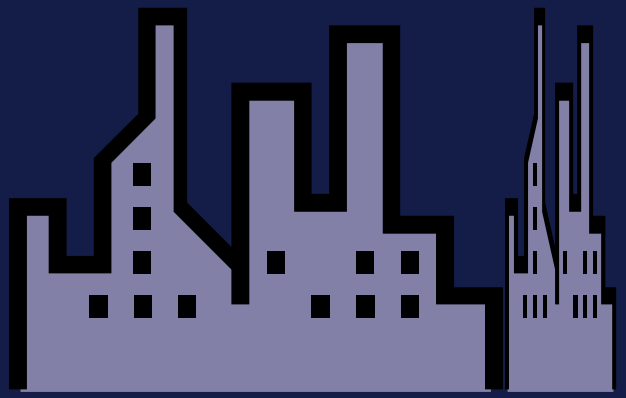
Power continue to be less expensive at Night because of Generation Load Factor



4 Buildings x 1 Megawatt

= 4 Megawatts

8,000 mW-h Sold



5 Buildings with TES @ 0.8 mW

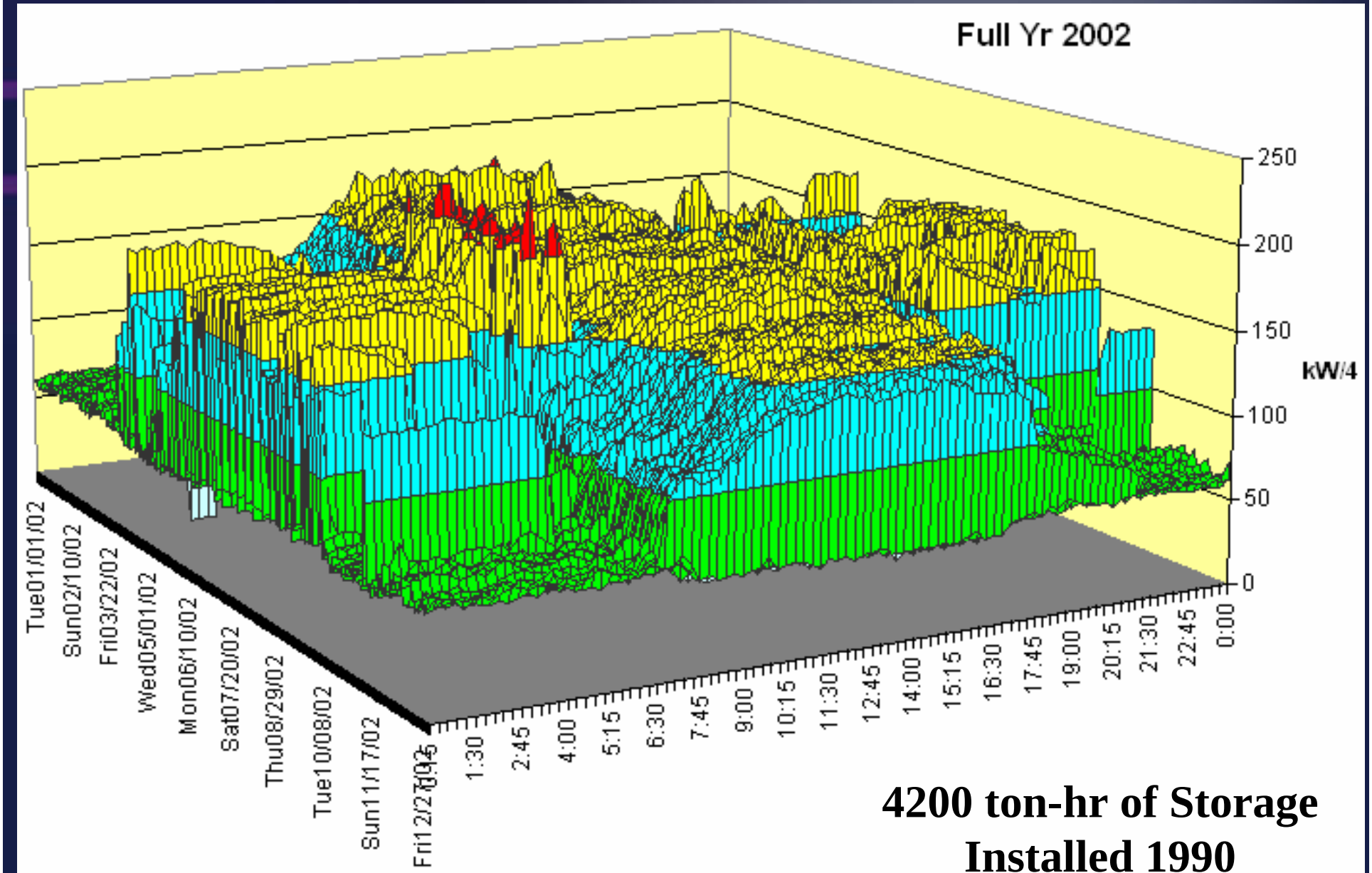
= 4 Megawatts

10,000 mW-h Sold!

The same generator produces

25% more sellable kW-h!

3-D Electric Load Profile -- Full Year



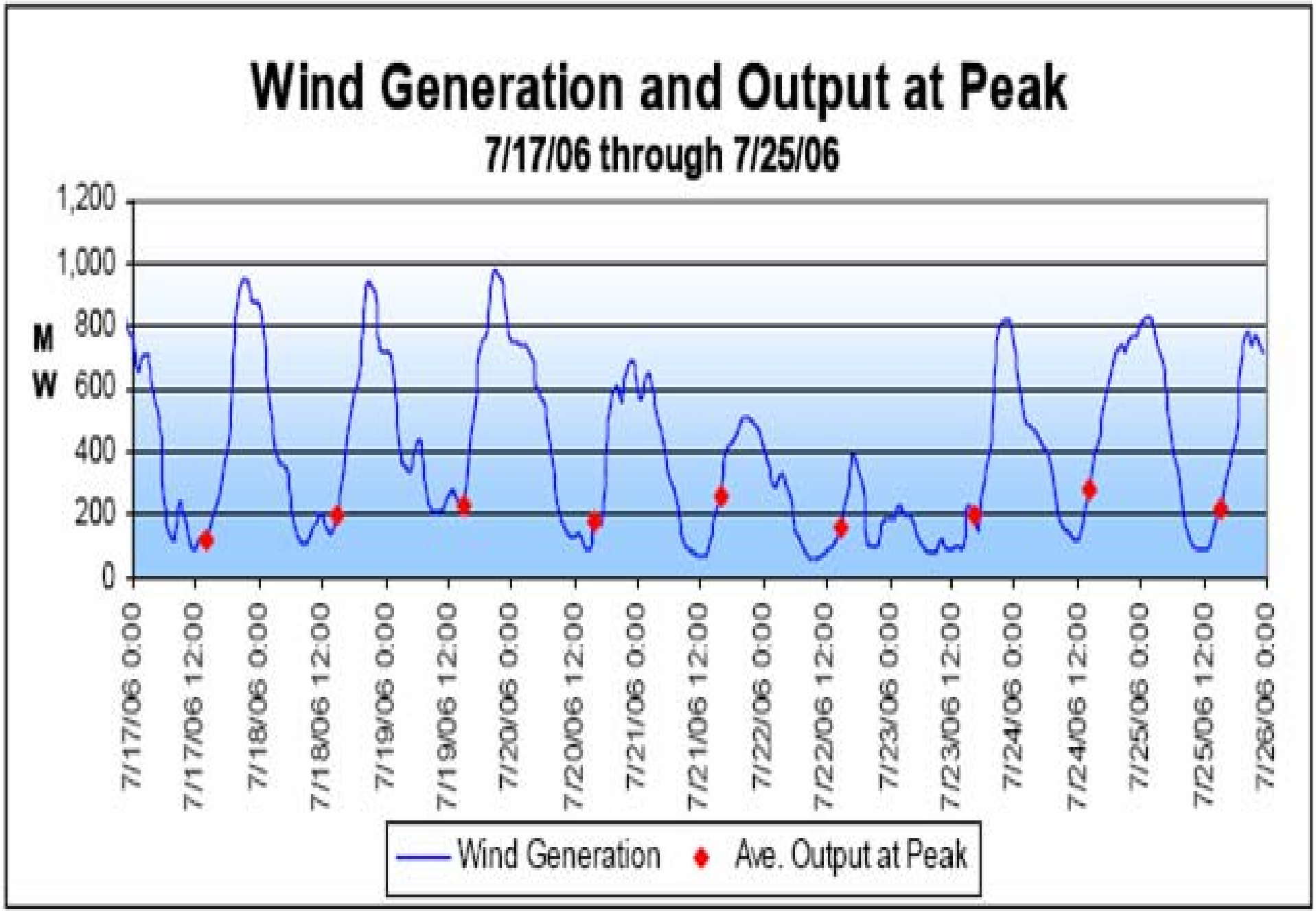
4200 ton-hr of Storage
Installed 1990

Replace

Stored Energy

Energy

Where is the Storage?


Wind Generation and Output at Peak
7/17/06 through 7/25/06
MW
1,200
1,000
800
600
400
200
0
7/17/06 0:00
7/17/06 12:00
7/18/06 0:00
7/18/06 12:00
7/19/06 0:00
7/19/06 12:00
7/20/06 0:00
7/20/06 12:00
7/21/06 0:00
7/21/06 12:00
7/22/06 0:00
7/22/06 12:00
7/23/06 0:00
7/23/06 12:00
7/24/06 0:00
7/24/06 12:00
7/25/06 0:00
7/25/06 12:00
7/26/06 0:00
Wind Generation
Ave. Output at Peak

Large Scale Sustainable Energy will Require Storage

1 TRILLION Watts
of Generation in USA (approx.)

Costs of New Generation, Installed[1]

Gas Turbine	**$0.70 to $1.00/Watt**
New Coal Plant	**$2.00 to $4.00/Watt**
New Combined Cycle Coal Plant	**$3.00 to $5.00/Watt**
New Clean Coal	**$4.00 to ??????/Watt**
Nuclear	**$4.00 to $8.00/Watt**
Wind (~ ?20% Peak Reduction)	**$1.50 to $2.50/Watt**
PV (30% Cap Factor ~ 15% Peak Red[2])	**$7.50/ Watt**

STORAGE (Thermal) **$0.50 to $1.00/Watt**

[1]FERC

[2]NREL Report

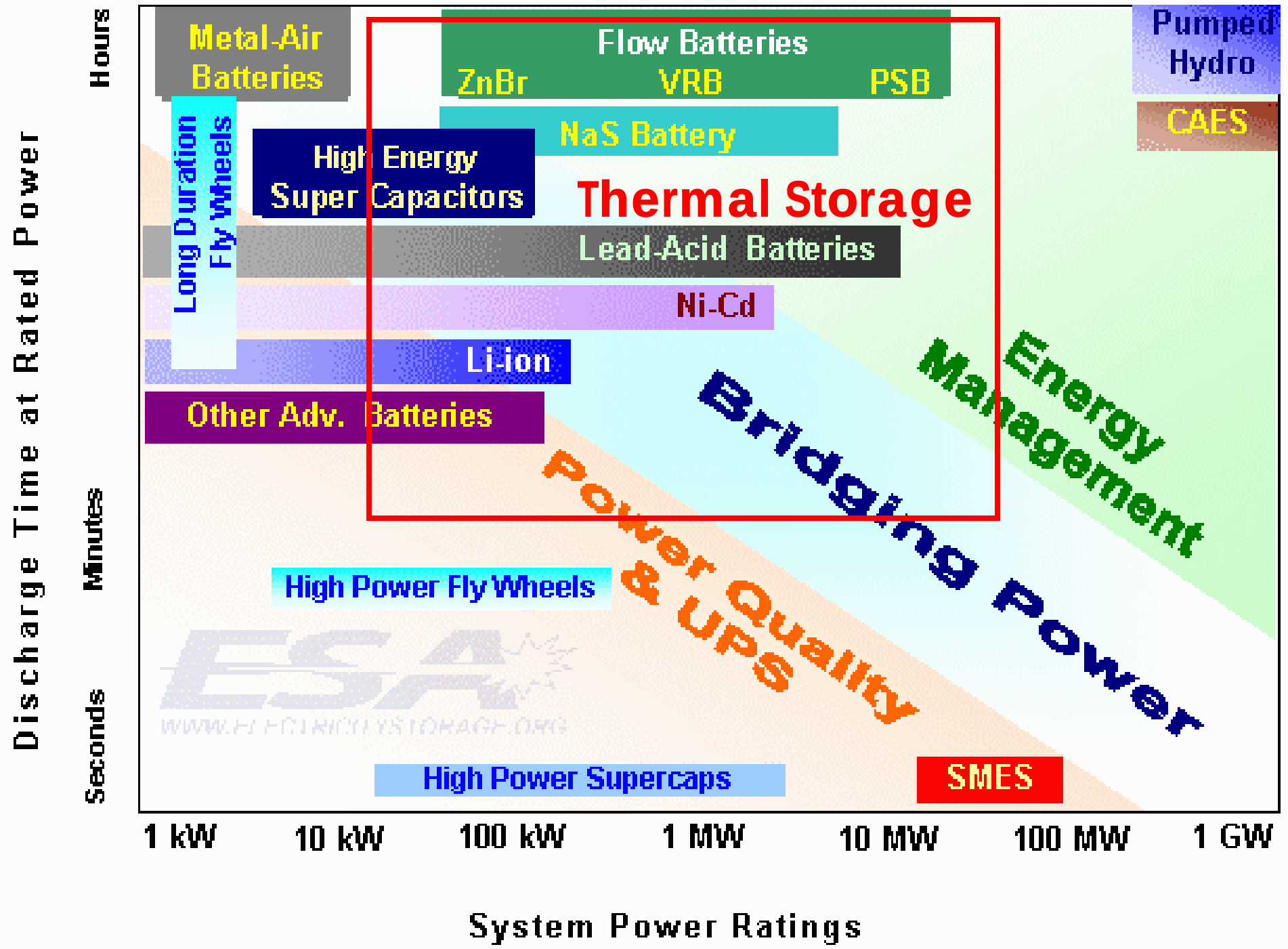
California ISO Report
(Independent Systems Operator)

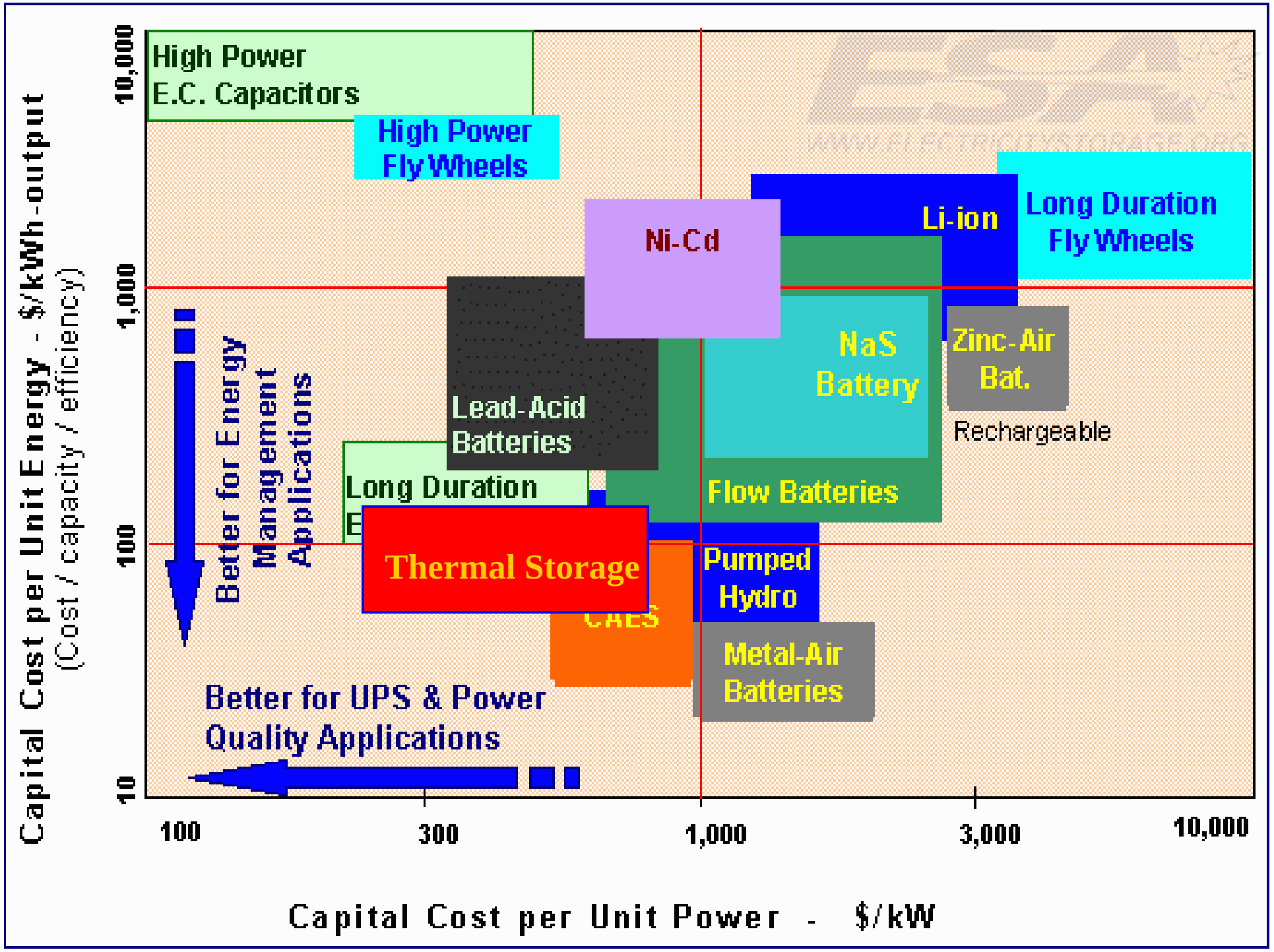
Storage

(Electric, Thermal, Compressed Air, etc.)

will be critical for Large Scale

Implementation of Sustainable Energy


Discharge Time at Rated Power
Hours
Minutes
Seconds
Metal-Air Batteries
Flow Batteries
ZnBr
VRB
PSB
Pumped Hydro
CAES
NaS Battery
High Energy Super Capacitors
Long Duration Fly Wheels
Thermal Storage
Lead-Acid Batteries
Ni-Cd
Li-ion
Other Adv. Batteries
Energy Management
Bridging Power
Power Quality & UPS
High Power Fly Wheels
High Power Supercaps
SMES
1 kW
10 kW
100 kW
1 MW
10 MW
100 MW
1 GW
System Power Ratings


High Power
E.C. Capacitors
High Power
Fly Wheels
Ni-Cd
Li-ion
Long Duration
Fly Wheels
NaS
Battery
Zinc-Air
Bat.
Rechargeable
Lead-Acid
Batteries
Long Duration
E
Flow Batteries
Thermal Storage
Pumped
Hydro
CAES
Metal-Air
Batteries
Better for Energy
Management
Applications
Better for UPS & Power
Quality Applications
10,000
1,000
100
10
100
300
1,000
3,000
10,000
Capital Cost per Unit Energy - $/kWh-output
(Cost / capacity / efficiency)
Capital Cost per Unit Power - $/kW

Thermal Energy Storage For Off-Peak Cooling

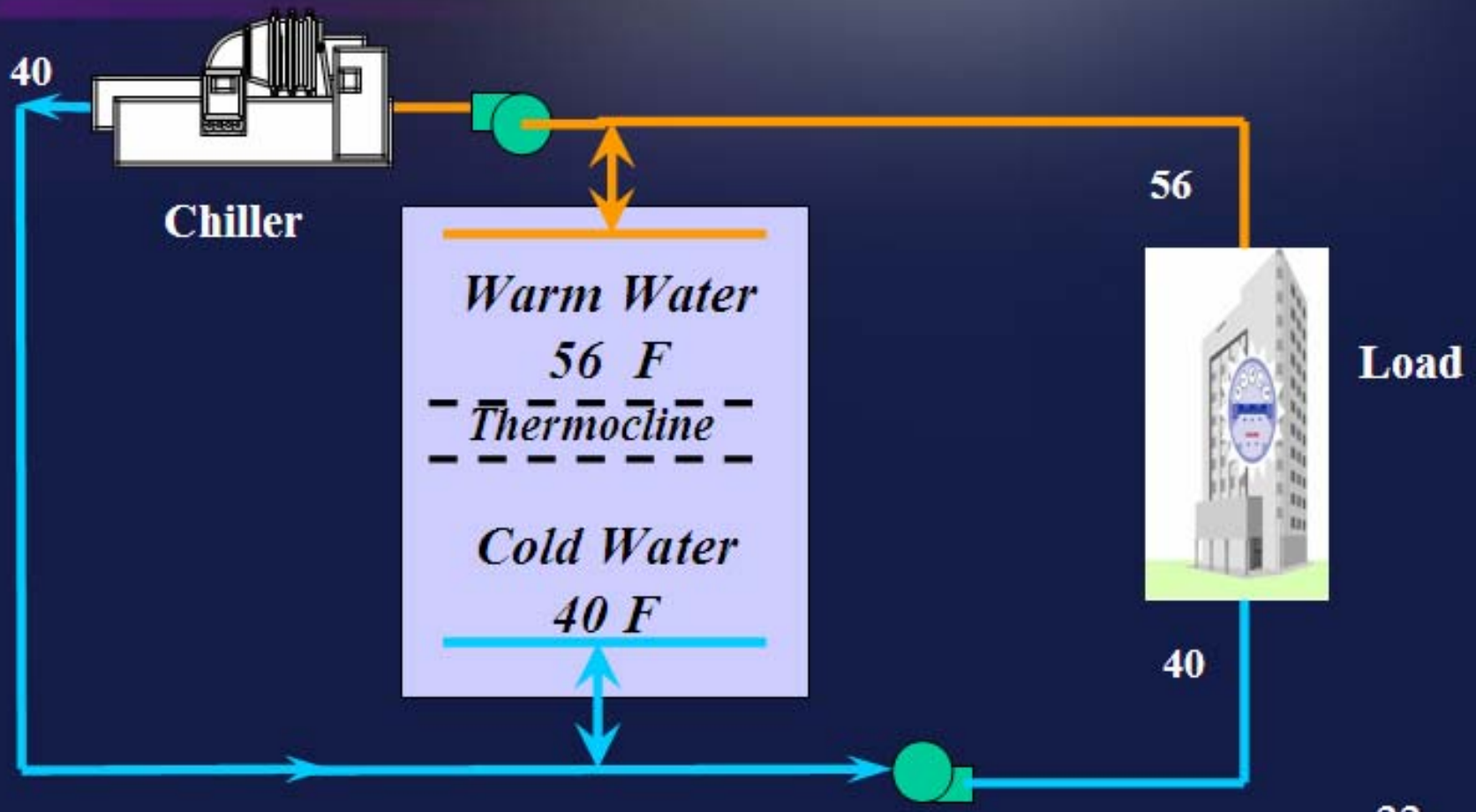
- What is it?
- How does it work?
  - Two Basic Systems
    - Water
    - Ice

Water Storage System

So what is "Different"?

Storage Tank

Keeping System delta T is a must



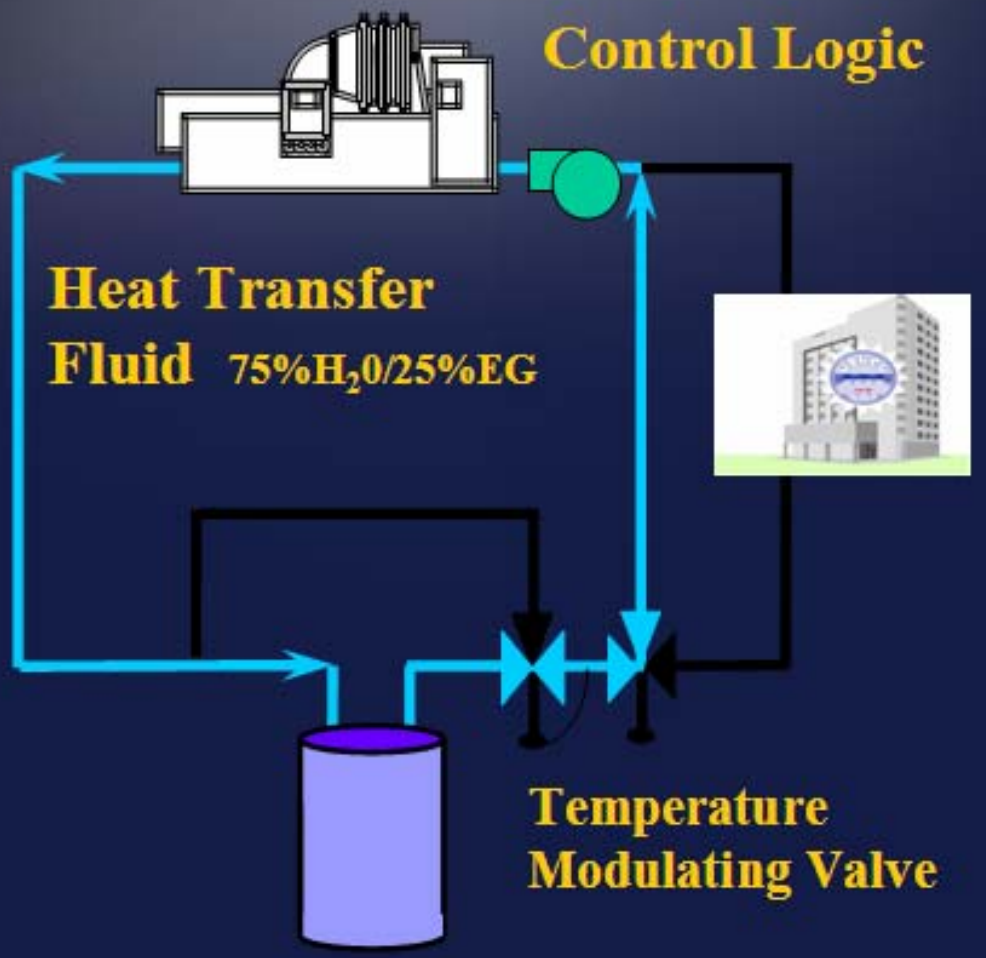
Ice Storage Systems

Almost like Non-Storage System

Chiller Based System

Closed System

So what is "Different"?

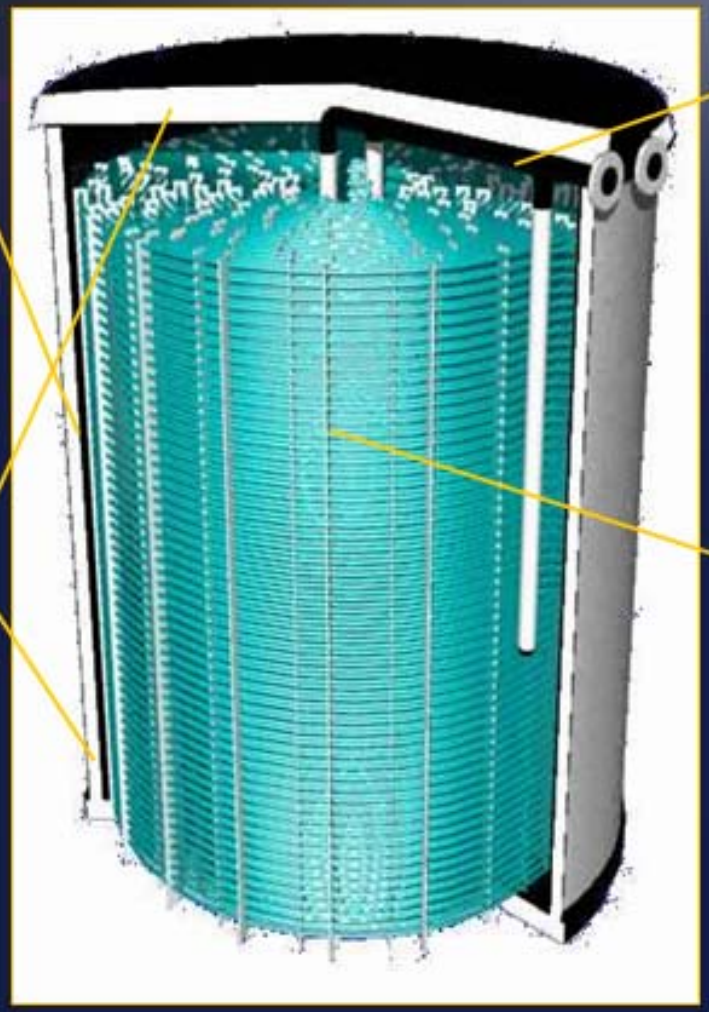


1 Bryant Park, New York City
Bank of America / Durst Organization

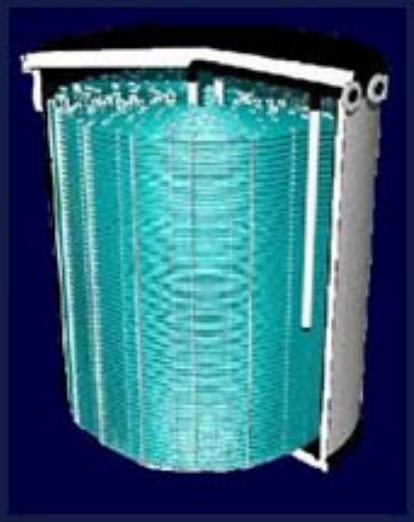
~2.2 Million ft^2
Going for LEED Platinum

History Channel
"Sky Scrapers" 9-7-04

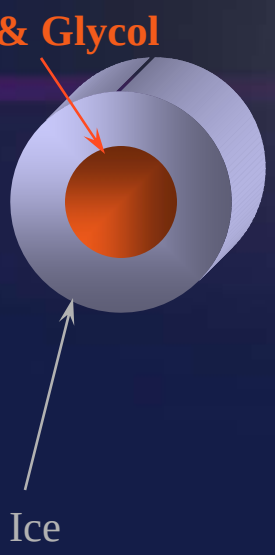
Thermal Storage Tank Ice-on-Coil Internal Melt

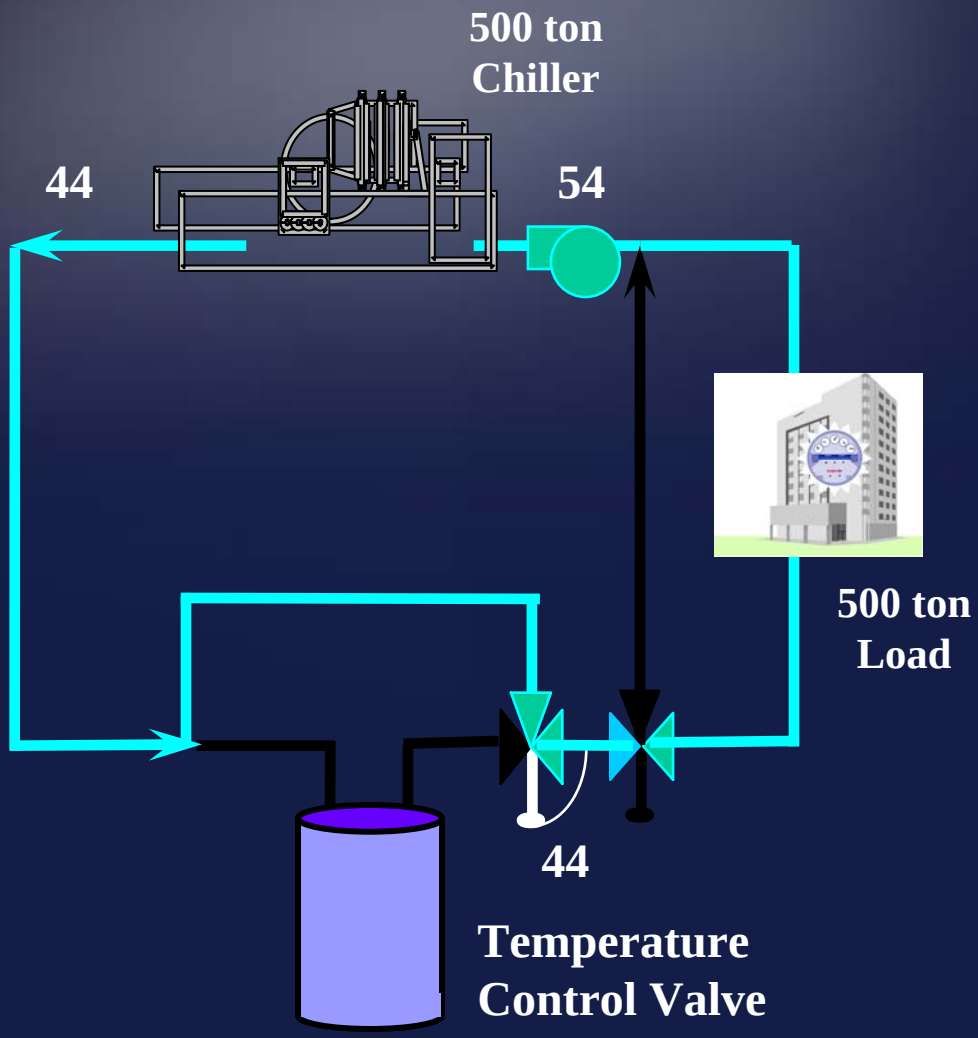


Ice Making (Off-Peak)



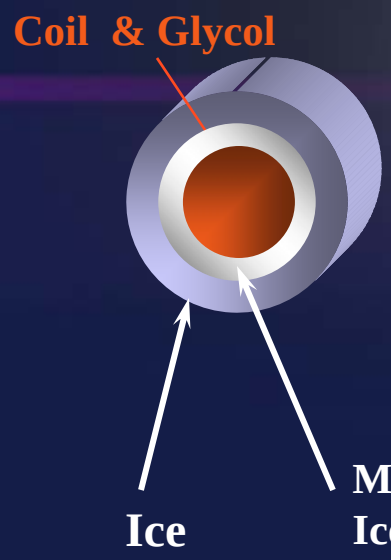
Direct Cooling

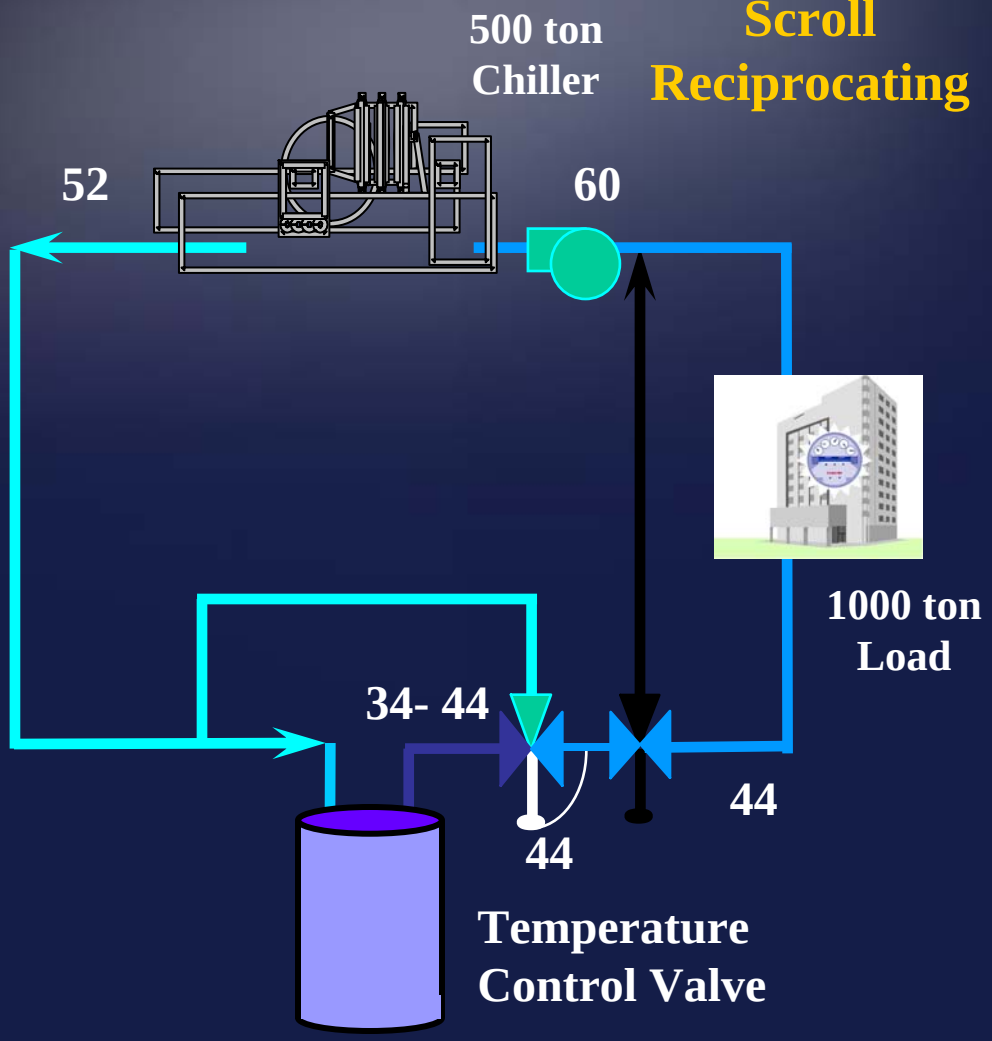




Ice and Chiller Cooling

Centrifugal
Screw
Scroll
Reciprocating

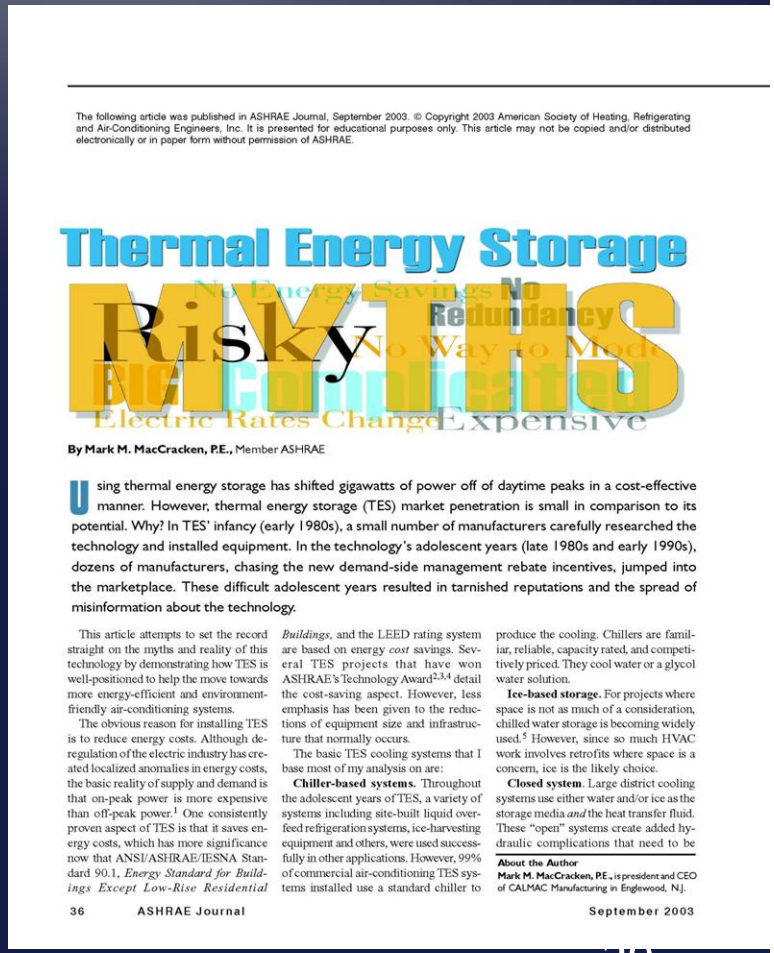




Thermal Energy Storage Myths Article
(Ashrae Journal Sept 03)

1. Uncommon
2. Too Much Space
3. Too Complicated
4. Doesn't Save Energy
5. Too Expensive
6. Lack of Redundancy (Risky)
7. Rates Will Change
8. Modeling doesn't Show Results

Reality: TES is a Proven Technology that saves Money and Energy



The following article was published in ASHRAE Journal, September 2003. © Copyright 2003 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. It is presented for educational purposes only. This article may not be copied and/or distributed electronically or in paper form without permission of ASHRAE.

Thermal Energy Storage

MYTHS

No Energy Savings No Redundancy Risky No Way to Model Big Complicated Electric Rates Change Expensive

By Mark M. MacCracken, P.E., Member ASHRAE

Using thermal energy storage has shifted gigawatts of power off of daytime peaks in a cost-effective manner. However, thermal energy storage (TES) market penetration is small in comparison to its potential. Why? In TES' infancy (early 1980s), a small number of manufacturers carefully researched the technology and installed equipment. In the technology's adolescent years (late 1980s and early 1990s), dozens of manufacturers, chasing the new demand-side management rebate incentives, jumped into the marketplace. These difficult adolescent years resulted in tarnished reputations and the spread of misinformation about the technology.

This article attempts to set the record straight on the myths and reality of this technology by demonstrating how TES is well-positioned to help the move towards more energy-efficient and environment-friendly air-conditioning systems.

The obvious reason for installing TES is to reduce energy costs. Although deregulation of the electric industry has created localized anomalies in energy costs, the basic reality of supply and demand is that on-peak power is more expensive than off-peak power.[1] One consistently proven aspect of TES is that it saves energy costs, which has more significance now that ANSI/ASHRAE/IESNA Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, and the LEED rating system are based on energy *cost* savings. Several TES projects that have won ASHRAE's Technology Award[2,3,4] detail the cost-saving aspect. However, less emphasis has been given to the reductions of equipment size and infrastructure that normally occurs.

The basic TES cooling systems that I base most of my analysis on are:

Chiller-based systems. Throughout the adolescent years of TES, a variety of systems including site-built liquid overfeed refrigeration systems, ice-harvesting equipment and others, were used successfully in other applications. However, 99% of commercial air-conditioning TES systems installed use a standard chiller to produce the cooling. Chillers are familiar, reliable, capacity rated, and competitively priced. They cool water or a glycol water solution.

Ice-based storage. For projects where space is not as much of a consideration, chilled water storage is becoming widely used.[5] However, since so much HVAC work involves retrofits where space is a concern, ice is the likely choice.

Closed system. Large district cooling systems use either water and/or ice as the storage media *and* the heat transfer fluid. These "open" systems create added hydraulic complications that need to be

About the Author

Mark M. MacCracken, P.E., is president and CEO of CALMAC Manufacturing in Englewood, N.J.

36 ASHRAE Journal September 2003

Thermal Energy Storage For Off-Peak Cooling

- What is it?
- How does it work?
- Why is it Green?

How do you measure “Green”?

One Metric is….

LEED™ Green Building Rating System

LEED

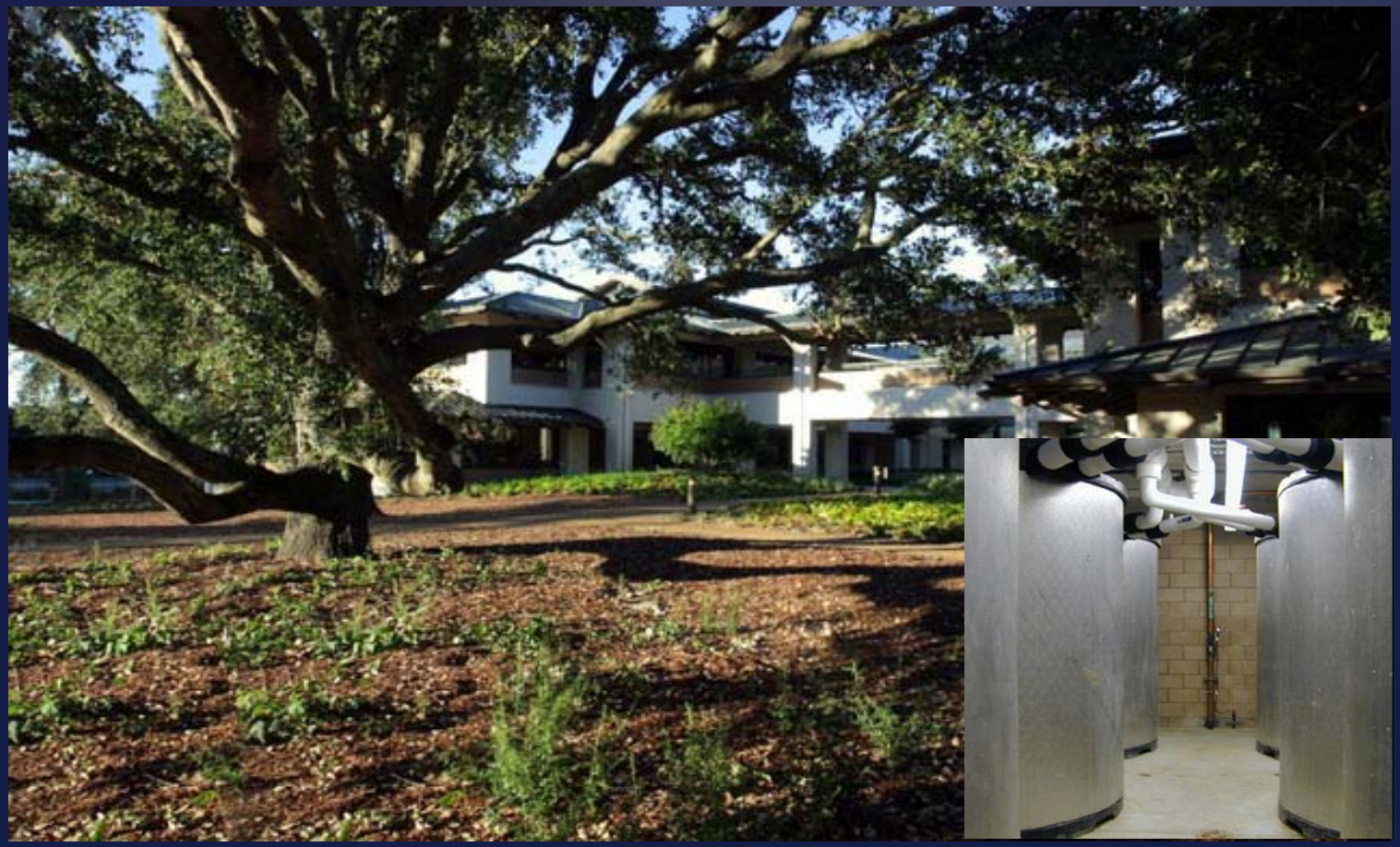
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

LEED™ Credits

Sustainable Sites:		points
Water Efficiency:		points
Energy* & Atmosphere:	14 17	points
Materials & Resources:	5 13	points
Indoor Environment Quality:	15	points
Innovation & Design:	5	points
	69	points

***10 Energy Credit are based on ASHRAE 90.1 which is based on Energy COST Reduction**

William & Flora Hewlett Foundation
LEED™ Gold
35% Energy Cost Reduction (5points)



EPA/DOE Energy Star Building Label Program

The Centex Building in Dallas Texas is the highest rated building with an unprecedented 99 out of 100 rating.

It has the lowest Site Energy Intensity

It has 2400 Ton-hr of Ice Thermal Storage and a water cooled screw chiller.

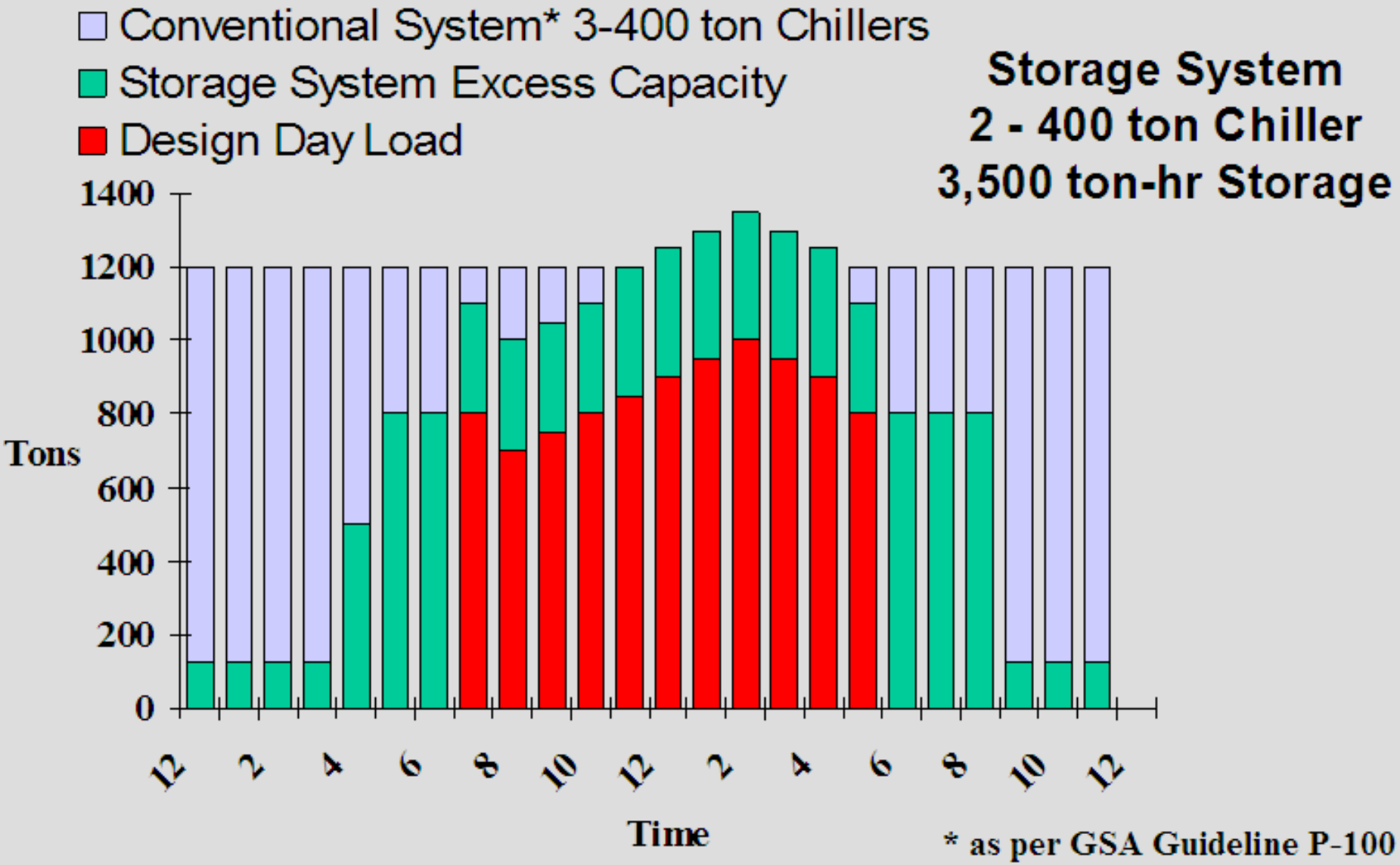
(www.energystar.gov)

Would qualify for 10 pts. in new LEED EB Rating System for Existing Buildings

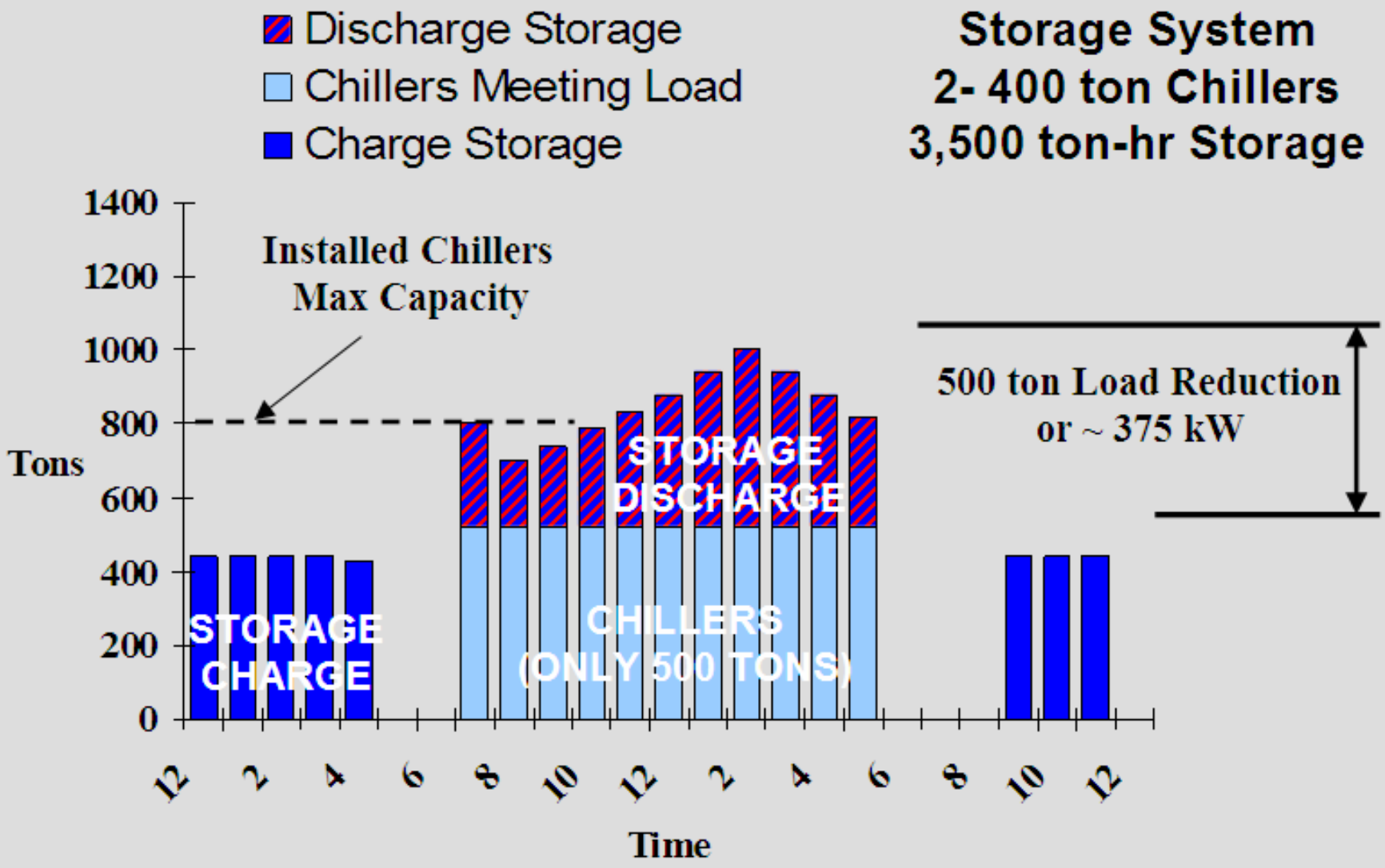
Real reasons Off-Peak Cooling is Green:

1. **It is much more Energy Efficient to create and deliver a kWh of Electricity at night then during the hot of the day.**
   - Research from the California Energy Commission on 2 Cal. Utilities Reports 8 to 34% savings in raw fuel when comparing On and Off Peak Operation!
   - Heat Rates for Base Load Plants ~7,800 Btu/kWh vs.
     Peaking Plants ~9,400 to 14,000 Btu/kWh
2. **The last power plants to come on during peak hours are normally the dirtiest per kW**
   - Ashok Gupta (Director of Energy, NRDC) in NYTimes article "Peak Shifting results in lower emissions because some of the plants used to meet demand peaks are among the dirtiest in the city"
   - New CA Report by Greg Kats *The Costs and Financial Benefits of Green Buildings* states Peak power in CA is twice as dirty as Off Peak Power.

Safety Factor and Redundancy Without Oversizing for same Cost



Design Day Off-Peak Cooling System



Thermal Energy Storage and Sustainable Buildings

(Ashrae Journal Sept 04)

Topics:

LEED

Why Green

Safety Factory

Redundancy

Back-up Generation

BUILDING FOR THE FUTURE

Thermal Energy Storage In Sustainable Buildings

By Mark MacCracken, P.E., Member ASHRAE

This article demonstrates why designing a building with stored cooling is a beneficial approach and how oversizing the chiller plant for safety factor does not make sense. This article discusses what makes thermal energy storage (TES) a green technology, TES and safety factor, and benefits from incorporating storage.

LEED™ Rating System

One system for rating the "greenness" of buildings is the U.S. Green Building Council's (USGBC) LEED rating system. Based on this unit of measure, TES is considered green. The ratings are based on a point system (10 points are for energy savings).

LEED points are based on ANSI/ASHRAE/IESNA Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, which is based on energy *cost* savings, not energy savings. Cost is the only common denominator for all the different energy-efficient possibilities, as well as the common metric that usually drives a building owner's decisions. To receive LEED points, the building must surpass Standard 90.1-1999 by more than a certain percentage for a certain amount of points (20% = 2 points, 30% = 4 points up to 60% = 10 points).

TES and LEED

The reason TES is a green technology in the LEED system is that, in most locations, electricity at night costs less than half as much as during the day.[1] As demonstrated in thousands of installations, major energy cost savings are realized by using inexpensive power at night to create and store cooling, and using storage to cool the building during the next day. These savings provide LEED points, which was demonstrated in California's first LEED 2.0 Gold building built by The William and Flora Hewlett Foundation in the City of Menlo Park.

The building had a total of 43 points (out of 69), of which five were because of the 35% energy cost reduction. This project took advantage of four major cost/energy-saving techniques including external shading, natural lighting, natural ventilation and off-peak cooling (OPC) using ice-based thermal storage. Three of the four are reducing the amount of mechanical cooling, and the OPC system shifts most of what mechanical cooling is required to the inexpensive off-peak period.

Real Reason Thermal Storage Is Green

Many studies, most notably one by the California Energy Commission,[2] have demonstrated that, for many reasons, it takes less fuel to make an off-peak kWh. The main reasons are:

- Off-peak, base-load plants are much more energy efficient than on-peak plants, with 7,900 to 8,500 Btu/kW (8335 to 8970 kJ/kW) heat rates typical for base-load plants. The existing stock of "peaking" plants, which are comprised mainly of simple cycle combustion turbine units, are in the range of 9,000 to 12,000 Btu/kW (9495 to 12 660 kJ/kW).
- Line losses are less off-peak because that much less power is transmitted at night.
- Spinning reserve requirements are lower. (Spinning reserve essentially means power plants are forced to spin turbines at night, without generating power. So, the plants are ready to help meet the following day's peak load). Therefore, lower on-peak power requirements translate into less waste from spinning reserves.

The results of the Califonia Energy Commission's study showed that for the two major California utilities, it required

MLGW GSA Rate (1,000 kW)

Energy:

Day: ~~$0.045/kWh~~ **$0.124**

Night: ~~$0.045/kWh~~ **$0.045**

Demand: ~~$13.00/kW/Month~~

How big an effect is the Demand Charge??

63% less costly at night

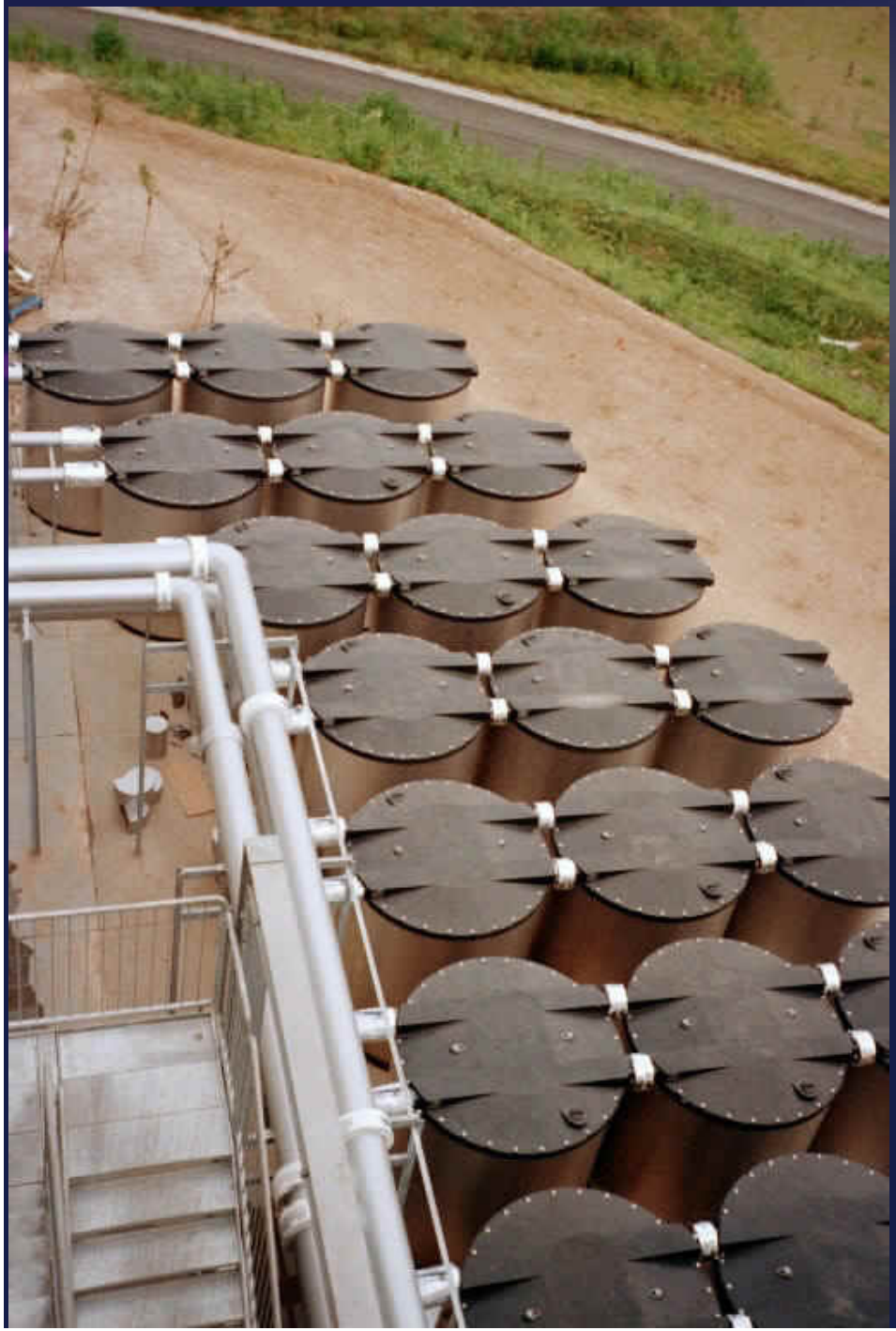
Thermal Energy Storage For Off-Peak Cooling

- What is it?
- How does it work?
- Why is it Green?
- Other “Green” Advantages
- **Applications/Case Studies**

Durst Headquarters Retrofit
1155 Avenue of the Americas

41 Stories
3400 Ton Hours Storage
Avoids ≈ 700kW out of
3500kW Original Total

UL
8,000 Ton-Hr
2.5 days to install



Costco Installations
3 in Japan
2 in Korea
2 in USA

Fossil Ridge HS – Poudre School District
Ft. Collins, CO

LEED Gold
290,000 ft²
Peak Load – 243 Tons
Actual Chiller – 125 Tons
1280 Ton Hrs Ice Storage

Credit Suisse
11 Madison Ave.

30 Stories, 2.2 Million Ft^2

6200 Ton Hours Storage

Savings ~ $1,000,000/year

Avoids ~ 1000 kW

Main reason for Storage: Resiliency


CALMAC
CALMAC
CALMAC
EXIT
Morgan Stanley
Westchester, NY

University of Arizona

Campus Statistics

- **28,300 Tons of Refrigeration**
- **12 Million Sqft.**
- **130 Buildings**
- **35 MW Peak**
- **14 MW of Gas Turbine Gen.**
- **14,000 ton-hr of Ice Storage**

Main reason for Storage: Optimizing Gas Turbine Generator's Efficiency, Emissions and Heat output


1 Bryant Park
Bank of America Tower
2.2 Million Sqft
New York's Most Environmentally Friendly Office Tower.
Member FDIC

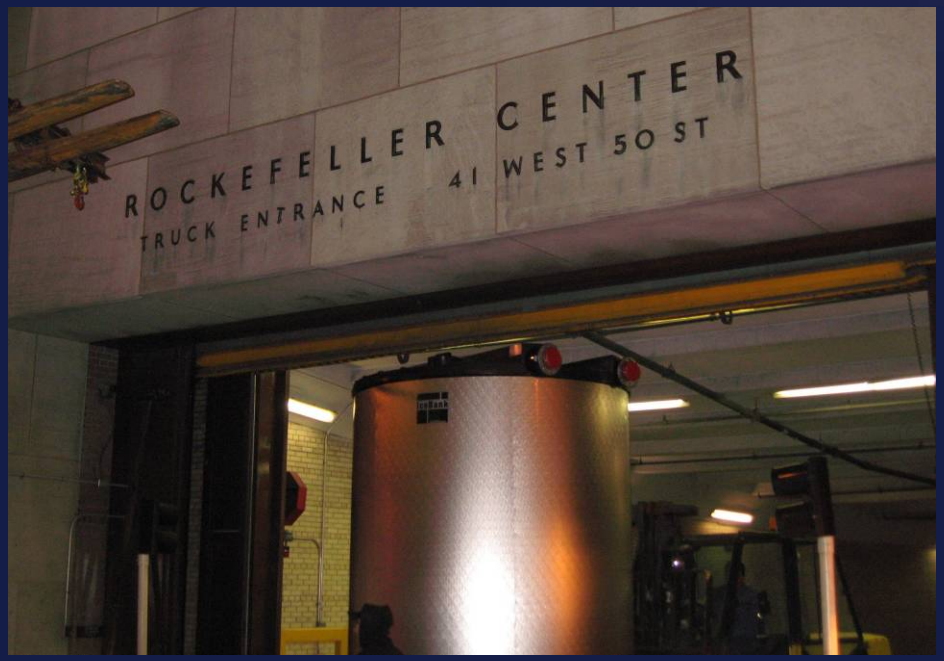
Bank of America Tower ICEBANK Facts

Over Half a Million Pounds of Ice made every night.

Enough Ice to Cool 250 Homes

1000 Tons of Air Conditioning Shifted to Off-Peak

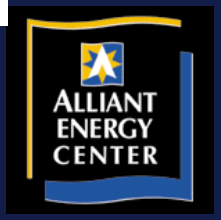
Rockefeller Center
NYC
9,000 Ton-Hr

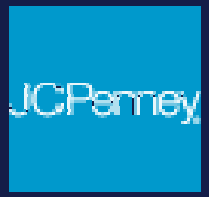


Off-Peak Cooling… in over 6000 installations in 35 countries, many installed over 20 years ago









Summary

Storage is Nature's way to Balance Supply and Demand

Engineer's Paradigm must change.

- **Instead of adding 20-30% to estimated Load,**
- **reduce by 20-30% and add Storage for Safety**
- **at no extra Cost.**

Cool Storage reduces

- **Operating Costs**
- **Load on Grid**
- **Impact on Environment**

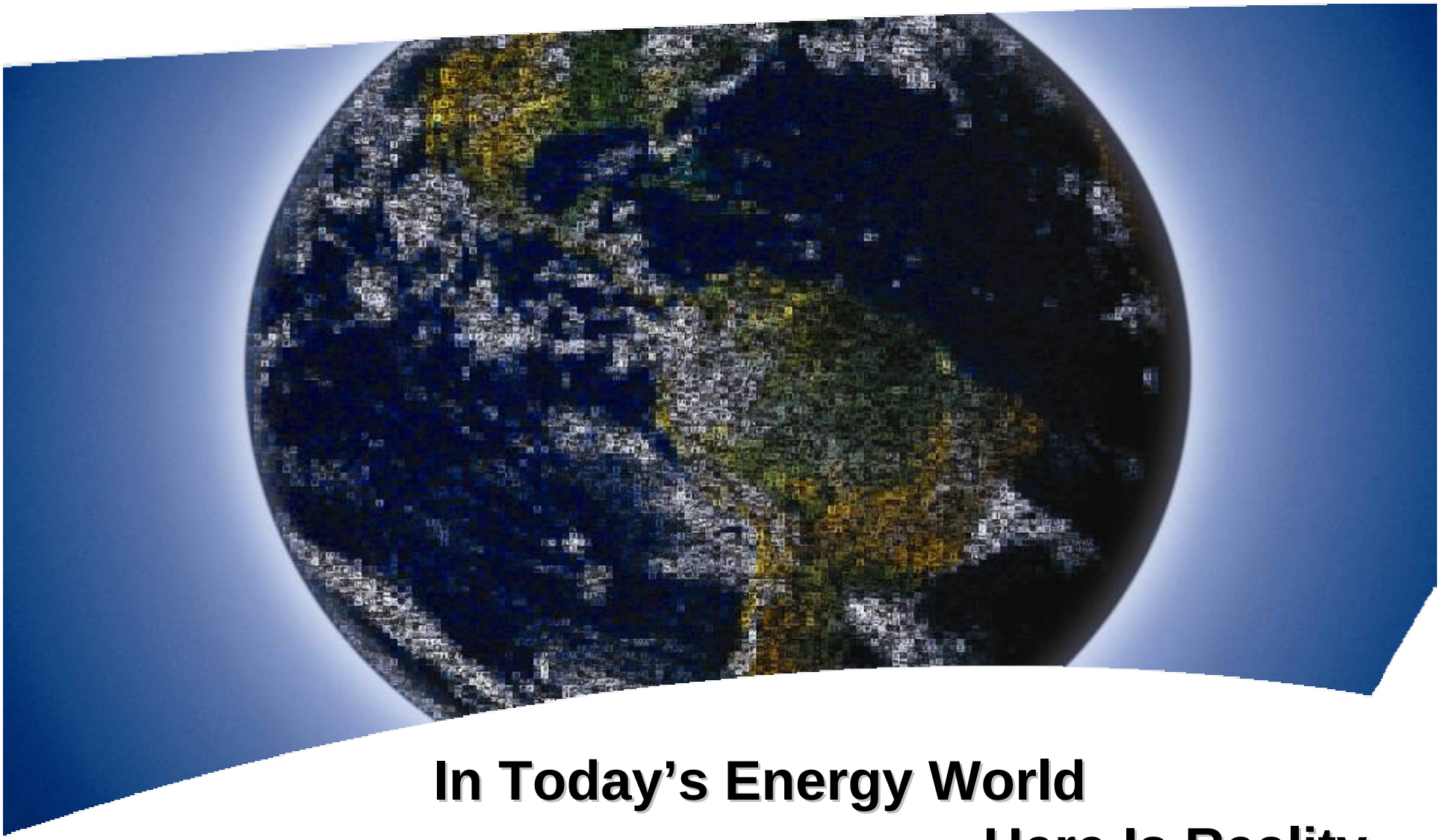
Questions?

Danfoss

TURBOCOR

ENERGY STAR PARTNER PRESENTATION
AUGUST 20, 2008
MAKING A WORLD OF DIFFERENCE TODAY

ENERGY STAR PARTNER



In Today's Energy World
…. Here Is Reality

WE'RE ALL IN A WORLD OF HURT

- **ENERGY ARE COSTS ARE GOING UP**
- **ENERGY SUPPLIES ARE DECLINING OR ARE AT POLITICAL RISK**
- **ENERGY EFFICIENCY, ENVIRONMENTAL INTEGRITY AND GLOBAL WARMING ARE NOW LINKED.**
- **ENERGY EFFICIENCY IS THE ONLY VIABLE SHORT-TERM TO MID-TERM ENERGY STRATEGY**

Danfoss TURBOCOR

The Universal Energy Dilemma

- **Government Building**
- **Medical Facility**
- **Manufacturing Plant**
- **School College or University**
- **Hotel**
- **Major Retail Facility**
- **Entertainment Complex**

Where do I find the next energy saving dollar?

Danfoss TURBOCOR

Dr. Raymond L. Orbach
Under Secretary for Science
U.S. Department of Energy

"The Challenge – We must meet the increasing demand for energy without adding catastrophically to atmospheric carbon dioxide."

"Current fossil energy sources, current energy production methods, and current technology cannot meet the challenge."

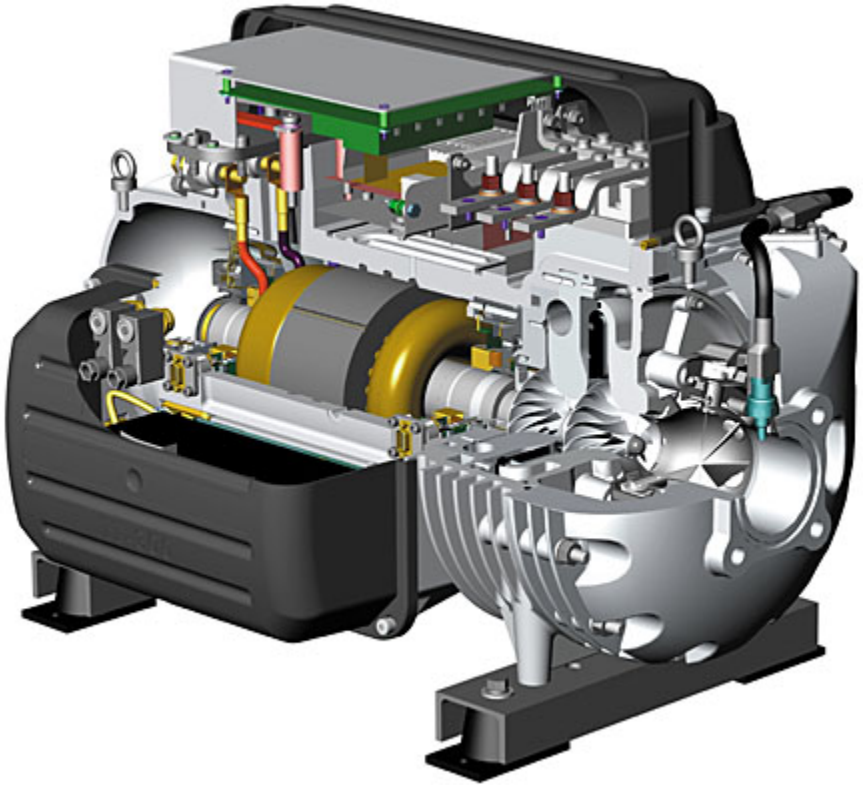
"Incremental changes in technology will not suffice."

"We need transformational discoveries and truly disruptive technologies."

Danfoss TURBOCOR

THE *DANFOSS* TURBOCOR COMPRESSOR IS

- **A TRANSFORMATIONAL TECHNOLOGY**
- **THAT IS**
- **A TRULY DISRUPTIVE TECHNOLOGY**



Danfoss

TURBOCOR

Introducing
A New Compressor Technology
For Today's Energy Reality

IN TODAY'S HVACR WORLD ..... WHEN YOU SAY COMPRESSOR IT CAN MEAN

- Reciprocating
- Rotary
- Scroll
- Screw
- Centrifugal

What can you do to a compressor ?

Danfoss TURBOCOR

THE CHOICES...THERE ARE TWO

REFINE THEM…

OR

REDEFINE THEM **!!!**

REDEFINING THE COMPRESSOR

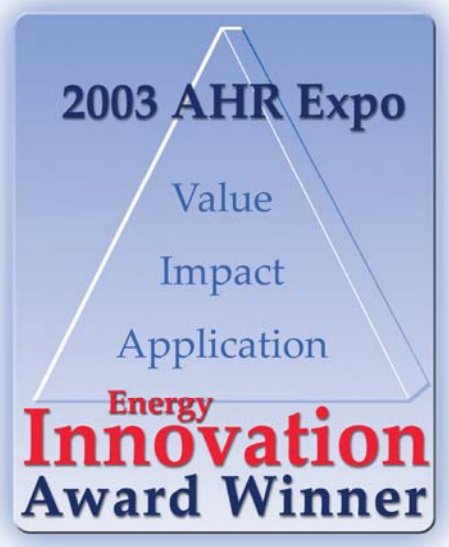
YEARS OF RESEARCH AND DEVELOPMENT HAVE PRODUCED A COMPRESSOR THAT IS:

- **LIGHT** (Less than 300lbs)
- **COMPACT** (approx.1/5 the size of an ordinary compressor)
- **VIRTUALLY FRICTIONLESS** (uses magnetic bearings)
- **QUIET** (less than 70dB at full load)
- **EMPLOYS ON BOARD DIGITAL ELECTRONICS**
- **ENERGY EFFICIENT**
- **OIL-FREE**
- **MULTI-AWARD WINNING DESIGN**

Danfoss TURBOCOR

U.S. EPA Climate Protection Award

ASHRAE/AHR Expo
Energy Innovation Award



Canada
Energy Award

DANFOSS TUROCOR
RECEIVES
2006 FROST SULLIVAN AWARD
HVAC Innovation

Danfoss TURBOCOR

Danfoss

TURBOCOR

TURBOCOR AT A GLANCE

The Turbocor Compressor

Danfoss TURBOCOR

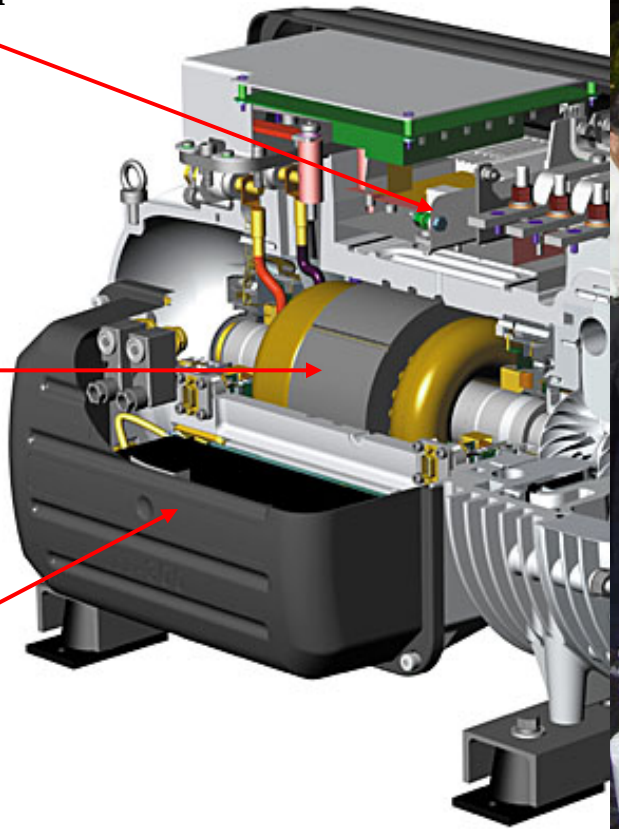
The Turbocor Compressor at a Glance

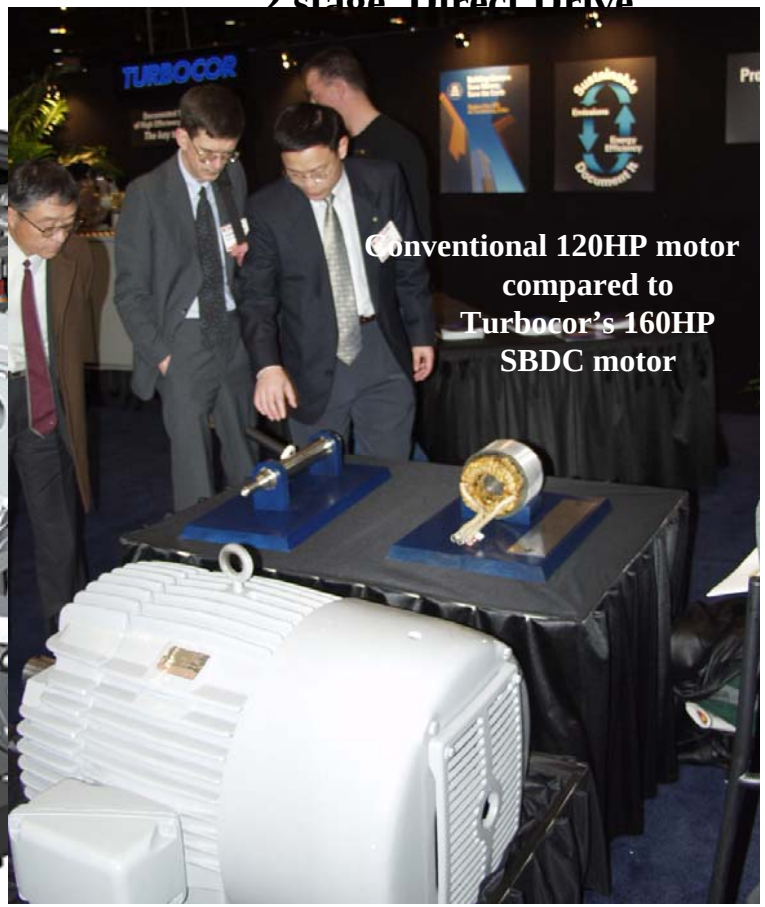
2 stage, Direct Drive

Inverter Speed Control

Permanent Magnet Motor

Integrated Controls

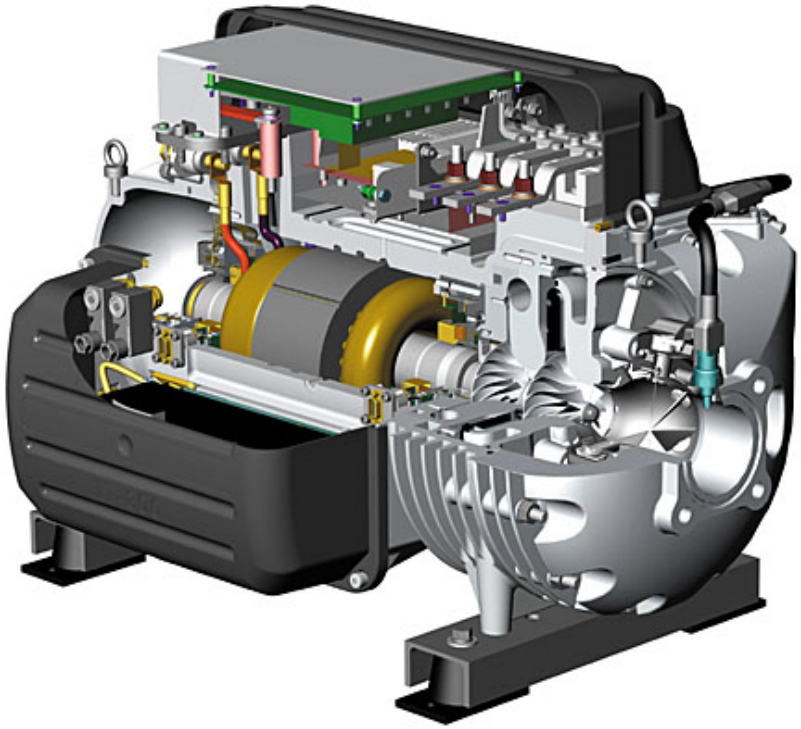


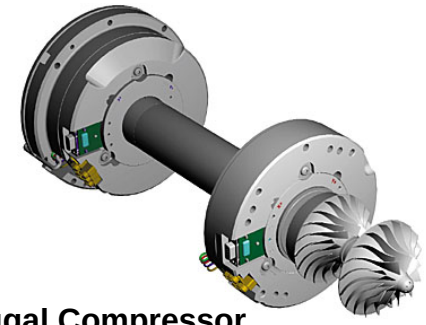


Conventional 120HP motor compared to Turbocor's 160HP SBDC motor

Danfoss TURBOCOR

Integrated Compressor Design - ICD





Centrifugal Compressor

Inverter Control

Magnetic Bearings

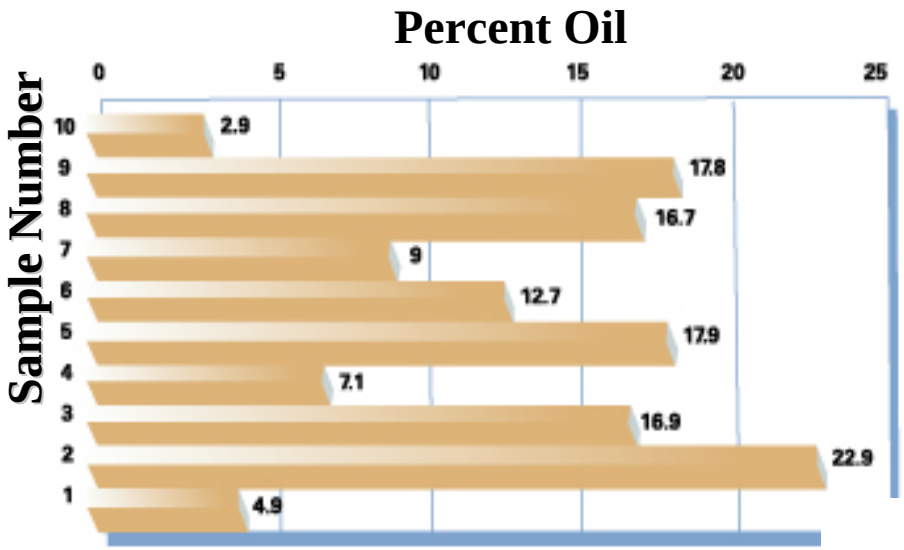
Danfoss TURBOCOR

Why Magnetic Bearings?

- **The magnetic bearings use 99.5% less energy when compared to conventional bearings**
- **Plus, in this tonnage size, they're the key to a cost effective "Oil-Free" design**

Danfoss TURBOCOR

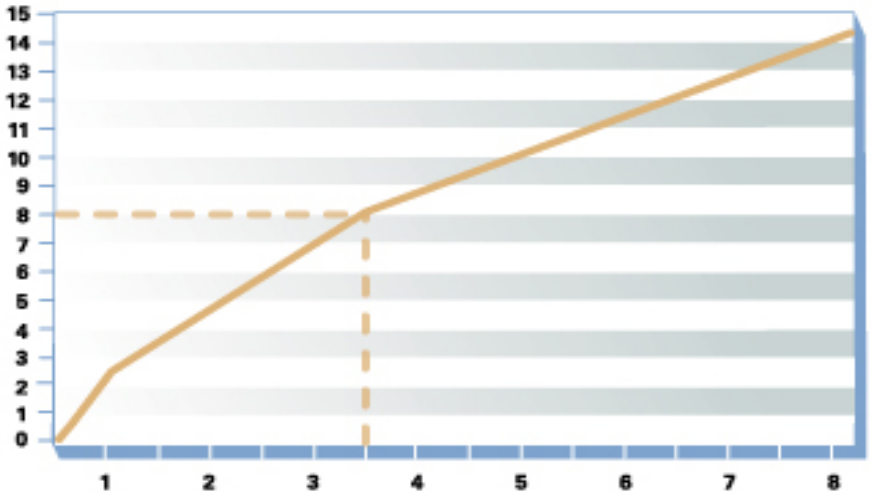
The effects of oil in a system



An ASHRAE study determined that the vast majority of installed chillers have an excess amount of oil in the cooling system

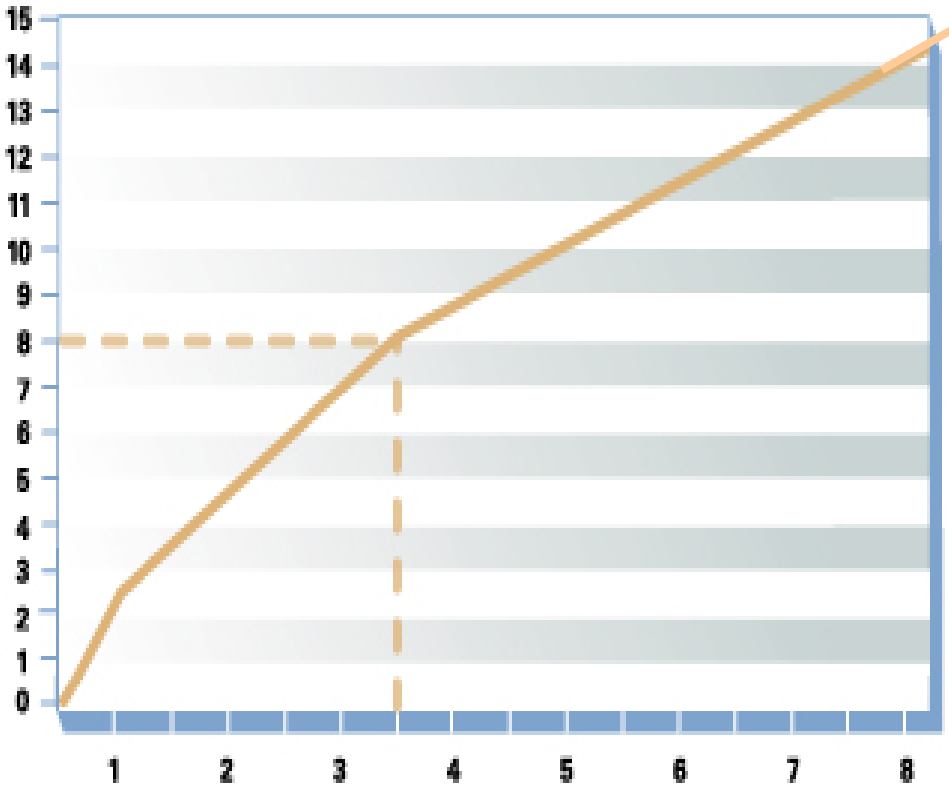
ASHRAE research study 601

3 ½% of oil in the refrigerant charge reduces system efficiencies by 8 %



Danfoss TURBOCOR

Average oil overcharge from the ten chillers tested



- In the ten (10) chillers tested in the ASHRAE study, the **average overcharge** of oil in the system was **12.88%,** this equated to an average **energy loss of about 21%**

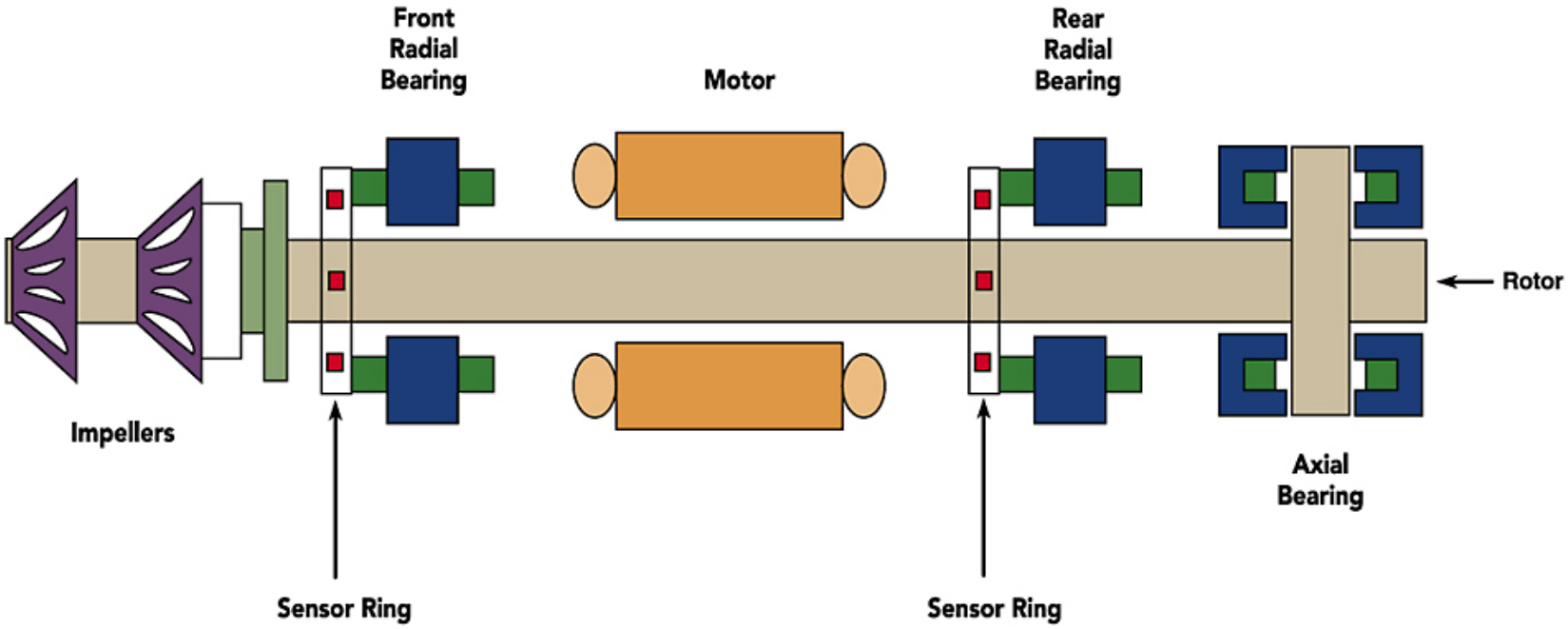
Danfoss TURBOCOR

Why Magnetic Bearings?

- **They are the KEY to redefining soft start in the HVAC Industry**
- **Whether 60 tons or 1,000 tons + - Retrofit or new equipment using Turbocor Technology starts on**
- **1.6 Amps**

Danfoss TURBOCOR

Danfoss Turbocor Compressor
How does it all work?



Danfoss

TURBOCOR

THIS IS A TECHNOLOGY THAT CHANGES THE WAY WE THINK ABOUT AIR CONDITIONING

A 250 Ton Centrifugal Chiller
Before

Danfoss TURBOCOR

A 250 Ton Centrifugal Chiller
After

Danfoss TURBOCOR

INTRODUCING

A PARADIGM SHIFT

- **COMPRESSOR DIVERSITY**
  - **ENERGY DIVERSITY**
  - **FUNCTIONAL DIVERSITY**
  - **OPERATIONAL DIVERSITY**

Danfoss TURBOCOR

HERE IS WHAT ARI HAS FOUND

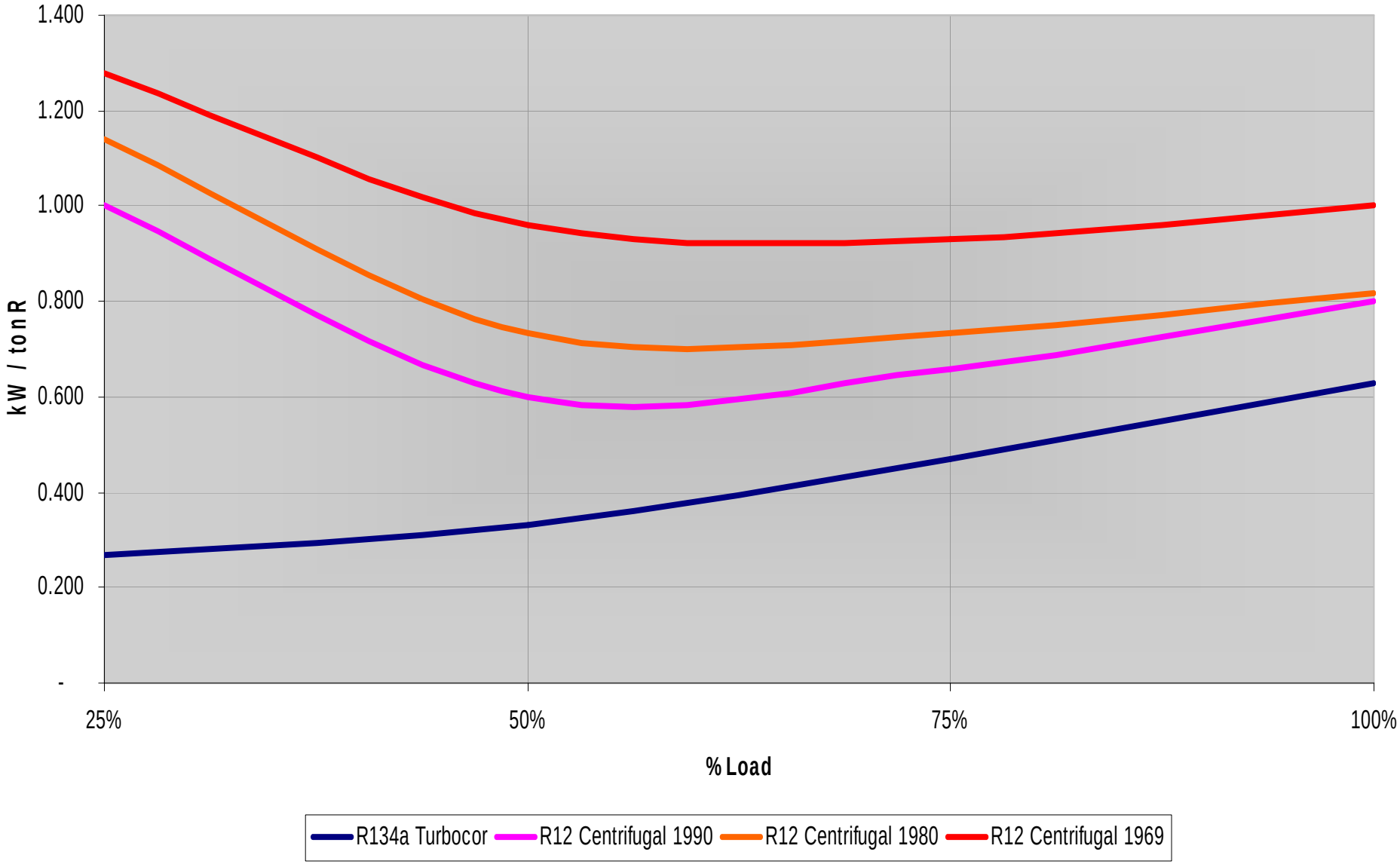
Most HVAC system design is based on what happens at peak load. In most cases, however, a building will only see that load for about 80 hours per year. In reality, many of the other assumptions made in determining the design load do not occur simultaneously, so the actual hours are even less.

ARI has found that typical commercial buildings in the United States operate 1 percent or less of the time at full-load tonnage.

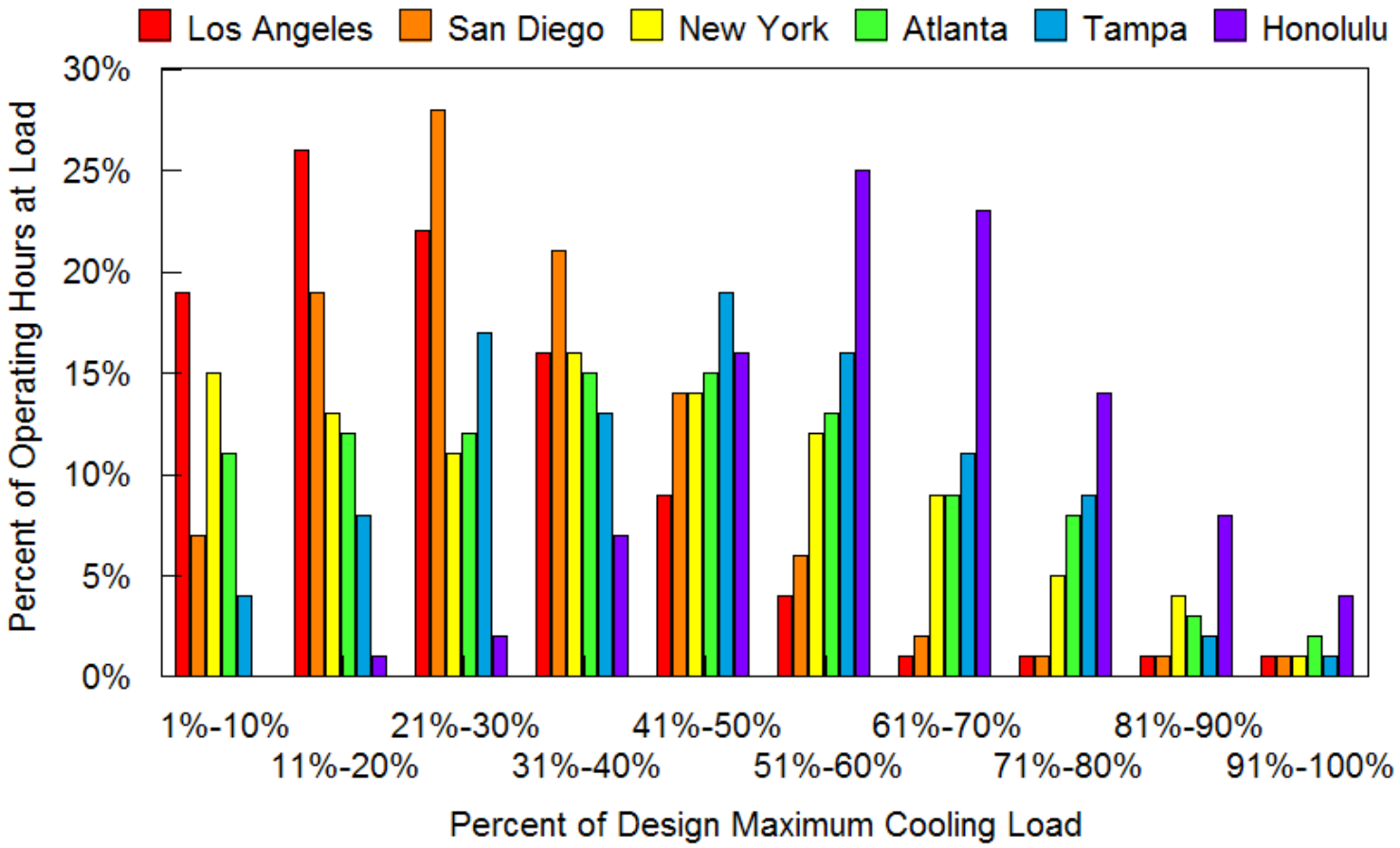
Buildings,January 2006

Danfoss TURBOCOR

Centrifugal Performance Improvement Over Time



Characteristics of Comfort Cooling Loads for Various Climates (temperate, tropical and transitional)



ENERGY DIVERSITY

- **THE ABILITY TO UTILIZE MULTIPLE COMPRESSORS TO FUNCTION AT PART LOAD ON OVERSIZED SHELLS TO MATCH AND OPTIMIZE PERFORMANCE AT THE PART LOAD OPERATING CONDITIONS THAT ARE THE MOST COMMON DURING THE EQUIPMENT'S TYPICAL OPERATING DAY.**

Danfoss TURBOCOR

FUNCTIONAL DIVERSITY

THERE ARE TWO FORMS

1. **REDUNDANCY THAT IS NOW BUILT-IN**

2. **LOW LOAD OFF-HOURS OPERATION – EFFICIENCY OF A PONY CHILLER IS NOW BUILT-IN.**

BOTH ARE THE PRODUCT OF A MULTIPLE COMPRESSOR APPLICATION

Danfoss TURBOCOR

OPERATIONAL DIVERSITY

- **IN A FAILURE MODE – OTHER COMPRESSORS WILL CONTINUE TO OPERATE**
- **TEMPORARY COOLING IS VIRTUALLY ELIMINATED.**
- **COMPRESSOR REPLACEMENT – NO LARGE CRANES OR SPECIAL EQUIPMENT**
- **MAINTENANCE IS SIMPLIFIED WITH NO REQUIRED SHUTDOWNS**

Danfoss TURBOCOR

Danfoss TURBOCOR

HOW IS THIS TECHNOLOGY BEING DEPLOYED?

A NATIONAL NETWORK
CERTIFIED RETROFIT CONTRACTORS

- **A/C AND W/C CHILLERS**
- **BUILT-UP DX SYSTEMS**
- **LARGE TONNAGE CONDENSING UNITS**
- **LARGE TONNAGE PACKAGE UNITS**

CONTRACTOR LOCATOR @

WWW.TURBOCOR.COM - RETROFIT

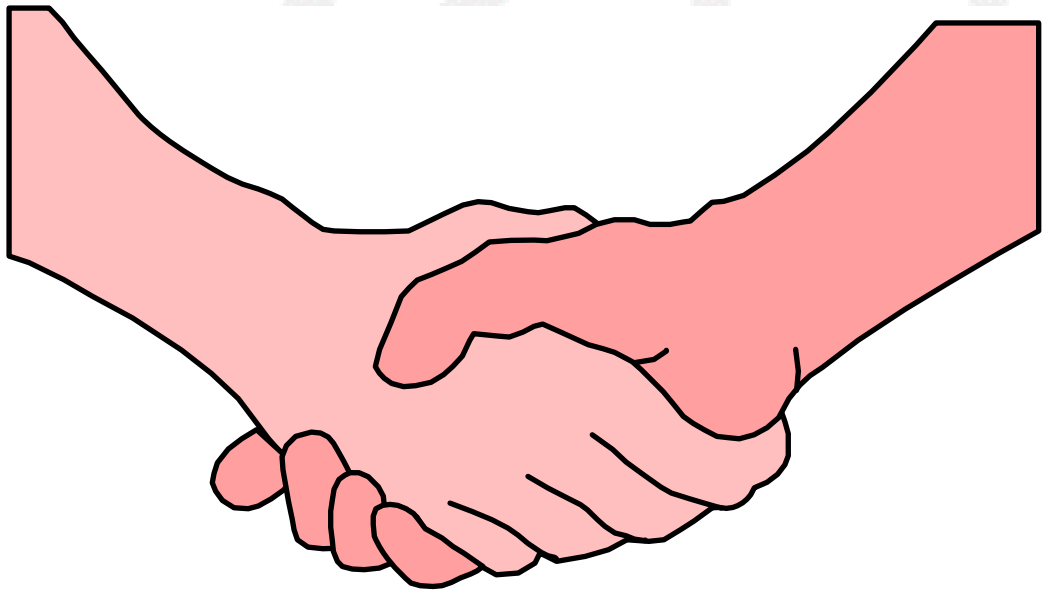
Danfoss TURBOCOR

THE OTHER PATH TO MARKET

- **ORIGINAL EQUIPMENT MANUFACTURERS (OEM)**
- **HAVE DEVELOPED A VARIETY OF HVAC PRODUCTS**

Danfoss TURBOCOR

TURBOCOR



McQuay International

McQuay Frictionless Centrifugal Chiller

- World's First ARI Certified Frictionless Chiller
- Capacity - up to 300 Tons
- Full Load as Low as .575 kW/Ton
- Incredible IPLV of .375 kW/Ton
  - 75% POINT .453 kW
  - 50% POINT .335 kW
  - 25% POINT .317 kW
- Whisper Quiet 77 dba (Per ARI 575)
- Environmentally Friendly Refrigerant 134A

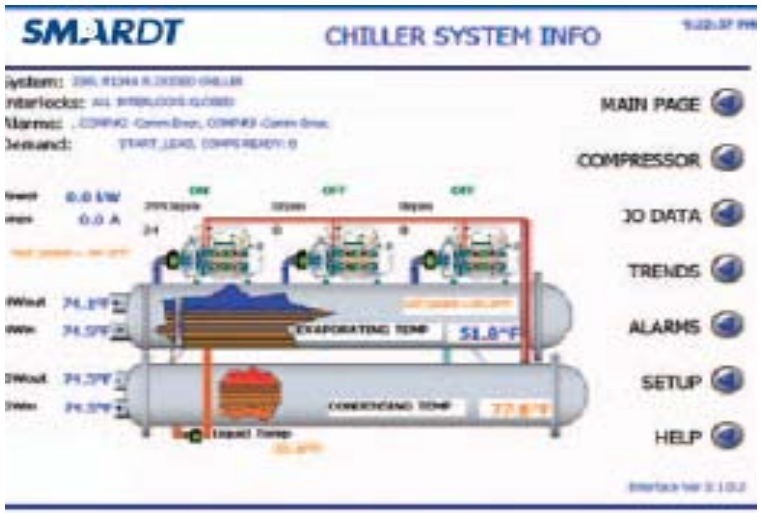
McQuay Air Conditioning

MULTISTACK MODULAR CHILLERS

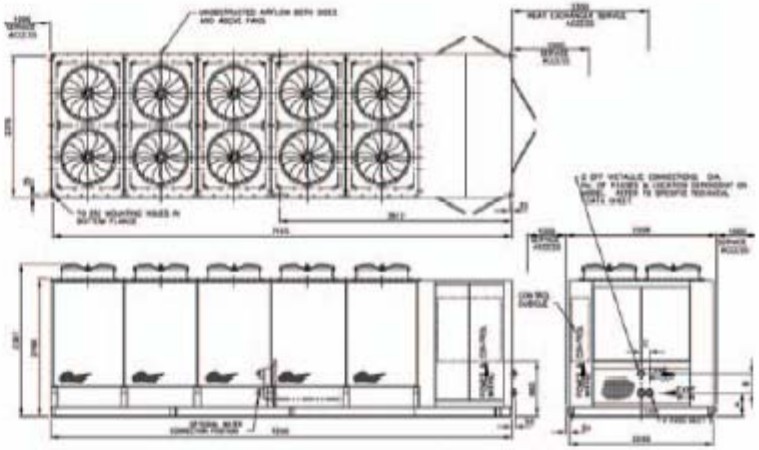
- Modular
- Energy Efficient
- Compact
- Quiet
- Now featuring
- Turbocor Compressors

Embassy Suites - Turbostack

SMARDT


SMARDT
CHILLER SYSTEM INFO
MAIN PAGE
COMPRESSOR
IO DATA
TRENDS
ALARMS
SETUP
HELP


SMARDT



Achieving Energy Goals

- Improve building energy performance
- Improve ENERGY STAR rating
- Reduce energy costs and risks
- Reduce CO2 emissions

Danfoss TURBOCOR

THANK'S FOR YOUR TIME

ADDITIONAL INFORMATION

www.turbocor.com

WE THINK YOU'LL AGREE

Danfoss TURBOCOR

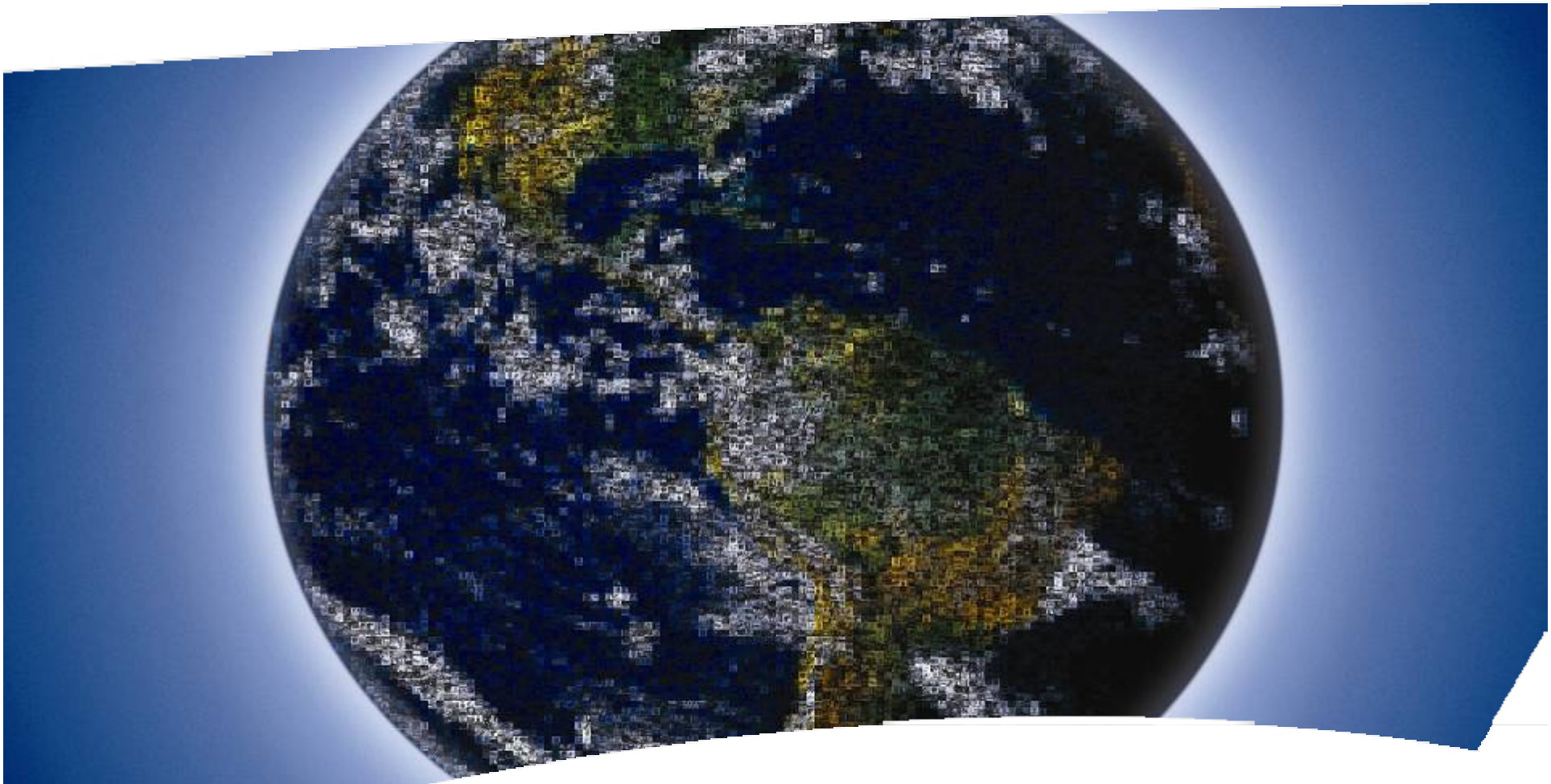
Contact Information

Dan Thatcher

Vice President Aftermarket Businesses

850 504-4800

dthatcher@turbocor.com



Danfoss Turbocor Compressors Are Making a World of Difference

Questions & Discussion

2008 Web Conferences

Month	Topic
January	ES Update
February	Green Power Strategies
March	Engaging Employees in Energy Efficiency
April	Leading Energy Programs – ES Partners of the Year
May	Energy Efficiency and Green Buildings
June	Our Top 3 Energy Projects
July	Motivating and driving facility performance
August	“Cool” Energy Savings Strategies
September	Supply Chain Energy & Climate Initiatives
October	Energy & Climate Risk Management
November	Energy Strategy & Project Financing

Past Presentations – See “Networking Opportunities” @ energystar.gov

2009 Web Conferences

- Have a good idea for web conference?
- Have a great energy management story?
- Have an issues your wondering about?
- Then contact: tunnessen.walt@epa.gov with some suggestions!

Thank You!