Innovative Solutions for High Performance Building Systems

United Technologies

Carrier

OTIS

K Balakrishnan, Director, Govt. Policy & Regulatory Affairs, UTC India (P) Limited
TERI-GRIHA National Conference on Green Design
New Delhi, Feb 15, 2013
Why We?

Office building energy use

- 24% Other
- 9% IT / electronics
- 10% Water heating
- 18% Lighting
- 39% HVAC

100%
28%
32%
40%

Transportation
Industry
Buildings*

Integrated Building Solutions

Holistic Approach to Building Systems

- Architecture and building systems choices
- High performance equipment
- Integrated control
- Renewable Resources
Certified Case Example

Pratt & Whitney – China Eastern Airlines
Shanghai Engine Center
Energy Use Reductions Achieved in Design

Baseline Total Energy 4,285 MWh per Year

Design Energy, 2,503 MWh per year

43.9% Energy Reduction
Baseline Architecture and Systems

Energy Use, MWh per Year

- **Area Lights**: 1,317
- **Process Loads**: 1,254
- **Space Heat**: 821
- **Space Cool**: 378
- **Vent. Fans**: 250
- **Pumps & Aux.**: 124
- **Hot Water**: 95
- **Heat Reject.**: 28
- **Ext. Usage**: 18
- **Task Lights**: 0

Perimeter glazing
Low natural illuminance
### Daylighting Case 1

#### Daylighting Analysis

**Daylight Factor**
- Contour Range: 0.4 - 0.4
- In Steps of 0.1

**Roof glazing**
- Non-uniform illuminance

#### Energy Use, MWh per Year

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![Daylighting Case 1 Diagram]
Daylighting Case 2

![Daylight Analysis Diagram]

**Energy Use, MWh per Year**

- **Baseline**
  - Area Lights: 1,317
  - Process Loads: 1,254
  - Space Heat: 821
  - Space Cool: 378
  - Vent. Fans: 250
  - Pumps & Aux.: 124
  - Hot Water: 95
  - Heat Reject.: 28
  - Ext. Usage: 18
  - Task Lights: 0

**Roof glazing**
Good uniform natural illuminance
Daylighting Case 2 Selected

Meets illuminance requirement
Balance lighting savings and thermal loads impact

Energy Use, MWh per Year

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Daylighting Factor

- Flat Roof Baseline
- Flat Roof + 10% Skylights
- Zig-Zag Roof + 5% Skylights
- Zig-Zag Roof + 20% Skylights
- Clerestory Roof Monitor + 10% Skylights
- Mod-Clerestory Roof Monitor + 5% Skylights
- Mod-Clerestory Roof Monitor + 20% Skylights

Illuminance

- Flat Roof Baseline
- Flat Roof + 10% Skylights
- Zig-Zag Roof + 5% Skylights
- Zig-Zag Roof + 20% Skylights
- Clerestory Roof Monitor + 10% Skylights
- Mod-Clerestory Roof Monitor + 5% Skylights
- Mod-Clerestory Roof Monitor + 20% Skylights

Balance lighting savings and thermal loads impact
High Performance Equipment

- Hybrid Chiller Plant: Variable Speed Centrifugal + Heat Pumps
- Variable speed pumps
- LED Lighting
Global HVAC Trends

Energy cost
- Life cycle cost analysis
- Change of energy source

Environment
- CO2 emissions
- Renewable energy

Regulations
- ASHRAE 189
- Labeling standards
- Tax incentives

Efficiency
- Zero-net energy buildings
- VFD / Inverter Technology
- Heat recovery systems
- Energy labeling

Refrigerants
- Low GWP & natural refrigerants

New technology & HVAC system requirements
Technology Trends

FS Centri Chillers
FS Screw Chillers
R 11 / R 123
Products

Centri with VFD
Screw with VFD
R 134a
Solutions
Delhi International Airport

19XRD – 8 x 2500 TR Centrifugal chillers

- Series Counter Flow Design
  - Better Efficiency
- Redundancy - Multi Compressor
- Low Starting Current
- Low Pressure Drop
- Reliability: Semi – hermetic design

- 19XR - 300 – 1500 TR with VFD option
- 19 XRD – 2000-3000 TR on High Voltage
ITC Royal Gardenia, Bangalore

23XRV - 3 x 425 TR Water cooled Screw Chillers

World’s largest and Asia’s first LEED Platinum Rated Building

23 XRV Water cooled Screw Chillers

- World’s first WC Screw Chiller with VFD
- Tri rotor screw
- IPLV as low as 0.3 IKW/TR
- 275 – 550 TR
Cisco Systems, Bangalore

30XA - 6 x 310 TR Air cooled Screw Chillers with Evaporative Cooling System

13% Savings in Annual Consumption
20% Reduction in Connected Load

30 XA Air cooled Screw Chillers

- Made in India
- Aqua Thrust – 80-280 TR (9 models)
- Aqua Force – 78-430 TR (17 models)
- Lead time of 4-5 weeks
Chiller Part Load Efficiency

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<th>Type</th>
<th>IPLV (kW/Ton)</th>
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<tr>
<td>Tr-rotor Screw</td>
<td>0.33</td>
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<tr>
<td>ASHRAE-Centrifugal</td>
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<td>High Eff-Centrifugal</td>
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<td>ASHRAE-Screw</td>
<td>0.57</td>
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<td>High Eff-Screw</td>
<td>0.48</td>
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40% higher than ASHRAE 90.1
Technology Trends

Fixed Speed Systems
Partial Inverter VRF
Unlabelled products
Refrigerant R-22
Inverter Cassettes

Inverter Systems
Full Inverter VRF
Energy Labeling
Refrigerant R-410
Inverter Cassettes
R-410a Cassettes

- 1.5, 2, 3 & 4 TR
- Compact Size
- Low Noise
- Reliable & Durable
- Energy Efficient

R 410a Cassettes

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<th>Indoor Unit</th>
<th>Gymnasiums</th>
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Retail Outlets

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<tr>
<th>18K Cassette</th>
<th>24K Cassette</th>
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<tr>
<td>4 star</td>
<td>4 star</td>
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VRF Technologies

All Inverter

Single inverter

Partial inverter

Digital Scroll
Non-Inverter

PART LOAD POWER CONSUMPTION

In Part loads, SMMSi is more efficient on energy saving
Talwalkars

Toshiba Digital Inverter Cassettes & hi-wall – 1200TR, 40 Gyms

Digital Inverters

• Save up to 40% power
• BMS Compatibility
• Long piping Lengths
• Low starting Current
• All weather ACs

1.5, 2, 3, 4, 5, 8 TR

R410A

Annual power consumption

40% reduction

Conventional type

Digital inverter
Toshiba Digital Inverters – Cassettes & Ducted – 50 Stores, 1500 TR

Digital Inverters
- Save up to 40% power
- BMS Compatibility
- Long piping Lengths
- Low starting Current
- All weather ACs
Condominium Solutions

- Solutions: VRF, Digital Inverters (1:1), Hi walls (1:1)
- Best-in-class efficiency: value addition for end customers
- Low starting current – helps in reduction of power backup cost
- Redundancy in Toshiba VRF for apartments
Customer Challenges

Different HVAC systems and technologies - what is the right solution for my application?
New Business Process

Design Goals
- Energy cost
- Energy density
- Sustainability/green
- First, life cycle cost

Other design inputs:
- Building use
- Weather data
- Building geometry

System Simulation
- AdvanTE³C Solutions Center
- Tools:
  - Carrier HAP
  - TRNSYS
  - eQuest

Carrier Solution
- System architecture
- Operational parameters
- Existing components
- New components

*AdvanTE³C is contributing to the design of the future zero net energy buildings*
AdvantEC Solutions Centre

- Develop unique solutions to meet customer challenges
- Deploy solutions that involve equipment, controls, algorithms
- From equipment approach to system approach
- Leverage Carrier’s broad product and technology portfolio

Vertical Market Priorities

- Large Buildings & Small Offices
- Hotels
- Cooling & Heating Districts
- Data Centers
- IT Electronic Manufacturing
- Hospitals
THE WAY TO GREEN

It is about our commitment to continually moving our company and our customer forward.
COMPARISON

Conventional elevator vs GeN2 system

- Conventional Steel Rope vs Flat Belt
- Geared Machine vs Gearless Machine
- Conventional Drive vs ReGen™ Drive
GeN2 REVOLUTIONIZES PROPULSION

Polyurethane Coated Steel Belt + Compact & efficient gearless PM machine

Best-in-Class energy savings and performance

VDI 4707 ENERGY – CLASS A CERTIFIED
REGEN DRIVE – HOW IT WORKS?

**Electrical power Consumption**
- Heavily loaded car
- Lightly loaded car

**Electrical power Generation**
- Heavily loaded car
- Lightly loaded car
REGEN DRIVE – HOW IT WORKS?

Energy consumed with fully-loaded car in up direction (FLU)
Energy generated with fully-loaded car in down direction (FLD)
• Compass **groups** passengers going to **common or nearby floors** to same car
• Controls number of unique stops
ESC REGEN DRIVE SAVINGS

Continuous Mode | Star/Delta Mode | Full Load VF Mode | Regen Drive System

45%

Note: Continuous 0.5m/s running escalator without VF function and with IM motor and worm gear @ ISO defined commercial application, light duty and traffic pattern A. Regen is with a PM motor, worm gearbox with 0.25m/s standby speed with INT operation.
ECOSY

High Efficient Lubrication System:

Benefit

- Extremely Low Oil Consumption, 95% reduction (40 litre to 1 litre)
- Superior Lubrication
- Very Easy Maintenance
REFERENCE PROJECTS – GeN2

- Beijing Metro Line, China
- Great India Place, Noida
- Christ the Redeemer, Brazil
- Burj Khalifa, UAE
Effective Automation

- Lighting Control
- Demand Controlled Ventilation
- Economizer Mode
Renewable Resources

- Solar thermal
domestic hot water
- Solar PV + Wind exterior lighting
Design Case End Result

- 43.9% Energy Use Reduction
- 3.1% Energy from Renewable Resources
Observations and Conclusions

• Holistic approach to building design and operation allows best overall outcome

• Integration and interaction between many systems should be taken into account

• Broader use of existing energy efficient technology can benefit current designs
Sustainable Design as Balance

• Balance between competing forces

Source: Multiple Sources including Andy Savitz (The Triple Bottom Line) and John Elkington (Cannibals with Forks: the Triple Bottom Line of 21st Century Business)
Thank you!
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