Existing Today
Retrofitted for Tomorrow
Urbanisation
Population Shifts and Energy Demand

<table>
<thead>
<tr>
<th>Region</th>
<th>% of Final Energy Use in Urban Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>86%</td>
</tr>
<tr>
<td>Pacific OECD</td>
<td>78%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>81%</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>72%</td>
</tr>
<tr>
<td>Former USSR</td>
<td>78%</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>54%</td>
</tr>
<tr>
<td>Latin America</td>
<td>85%</td>
</tr>
<tr>
<td>North Africa &amp; Middle East</td>
<td>84%</td>
</tr>
<tr>
<td>China &amp; Central Pacific Asia</td>
<td>65%</td>
</tr>
<tr>
<td>Pacific Asia</td>
<td>75%</td>
</tr>
<tr>
<td>South Asia</td>
<td>51%</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>76%</strong></td>
</tr>
</tbody>
</table>

Source: Global Energy Assessment (2012)
Global

Transportation 28%

Industry 32%

Buildings 40%

Buildings (USA)

HVAC 40%

Lightings 16%

Water heating 10%

Electronics 9%

Other 25%

Hotel (Tropics)

Chiller Plant 45%

Other 15%

Lifts 5%

Lighting 20%

Airside 15%


Source: Carrier Singapore’s estimates
HIGHER VARIABILITY AND HIGHER ENERGY CONSUMPTION OF THE CHILLER PLANT IS LEADING TOWARDS HIGHER OPERATIONAL COST.

ENERGY IN BUILDINGS

High Usage Variability

Low Usage Variability

HVAC Plant Room 45%

PUMPS 30%
COOLING TOWER 5%
CHILLER 65%

Low Energy Consumption

Airside 15%
VERTICAL TRANSPORTATION 5%
OTHERS 8%
LIGHTING 27%

High Energy Consumption
As per ASHRAE guide performance evaluation

NEEDS IMPROVEMENT

> 1.2

POOR

0.8 – 1.2

FAIR

0.7 – 0.8

GOOD

0.5 – 0.7

PLANT ROOM ENERGY CONSUMPTION

Efficiency Variance Vs Design

COOLING CAPACITY

Actual Working Mode

Design mode
REASONS OF ENERGY LOSS

- Old Equipment
- Low Efficiency Equipment
- Improper Maintenance
- Poor Water Quality

- Unsyncronized
- Synchronized

- Visible
- Hidden?

- Fouled Condenser Tubes
- Many Piping Bends
- Wrong Cooling Tower Installation

- Non Coordinated System
- Wrong Equipment Selection
- No Measurement / Diagnostics
- System Waste
PLANT ROOM SYSTEM

Each equipment has its own Operating Curve at various Load and Ambient (Operating) Conditions

System Level efficiency depends on:

- Equipment Efficiencies
- Synchronization between equipment at varying operating conditions
- Optimization algorithms to deliver the output at lowest energy
PLANT ROOM ENERGY CONSUMPTION
Efficiency Improvement

Measurement & spot analysis
Assess load & energy profiling
Micro level equipment assessment
Multi-level energy solution proposals
Installation With guaranteed payback
Green Maintenance
Energy Sustenance

360° solution
Case Studies: India

ASHRAE Guide

Chiller Plant System Efficiency (kW/ton)

$98k/yr Committed savings

$131K/yr Committed savings

$545k/yr Committed savings

$221k/yr Committed savings

$130k/yr Committed savings

$90k/yr Committed savings

10.4 Million Units of energy saved in 2017
**Taj Hotel Case study**

**2014 Baseline**
- 52-58% Electricity Consumption from HVAC
- 40-45% Contribution from Chillers, Pumps & CT

**Intervention:**
- Building Audit
- Energy Efficient VFD Chiller Retrofit
- Plant System Manager with advanced controls

**Results:** Nine Months – July’15 to Mar’16 (without peak months Apr-June)
- 26% Plant Room Efficiency Improvement
- 100,000 KWH Savings
- 90 Lacs Monetary Savings
- 23000 Litres of HSD Savings for Diesel Generator
CASE STUDIES - ASIA

Novotel Mumbai Juhu
Savings: 30%
Payback: 2.2 years

Hilton Shanghai Jing’An
Savings: 30%
Payback: 2.7 years

Intercontinental Singapore
Savings: 35%
Payback: 2.8 years

PJ Hilton
Savings: 13%
Payback: 3.5 years

Traders Hotel
Savings: 56%
Payback: 3.8 years

Dusit Princess
Savings: 33%
Payback: 7.5 years
UTC TERI CENTRE OF EXCELLENCE

- Study of Energy Efficiency in Building in five climatic zone in India
- ASHRAE Level 2 Audits
- Enabling Asset owners to realize the energy savings potential
- 32 Detailed Audits Completed & 26 Mil KWH Savings potential identified per annum
- TERI UTC COE program intends to cover the Retrofit Project Cycle.
- COE can assist in sourcing technology to implementation and verification of energy savings.
Infosys Case study

- Optimum Energy Use
- Improved Comfort
- Operational Efficiency
- Lower Breakdown

$80M Electrical Energy Cost

3X Lighting Energy

3X Air-con Energy

Green Milestones During 2007-2014

- $80 Million saved in electrical costs
- 55% reduction in per capita greenhouse gas emissions
- 35.5% reduction in per capita water usage

- 30% less power consumed by green buildings
- 0.45 watt per sq ft lighting power density vs 3.5 globally
- 7.6 cubic feet per minute (CFM) targeted for radiant cooling

Infosys brings home the green
CONVERGING BUILDING TRENDS

Operational efficiency

- Vertical Transportation
- Security systems
- Fire systems
- Building management

Energy efficiency

- HVAC
- Controls

Energy efficiency breakdown:
- HVAC: 40%
- Water Heating: 10%
- Lighting: 16%
- HVAC controls: 9%
- IT/Electronics: 9%
- Heating: 10%
- Lifts: 5%
- Others: 20%

Data source: U.S. DOE, building energy book
The Next Evolution….Analytics using IOT!
United Technologies is one. Few companies can change the world.