Data driven high performance buildings

Guruprakash Sastry

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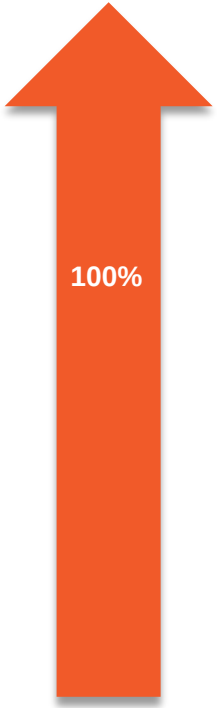
2008 to 2014



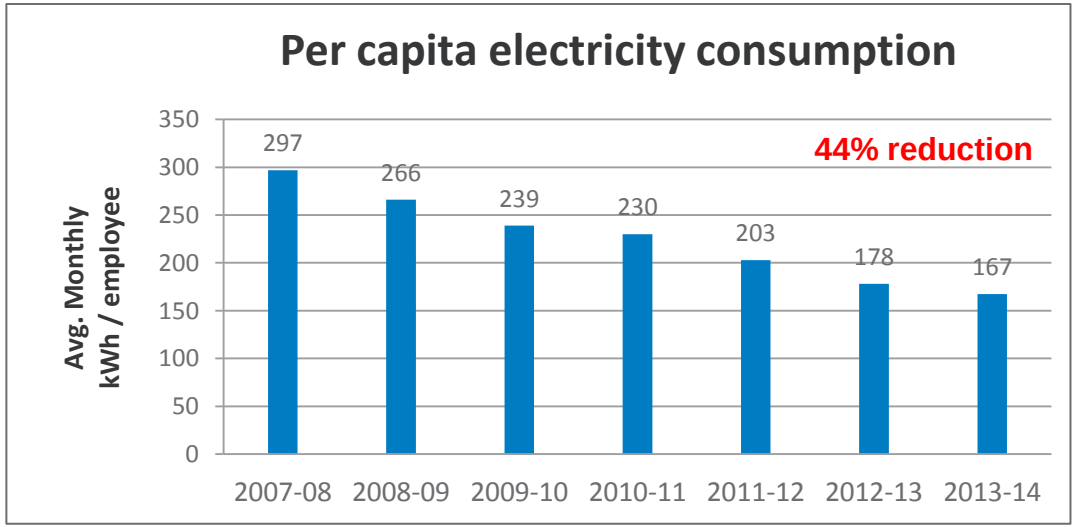
Increase in no. of employees in India

Absolute Increase in energy

663 Million kWh avoided

0.56 Million Tons of CO_2 avoided

80 Million USD electricity bills avoided



What is possible? Standard Vs. efficient design

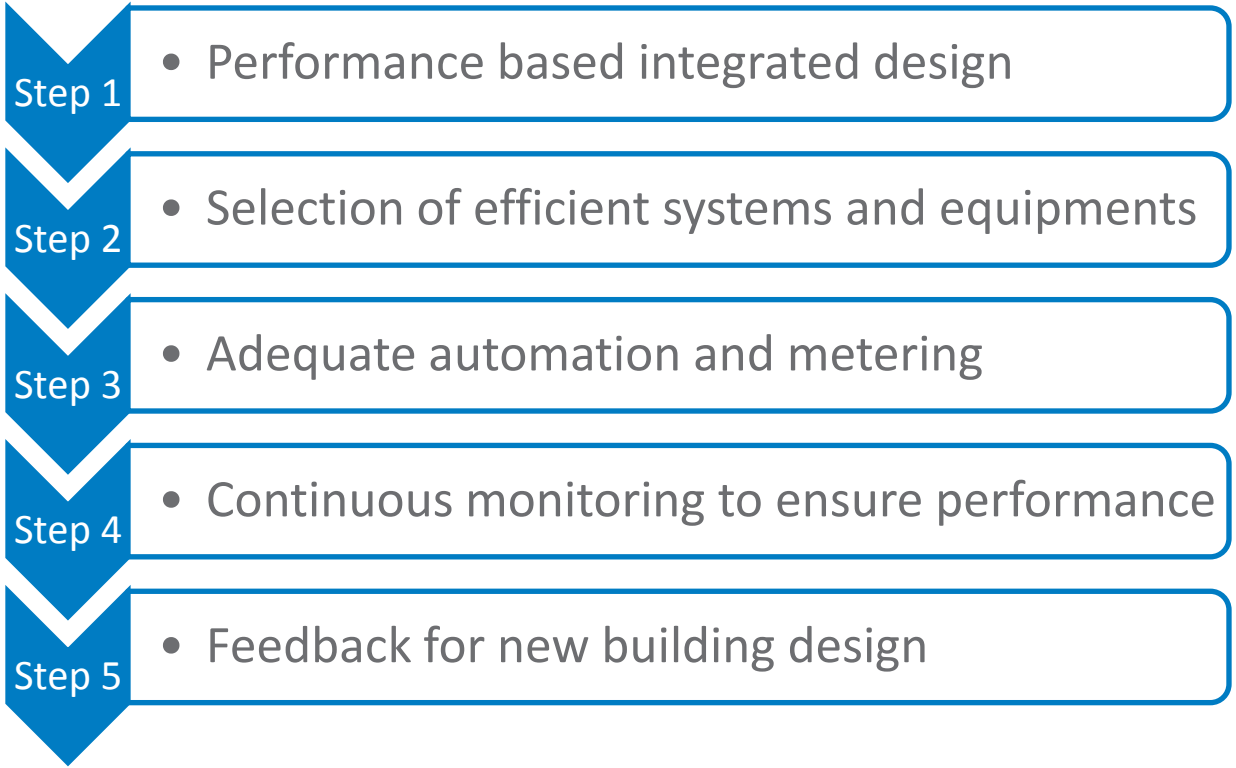
	Performance metric	Standard design	Efficient design	% Reduction
1	Building energy consumption	250 kWh/m2/year	75 kWh/m2/year	70%
2	Lighting design	1.2 W/sqft	0.48 W/sqft	60%
3	Air-conditioning design (Reduction in heat load)	300 sqft per TR	750 sqft per TR	60%
4	Total building electrical design	8 W/sqft	3.5 W/sqft	56%

Benefit of efficient design on capital and operating cost

Electrical infrastructure required for 10 lac sqft building

Sl. No.	System Description	Units	Standard design	Efficient design	Cost savings in INR Crores	Cost savings in INR/sqft
01	Total electrical demand	Mega Watt (MW)	8	3.5	-	-
02	Total cost of Transformer, DG, HVAC and electrical system	Crores	85 cr.	60 cr.	25 cr.	250
03	Annual energy consumption (@ INR 6 /kWh)	Crores	14 cr./annum	4.5 cr. /annum	9.5 cr. /annum	95/annum

Approach to super efficient buildings

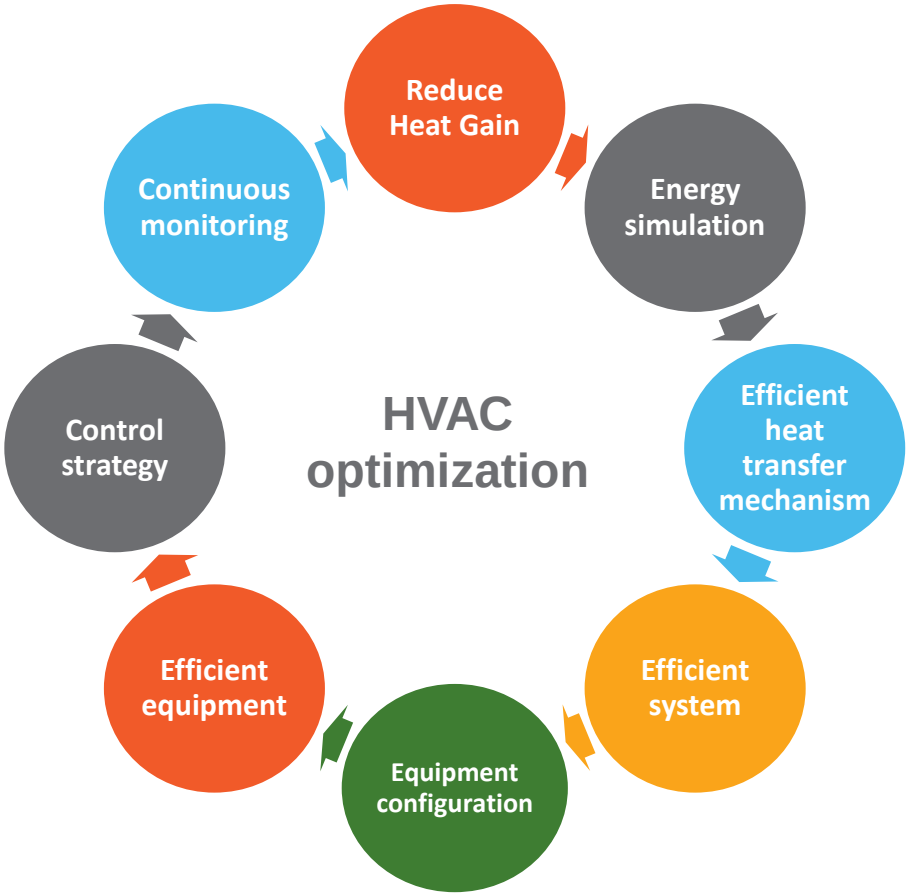


Integrated goal oriented design process

	HVAC Goal	Lighting Goal	Water Goal
GOAL	▪ Max envelope heat gain – 0.75 W/ft^2 ▪ Total building @ 750 to 1000 sqft/TR ▪ 25 deg C, 55% RH	▪ Lighting power density of 0.45 W/ft^2 ▪ 90% of building to be day lit ▪ No glare throughout the year	▪ 15 LPD fresh water for office building ▪ Zero discharge ▪ 100% self sufficient
TEAM	▪ Architects ▪ Facade Specialists ▪ IT Specialists ▪ HVAC Engineers ▪ Lighting Specialists	▪ Architects ▪ Facade Specialists ▪ Lighting Specialists ▪ Electrical Designers	▪ PHE Engineers ▪ Architects ▪ Landscape Architects

Optimization strategy

Results in ‘4x’ reduction in air conditioning energy



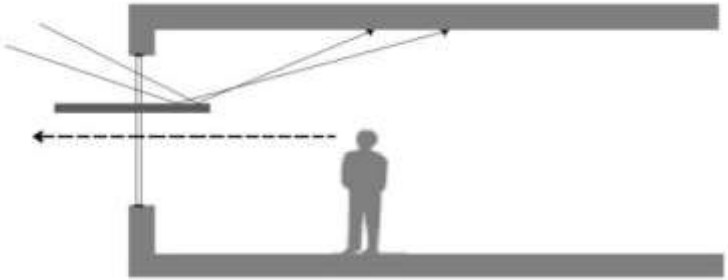
Inefficient building design

Inefficient building design

Inefficient building design

Inefficient building design

Efficient building design



Light shelves allow daylight to penetrate deeper into the buildings

Mysore SDB 5 building with above strategies

Bright day light without glare at SDB-5 Mysore

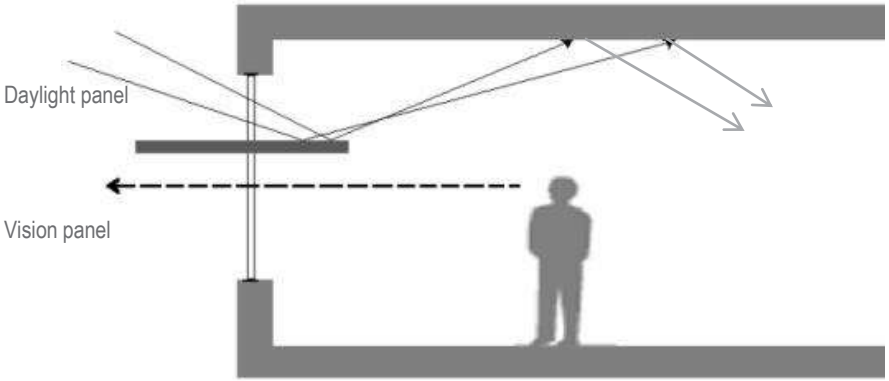
Building shape and orientation

- Passive design: Right orientation - Restricted building span to 18 m

Window-wall ratio < 30%

Efficient window design

Efficient window design



Light shelves for deeper penetration of day light

To take daylight deeper into floors

Maximize natural light and views

Efficient building envelope

SDB-1, Infosys Hyderabad campus

Efficient building envelope

SDB-6,
Infosys Mysore
campus

Efficient building envelope

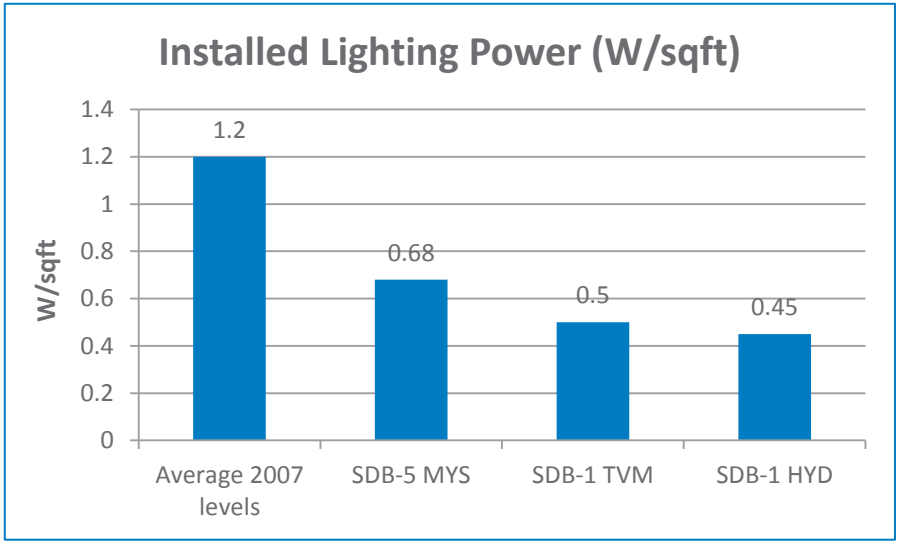
SDB-4 & 5,
Infosys Hyderabad campus

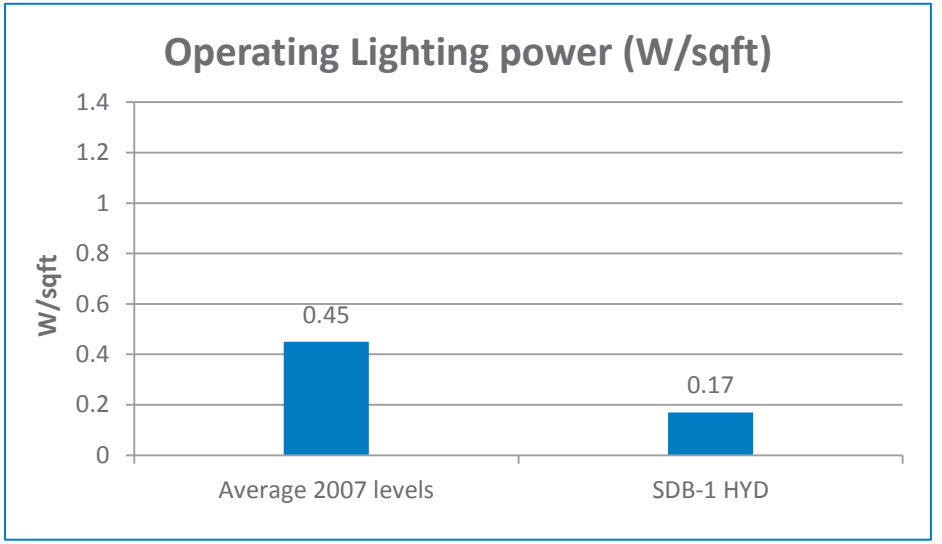
Cool roofs for all buildings

- 2.6 million sqft area covered with white roof
- About 5% reduction in HVAC energy

Reduces building heat gain and urban heat island effect

Artificial Lighting system and controls



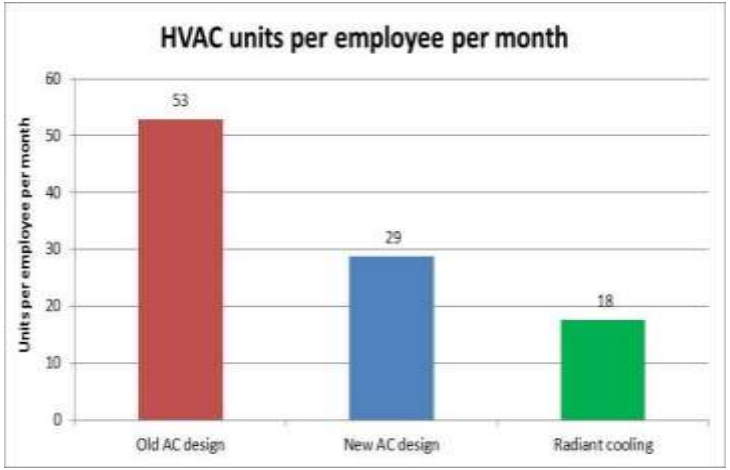


2X reduction in the installed lighting load

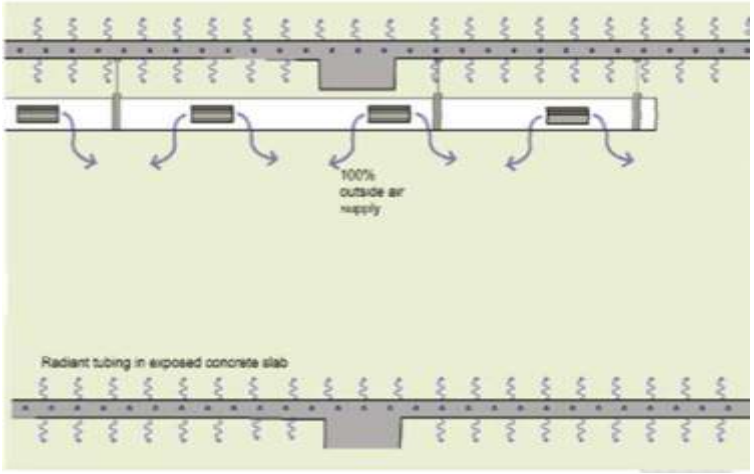
~3X reduction in lighting energy consumption

Efficient HVAC system - Radiant cooling

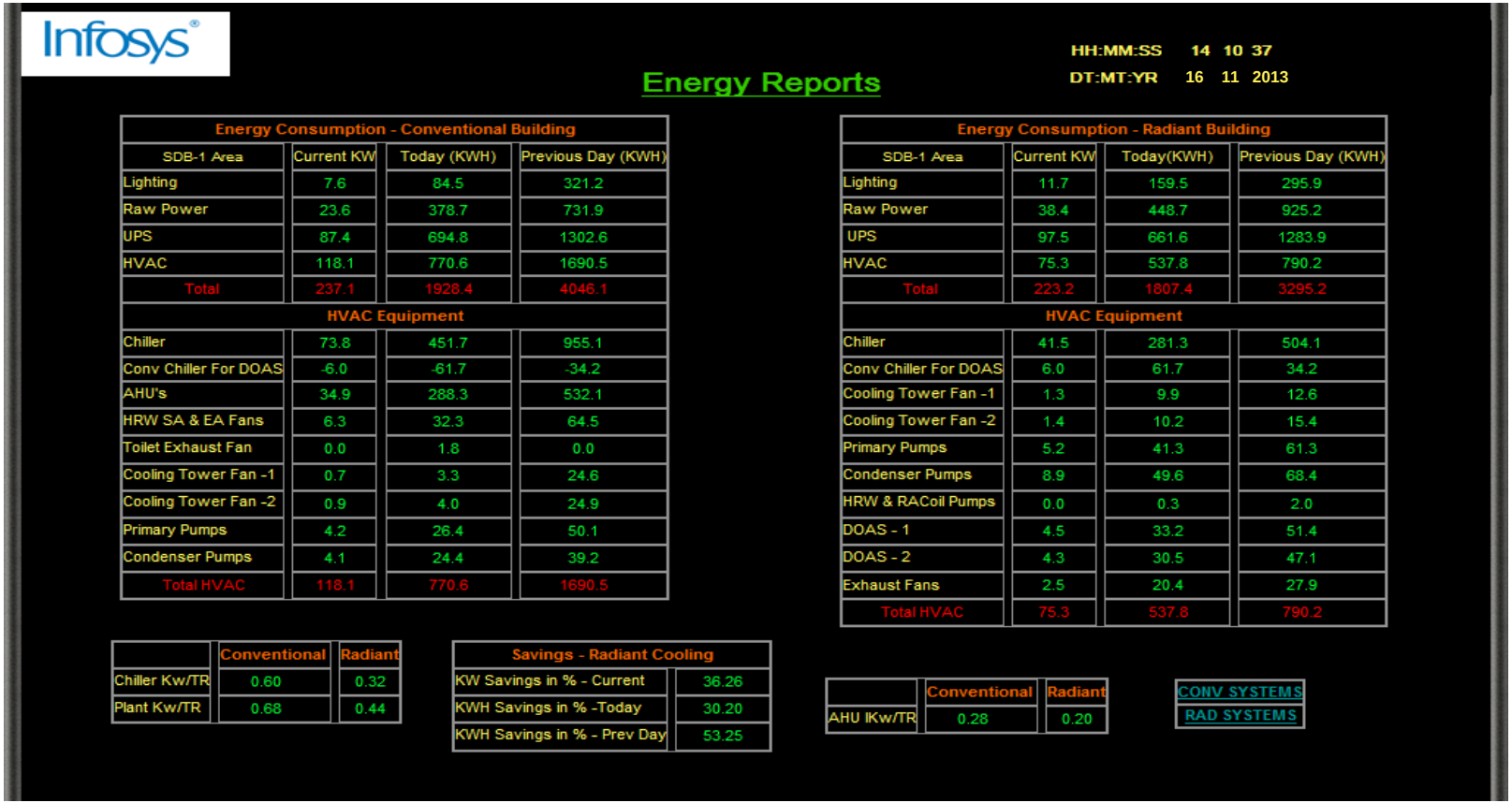
- Requires 75% less air compared to conventional systems
- 30% more efficient than conventional HVAC systems
- Higher thermal comfort on account of better mean radiant temperature
- Highest indoor air quality
- Radiant system equipment requires lesser space



Radiant cooling



Radiant cooling - results



Infosys

Energy Reports

HH:MM:SS 14 10 37
DT:MT:YR 16 11 2013

Energy Consumption - Conventional Building			
SDB-1 Area	Current KW	Today (KWH)	Previous Day (KWH)
Lighting	7.6	84.5	321.2
Raw Power	23.6	378.7	731.9
UPS	87.4	694.8	1302.6
HVAC	118.1	770.6	1690.5
Total	237.1	1928.4	4046.1
HVAC Equipment			
Chiller	73.8	451.7	955.1
Conv Chiller For DOAS	-6.0	-61.7	-34.2
AHU's	34.9	288.3	532.1
HRW SA & EA Fans	6.3	32.3	64.5
Toilet Exhaust Fan	0.0	1.8	0.0
Cooling Tower Fan -1	0.7	3.3	24.6
Cooling Tower Fan -2	0.9	4.0	24.9
Primary Pumps	4.2	26.4	50.1
Condenser Pumps	4.1	24.4	39.2
Total HVAC	118.1	770.6	1690.5

Energy Consumption - Radiant Building			
SDB-1 Area	Current KW	Today(KWH)	Previous Day (KWH)
Lighting	11.7	159.5	295.9
Raw Power	38.4	448.7	925.2
UPS	97.5	661.6	1283.9
HVAC	75.3	537.8	790.2
Total	223.2	1807.4	3295.2
HVAC Equipment			
Chiller	41.5	281.3	504.1
Conv Chiller For DOAS	6.0	61.7	34.2
Cooling Tower Fan -1	1.3	9.9	12.6
Cooling Tower Fan -2	1.4	10.2	15.4
Primary Pumps	5.2	41.3	61.3
Condenser Pumps	8.9	49.6	68.4
HRW & RACoil Pumps	0.0	0.3	2.0
DOAS - 1	4.5	33.2	51.4
DOAS - 2	4.3	30.5	47.1
Exhaust Fans	2.5	20.4	27.9
Total HVAC	75.3	537.8	790.2

	Conventional	Radiant
Chiller Kw/TR	0.60	0.32
Plant Kw/TR	0.68	0.44

Savings - Radiant Cooling	
KW Savings in % - Current	36.26
KWH Savings in % -Today	30.20
KWH Savings in % - Prev Day	53.25

	Conventional	Radiant
AHU IKw/TR	0.28	0.20

CONV SYSTEMS
RAD SYSTEMS

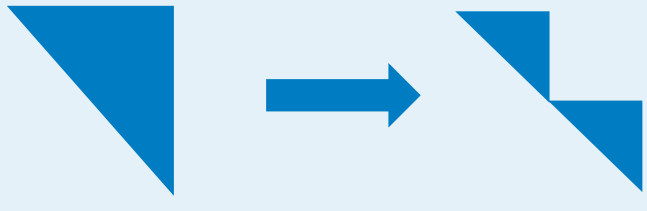
Efficient equipment configuration

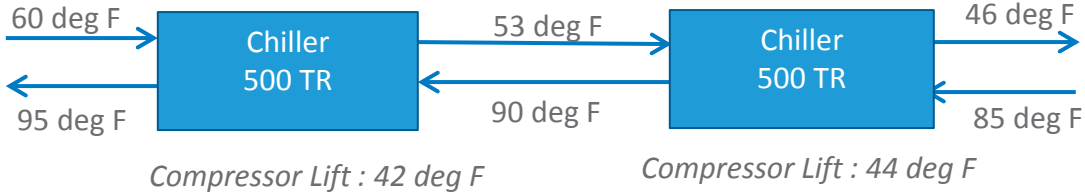
Chillers in series-counter flow arrangement

- Cooling is achieved in 2 smaller steps instead of 1 big step
- 7 % more efficient than regular chillers arrangement

Compressor Lift : 49 deg F

Standard arrangement





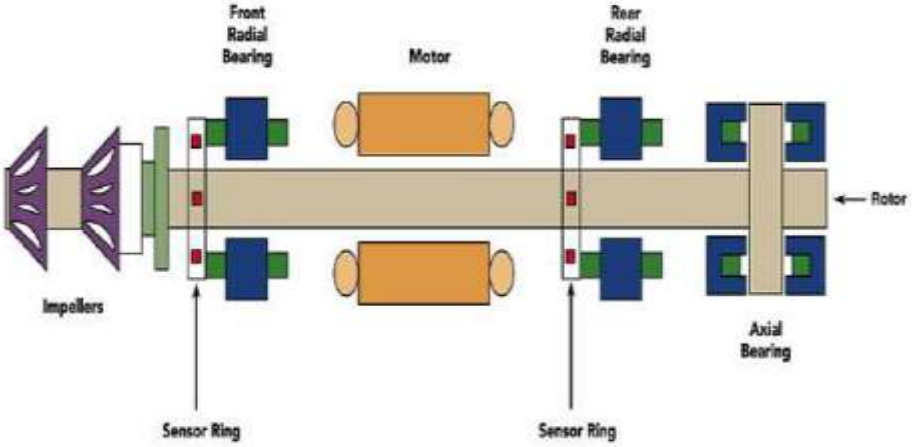
Compressor Lift : 42 deg F

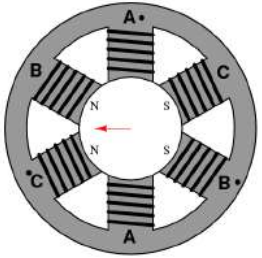
Compressor Lift : 44 deg F

Series counter arrangement

Efficient equipment

Chillers with magnetic bearings





8 % higher efficiency than regular chillers

- Magnetic levitation
- Very low friction
- No oil required

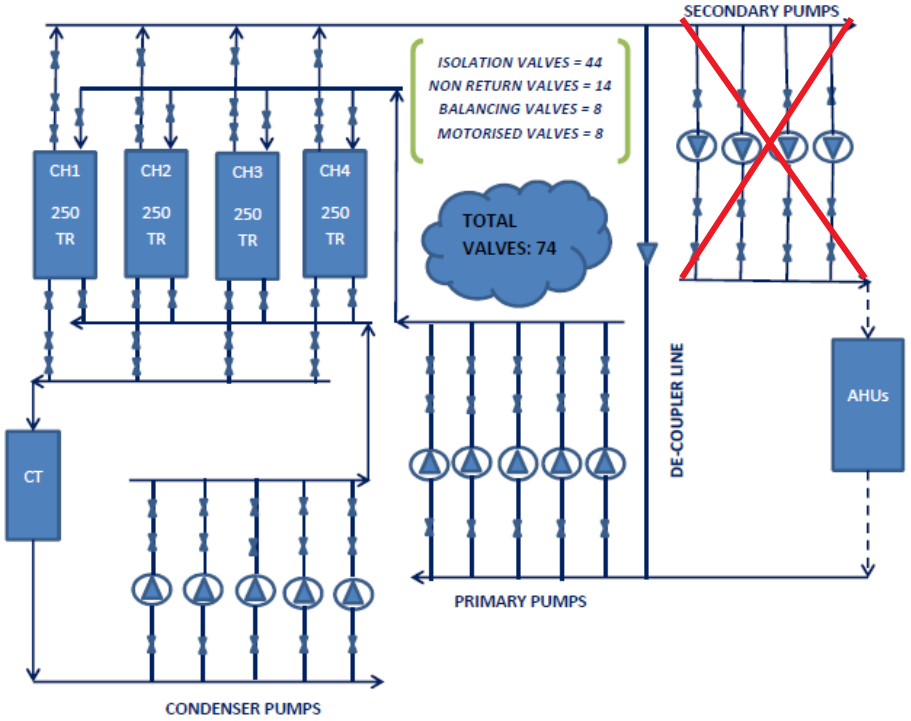
Data center Efficiency

PUE: 2.5

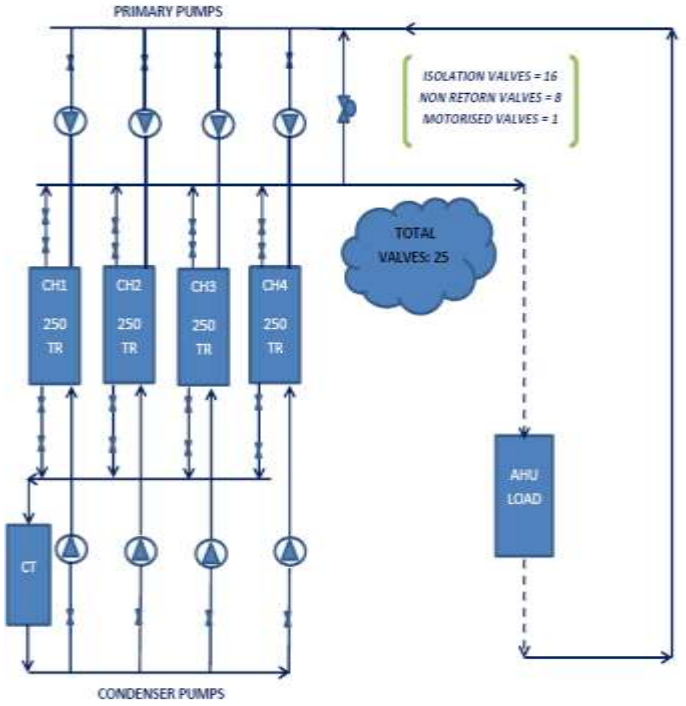
PUE: 1.13

Operating temperature	24 ^{0}C	25 ^{0}C	26 ^{0}C	27 ^{0}C
PUE	1.13	1.11	1.09	1.08

Re-engineered chiller plants



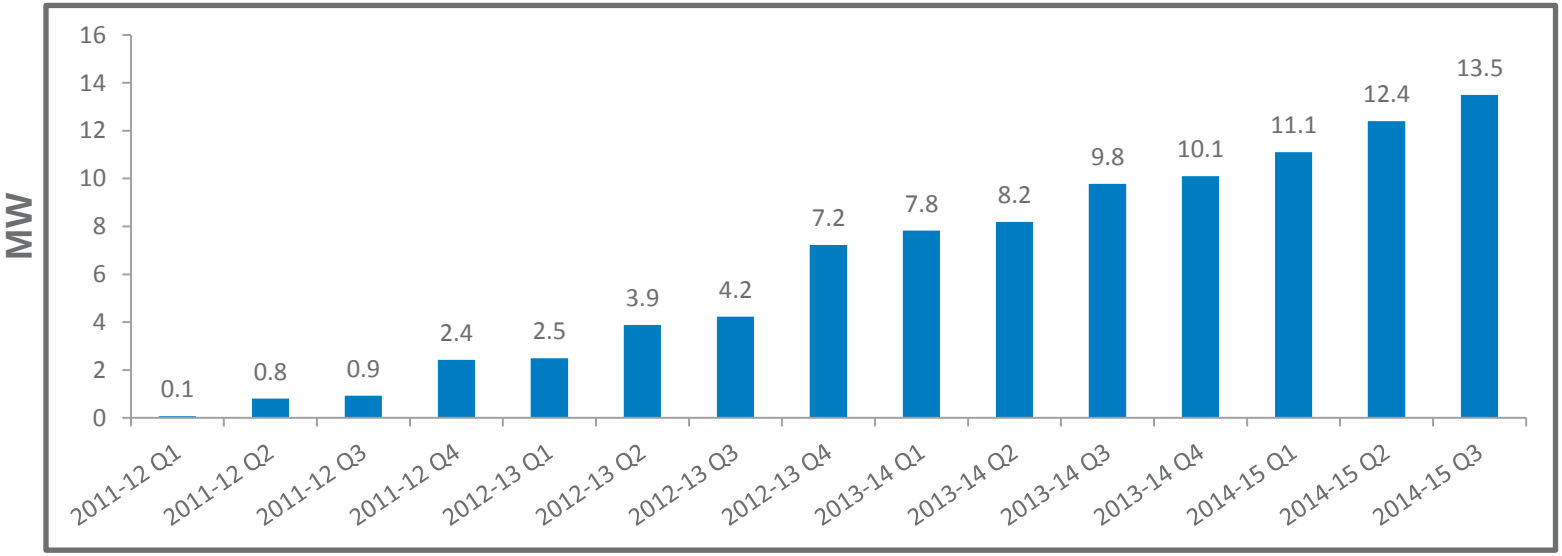
OLD



NEW

Retrofits – Air conditioning

13.5 MW reduction in connected load for HVAC systems



Cumulative quarterly Connected load reduction in MW

- Carried out deep retrofits for 31 chiller plants
- Reduced total chiller plants from 54 to 41 plants

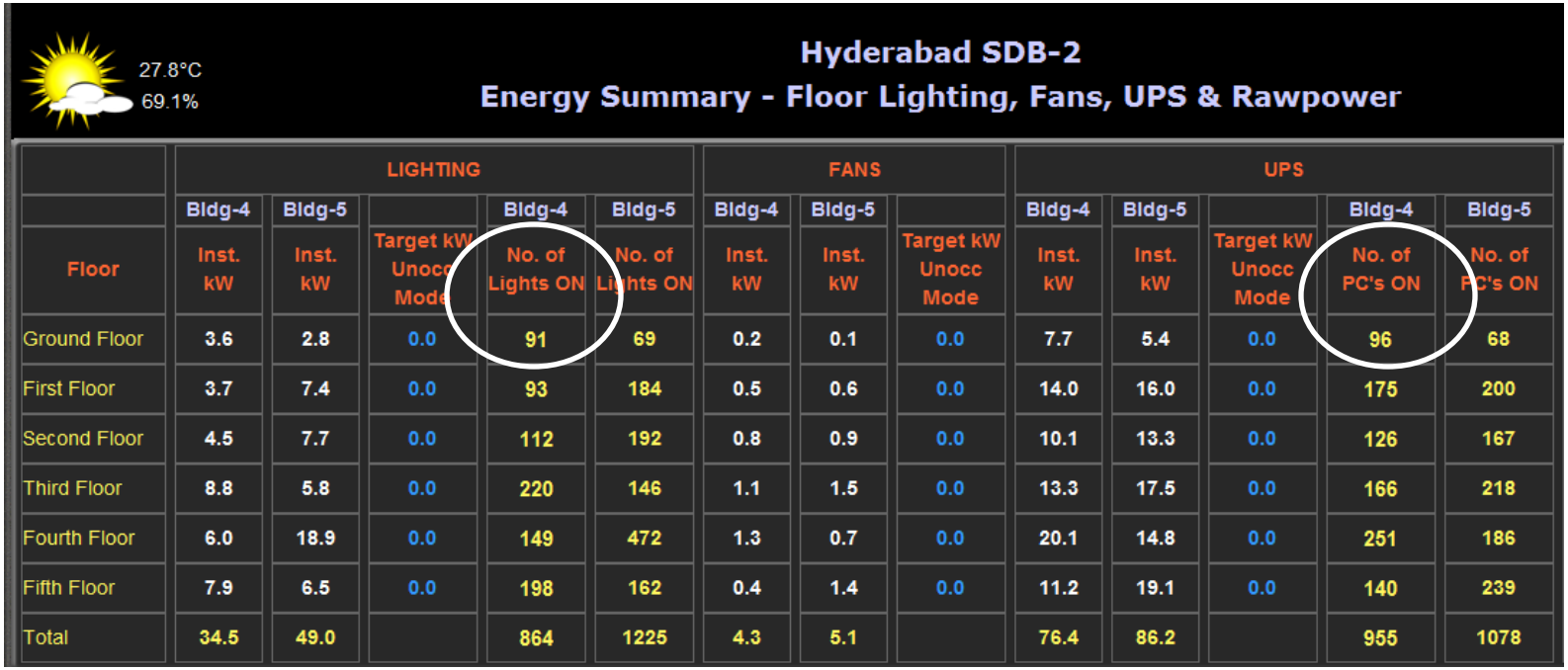
Retrofits – UPS

Replaced stand alone UPS with high efficiency modular UPS

10 MW reduction in connected load

Continuous monitoring at granular level

Continuous monitoring at granular level



	LIGHTING					FANS			UPS				
	Bldg-4	Bldg-5		Bldg-4	Bldg-5	Bldg-4	Bldg-5		Bldg-4	Bldg-5		Bldg-4	Bldg-5
Floor	Inst. kW	Inst. kW	Target kW Unocc Mode	No. of Lights ON	No. of Lights ON	Inst. kW	Inst. kW	Target kW Unocc Mode	Inst. kW	Inst. kW	Target kW Unocc Mode	No. of PC's ON	No. of PC's ON
Ground Floor	3.6	2.8	0.0	91	69	0.2	0.1	0.0	7.7	5.4	0.0	96	68
First Floor	3.7	7.4	0.0	93	184	0.5	0.6	0.0	14.0	16.0	0.0	175	200
Second Floor	4.5	7.7	0.0	112	192	0.8	0.9	0.0	10.1	13.3	0.0	126	167
Third Floor	8.8	5.8	0.0	220	146	1.1	1.5	0.0	13.3	17.5	0.0	166	218
Fourth Floor	6.0	18.9	0.0	149	472	1.3	0.7	0.0	20.1	14.8	0.0	251	186
Fifth Floor	7.9	6.5	0.0	198	162	0.4	1.4	0.0	11.2	19.1	0.0	140	239
Total	34.5	49.0		864	1225	4.3	5.1		76.4	86.2		955	1078

Intelligent building system monitors number of lights, fans and computers working on every wing in the building. Data from existing buildings used to better design future buildings

Continuous M & V – Design Vs Actual

Constant monitoring to get design efficiencies

Floor	Design Kw	Design Kw/Tr	Actual Kw	%	Actual ikw/Tr.	Kwh Today	% Today	Kwh Y Day	Kwh MTD	Mwh YTD
HVAC COMFORT										
Chiller - 1	252.0	0.48	0.7	0	0.00	97	3	1852	10182	27.70
Chiller - 2	271.0	0.51	122.0	45	0.56	1403	38	18	29676	31.64
LT CHW Pumps	44.0	0.04	8.9	3	0.04	201	5	313	4686	6.10
MT CHW Pumps	60.0	0.10	41.1	15	0.18	714	19	792	17286	48.73
CDW Pumps	60.0	0.06	15.0	5	0.06	231	6	292	4293	5.72
Cooling Towers	60.0	0.06	0.0	0	0.00	21	1	31	1364	2.79
DOAS's	74.0	0.14	51.8	19	0.00	699	19	1097	18213	81.75
HRW's	18.6	0.04	15.9	6	0.00	284	0	352	7604	29.13
Exhaust & Vent. Fans	14.7	0.03	17.6	6	0.00	338	9	351	7510	33.45
Total			273.5	100		3720	100	5098	100814	359.68

Provides data to optimize future building designs

Equipments	Inst. watt / Sqft	Current Year Peak Value	Current Year Peak Time
HVAC - High Side	0.03	1.16	7:39 AM 4/9/2012
HVAC - Low Side	0.04	0.30	8:05 AM 3/10/2012
HVAC - CRITICAL	0.07	0.22	6:10 PM28/10/2012
Lighting	0.13	0.20	6:37 PM 6/11/2012
Fans	0.03	0.05	10:13 AM 7/8/2012
Raw Power	0.04	0.12	6:06 PM 27/10/2012
UPS - Work Station	0.56	0.70	3:16 PM 25/9/2012
UPS - Server	0.03	0.04	9:49 AM 16/11/2012
Misc.	0.00	0.85	1:45 PM11/10/2012
Total	0.95	2.32	12:32 PM27/11/2012
SDB-2 Main Incomer	0.92	1.37	2:46 PM29/11/2012

Chiller plant efficiency trend

Central Command Center for ensuring efficient operations

Command center at Infosys Bangalore to monitor, manage and optimize resources usage

Data is important

- For ensuring long term performance
- For evaluating/deploying new technologies
- For improving new designs
- To know the reality!

Thank You

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