

Moving Towards
Net-Zero Energy Hospital Buildings

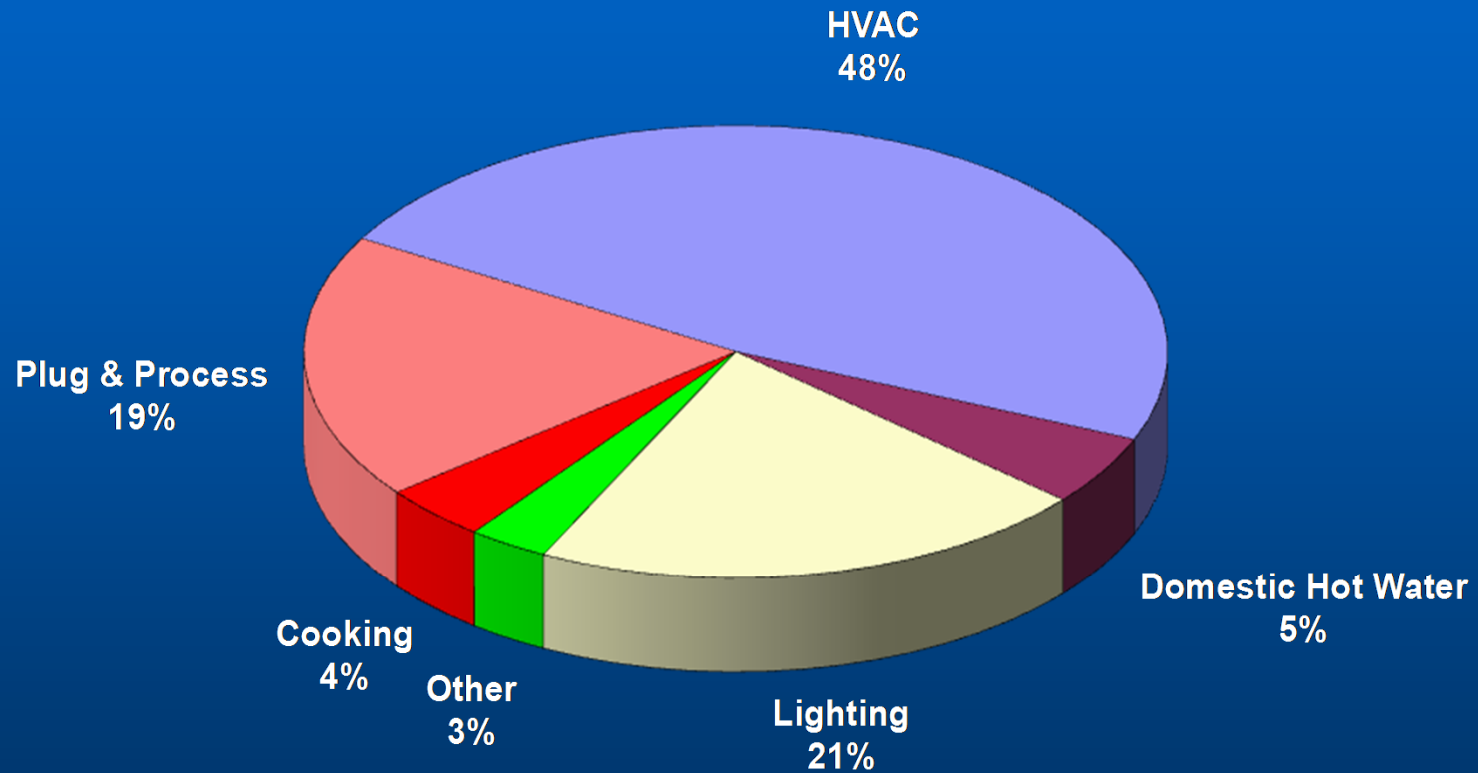
Building Life Cycle

- Phase 1 - Manufacturing of Products
- Phase 2 - Transportation of Product to Construction Site
- Phase 3 - Construction
- Phase 4 - Operation
- Phase 5 - Demolition and Recycle

Green Trends in Healthcare

- **Net-Zero Energy Building by 2025:**
A net-zero building produces as much energy as it uses over the course of one year
- **Carbon Neutral Building by 2030:**
Carbon neutral or net-zero carbon footprint is achieved by balancing the carbon released with an equivalent amount sequestered or offset.

Hospital Energy Consumption



Net Zero Energy Targets

Categories	ASHRAE 90.1
Innovative Design Strategies	50%
On-Site Renewable Energy	30%
Off-Site Renewable Energy	20%
Net Zero Energy	100%

NZEB Design Options by Climate

	Mild Climate (San Francisco Bay Area)	Cold / Hot & Humid Climate (Chicago)	Hot & Humid Climate (Abu Dhabi)	Hot & Dry Climate (Riyadh)	Pay Back (Years)
Innovative Design					
Passive Solar & Architecture	7.0%	10.0%	11.0%	11.0%	3
Day Lighting	2.0%	2.0%	2.0%	2.0%	3
Plug & Process Load	7.0%	7.0%	7.0%	7.0%	1
Water Savings	1.5%	1.5%	1.5%	1.5%	2
Heat Recovery (Primary) Constant Air Volume	8.8%	8.0%	-0.7%	10.0%	0
Heat Recovery (Primary) Variable Air Volume	12.6%	11.9%	10.1%	9.1%	0
Heat Recovery (Secondary) VAV	0.8%	1.2%	3.0%	3.2%	2
Heat Recovery (Tertiary) VAV	1.4%	2.0%	3.9%	4.0%	2
Unoccupied Setback	0.9%	0.8%	0.8%	0.5%	3
Displacement Ventilation	1.4%	1.4%	1.4%	1.4%	1
Fuel Cell / Cogeneration	2.5%	2.5%	2.5%	2.5%	5
Lighting	7.8%	7.8%	7.8%	7.8%	2
Sub-Total	54.0%	56.0%	50.0%	60.0%	2-3
On-site Renewable Energy					
Solar	8.0%	7.0%	10%	10.0%	5
Photovoltaic	8.0%	7.0%	10%	10.0%	10
Geothermal	5.0%	5.0%	5.0%	0.0%	10
Wind Turbines	5.0%	5.0%	5.0%	0.0%	10
Sub-Total	26.0%	24.0%	30.0%	20.0%	5-10
Off-site Renewable Energy					
Purchase from Utility Company	20.0%	20.0%	20.0%	20.0%	N/A
TOTAL:	100%	100%	100%	100%	

Green Guidelines

- US Green Building Council (USGBC) LEED Green Building Rating
- Green Guide for Healthcare (GGHC)
- Emirates Green Building Council (EGBC)
- Abu Dhabi Green Buildings (ADGB)

Design & Construction Rating Systems

CATEGORY	USGBC	GGHC	EGBC	ADGB
Sustainable Sites	14	21	13	15
Energy & Atmosphere	17	21	16	20
Water Efficiency	5	6	12	30
Materials & Resources	13	21	11	15
Indoor Environmental Quality	15	24	15	15
Innovation & Design Process	5	4	5	5
Total Points	69	97	72	100

CERTIFICATION	USGBC	GGHC	EGBC	ADGB
Certified	26 - 32	N/A	29 - 35	45
Silver	33 - 38	N/A	36 - 43	55
Gold	39 - 51	N/A	44 - 57	65
Platinum	52 or more	N/A	58 or more	75 or more

Operations

CATEGORY	USGBC	GGHC	EGBC	ADGB
Integrated Operations	N/A	5	N/A	N/A
Transportation Operations	N/A	3	N/A	N/A
Energy Efficiency	N/A	18	N/A	N/A
Water Conservation	N/A	8	N/A	N/A
Chemical Management	N/A	5	N/A	N/A
Waste Management	N/A	6	N/A	N/A
Environmental Services	N/A	9	N/A	N/A
Environmental Preferable Purchases	N/A	11	N/A	N/A
Innovation in Operations	N/A	7	N/A	N/A
Total Points	N/A	72	N/A	N/A



Cleveland Clinic Abu Dhabi

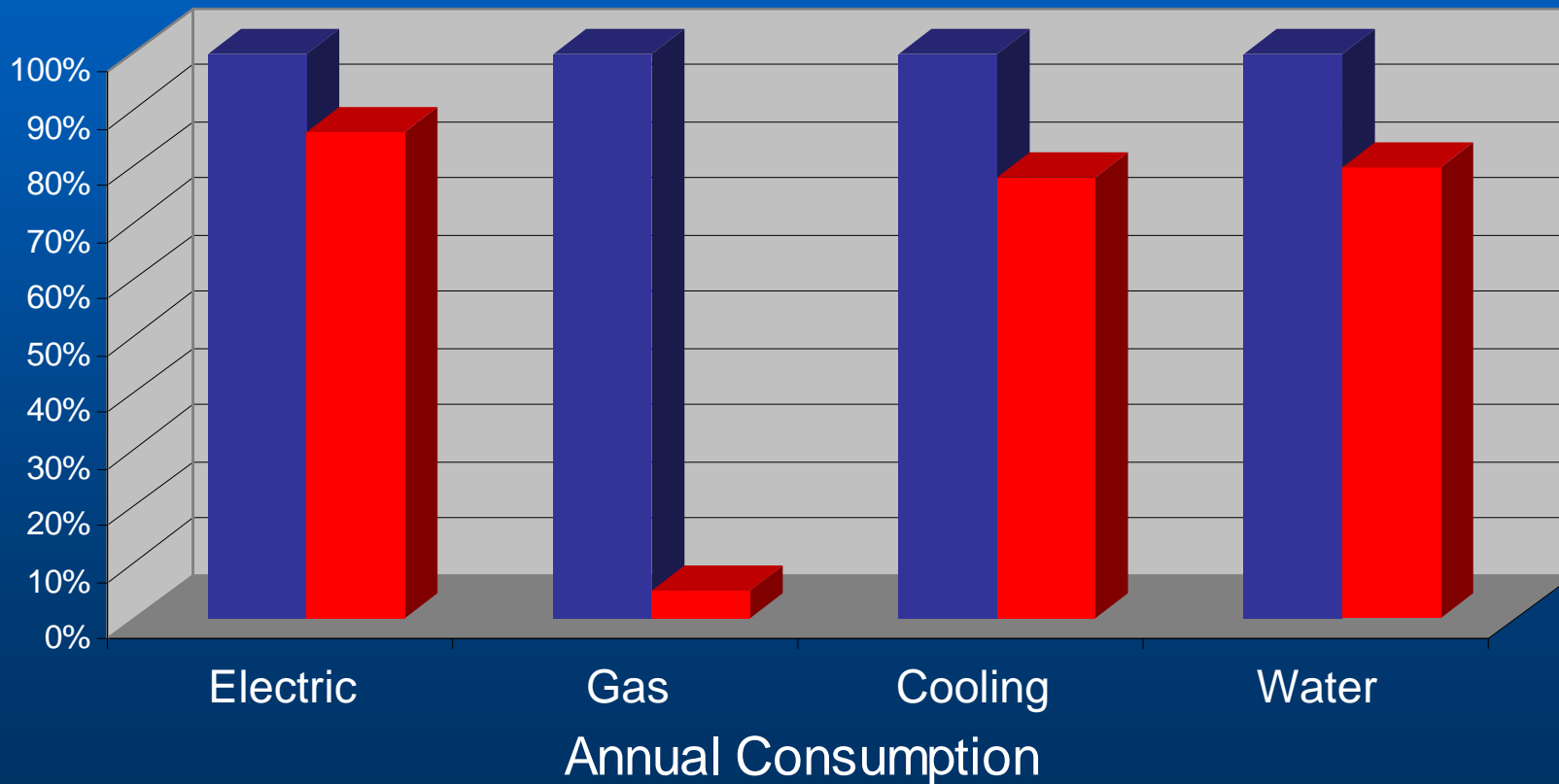
Unique UAE Design Conditions

- High Temperature
- High Humidity
- Sand Storms
- Water Shortage

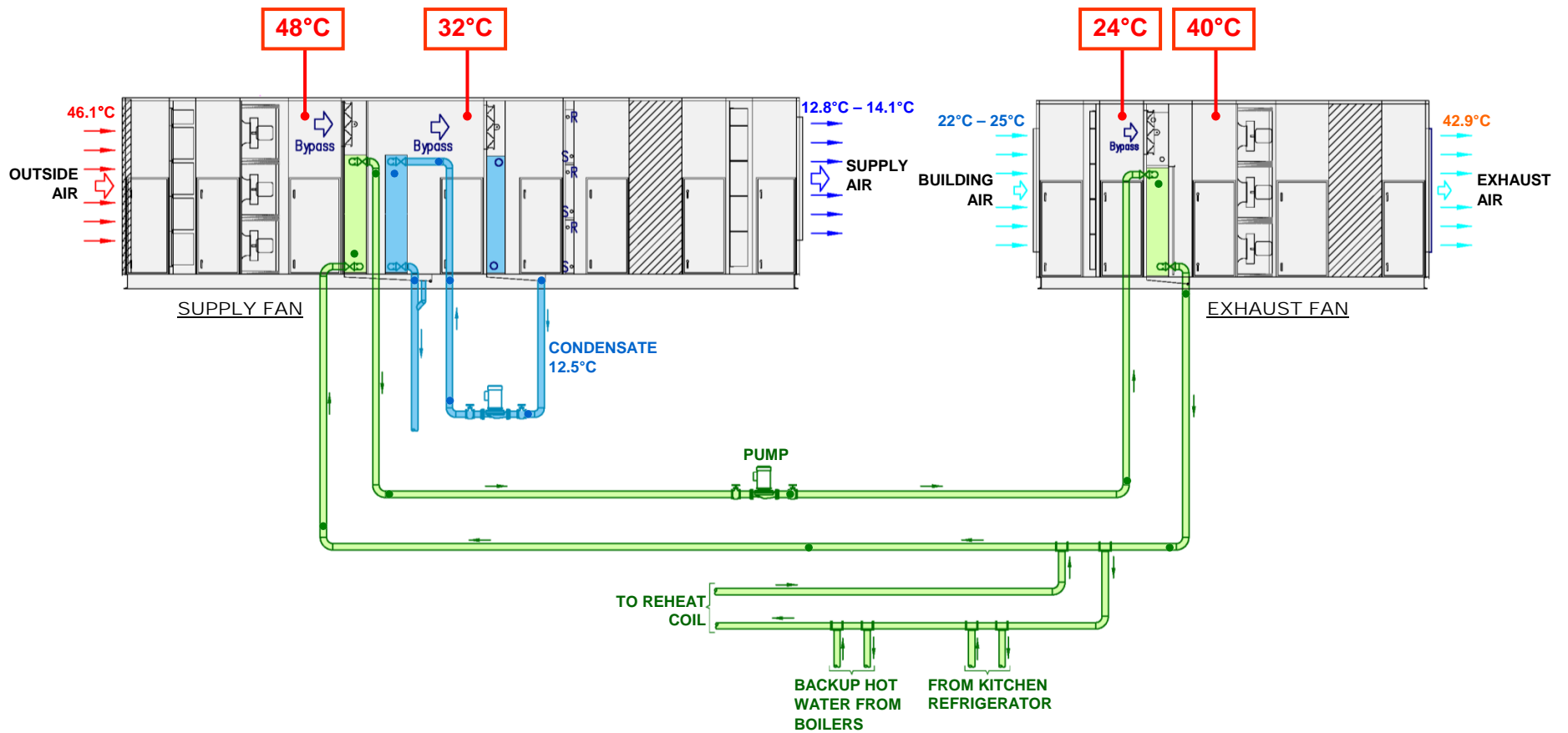
HVAC System Options

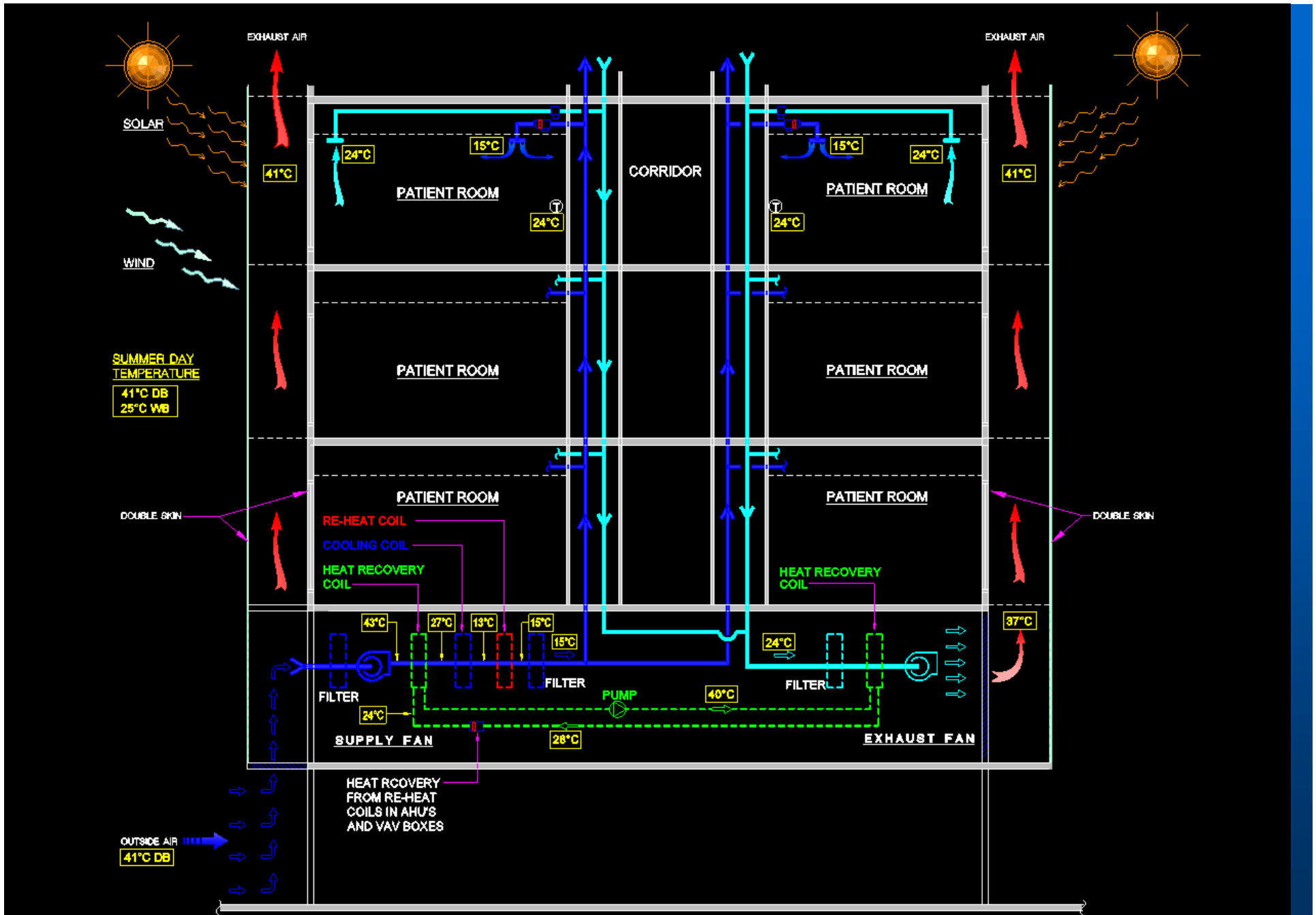
■ Return Air Constant Volume

■ 100% Outside Air Variable Volume

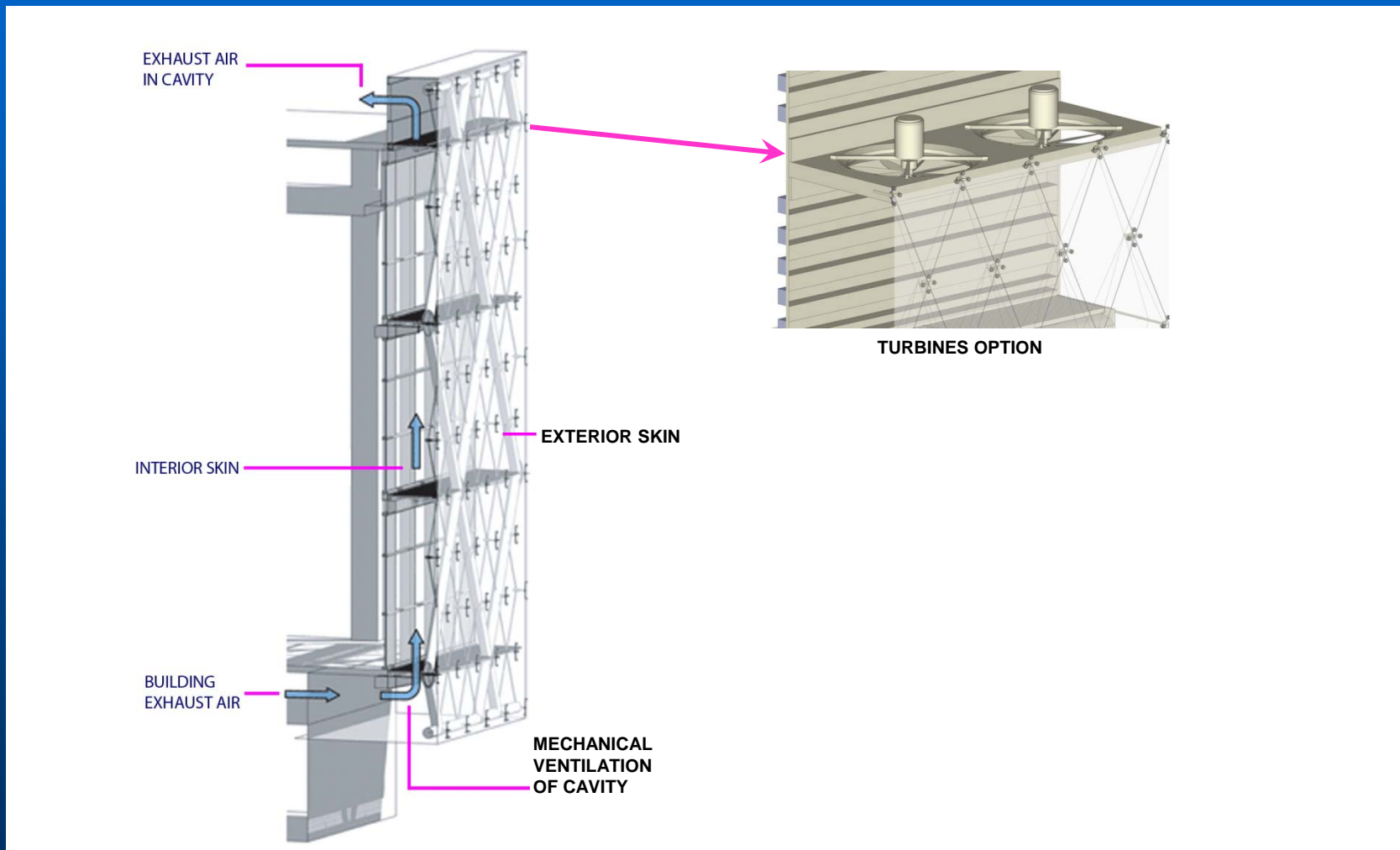


Heat Recovery



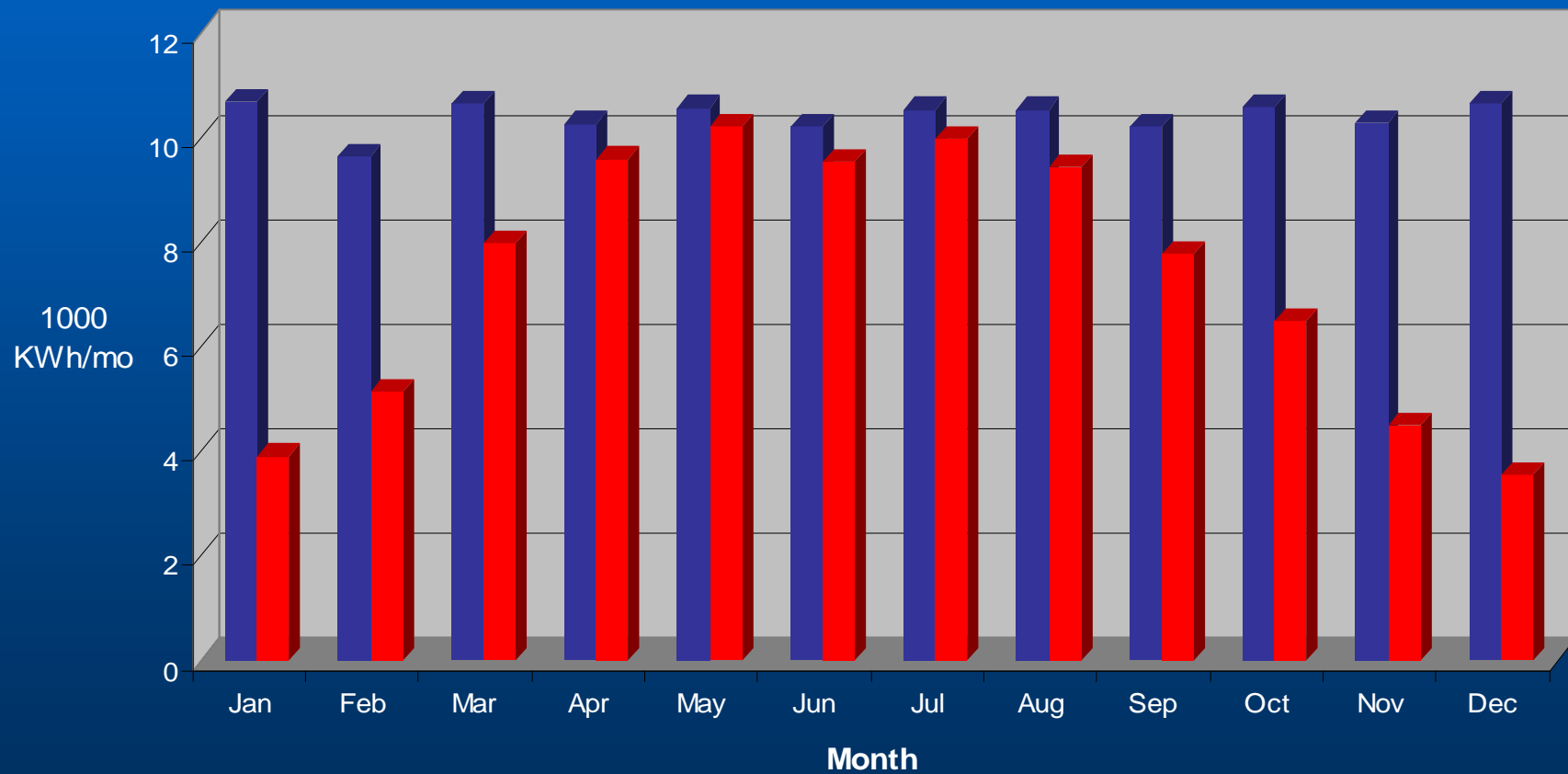


Curtain Wall



Solar Hot Water

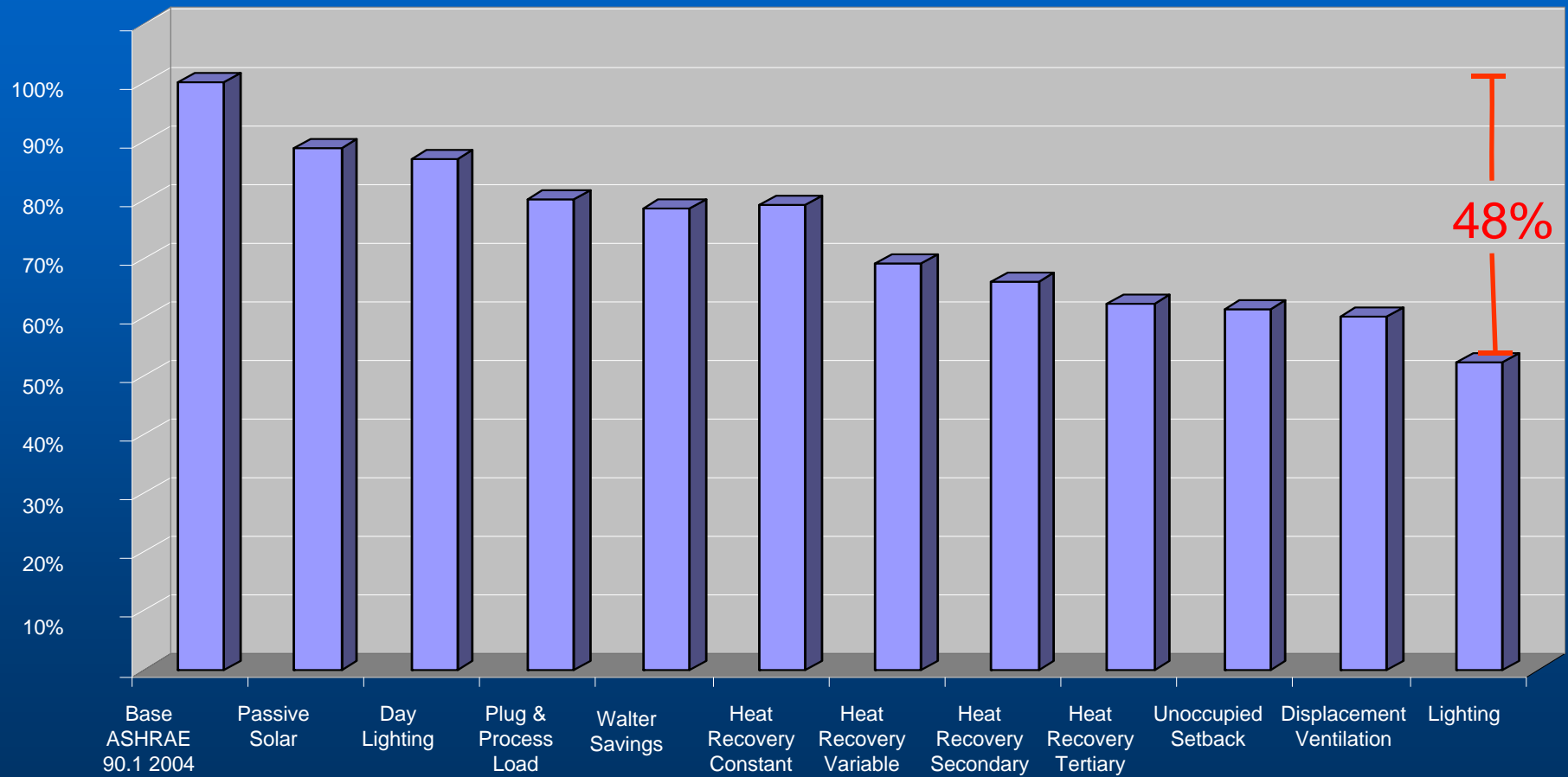
■ Domestic water heating demand ■ Domestic water heating by solar



Energy Analysis

Annual Energy Reduction

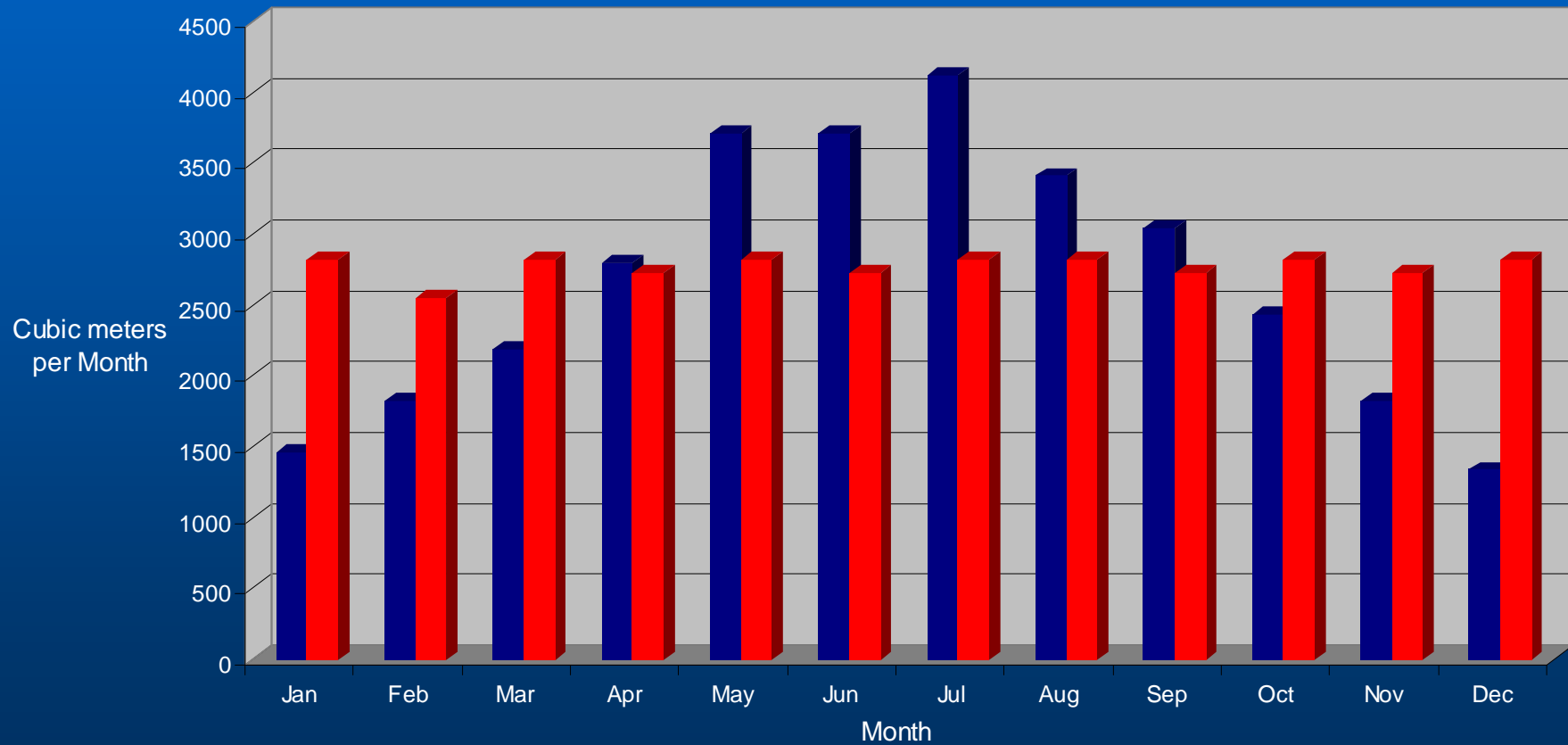
Abu Dhabi



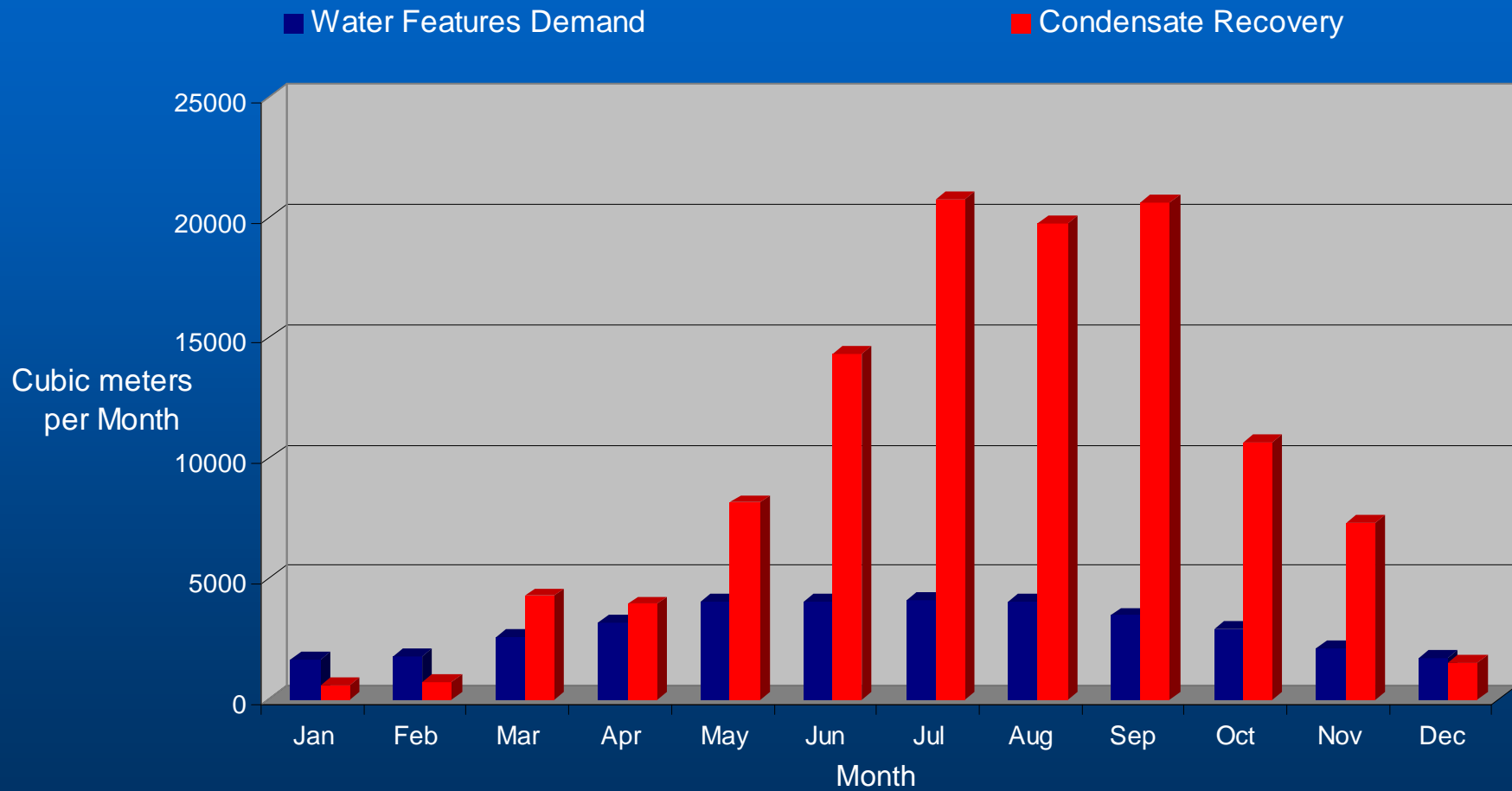
Grey Water Recovery

■ Irrigation Demand

■ Grey Water Recovery



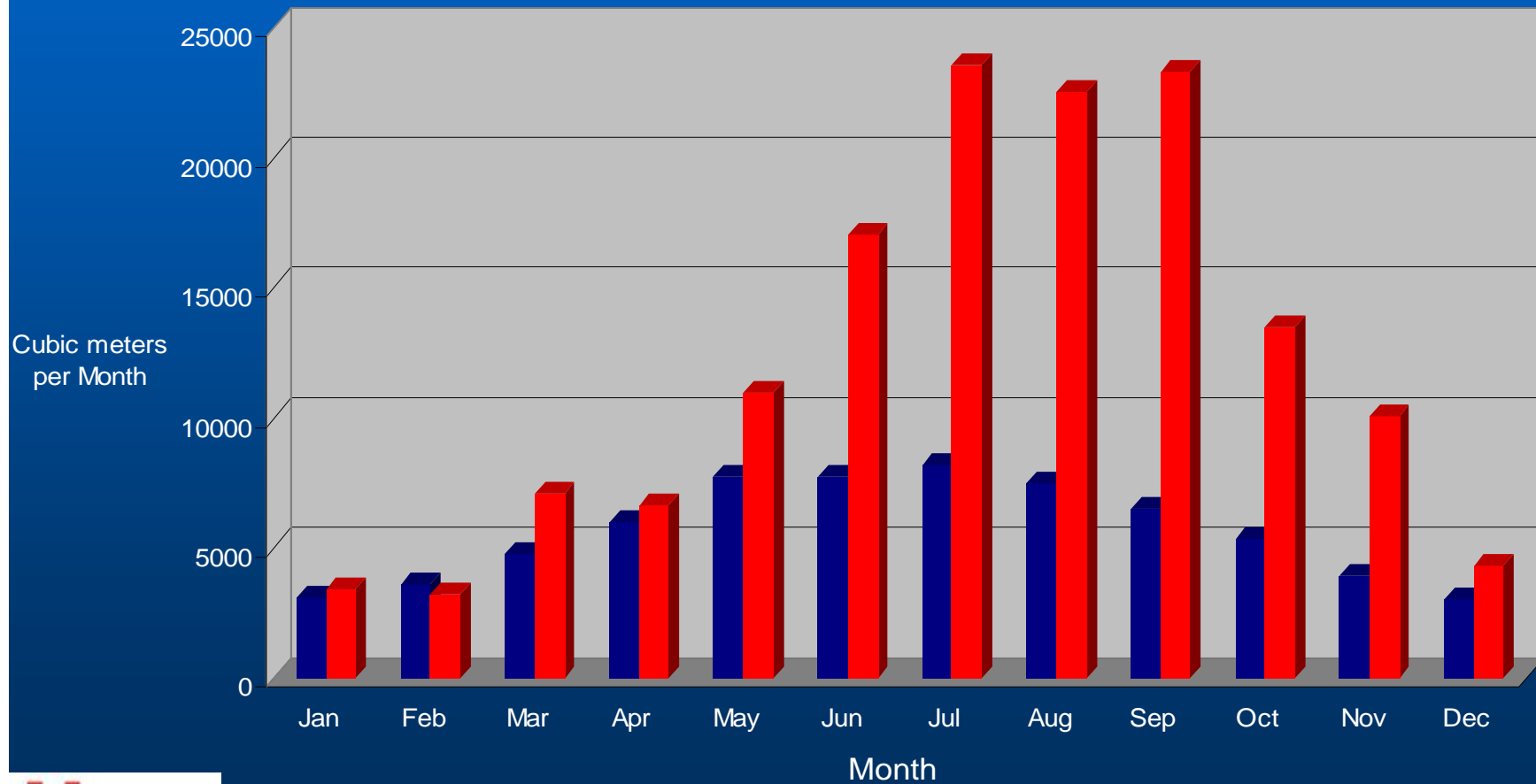
Condensate Water Recovery



Reclaimed Water (Grey Water and Condensate)

■ Irrigation and Water Feature Demand

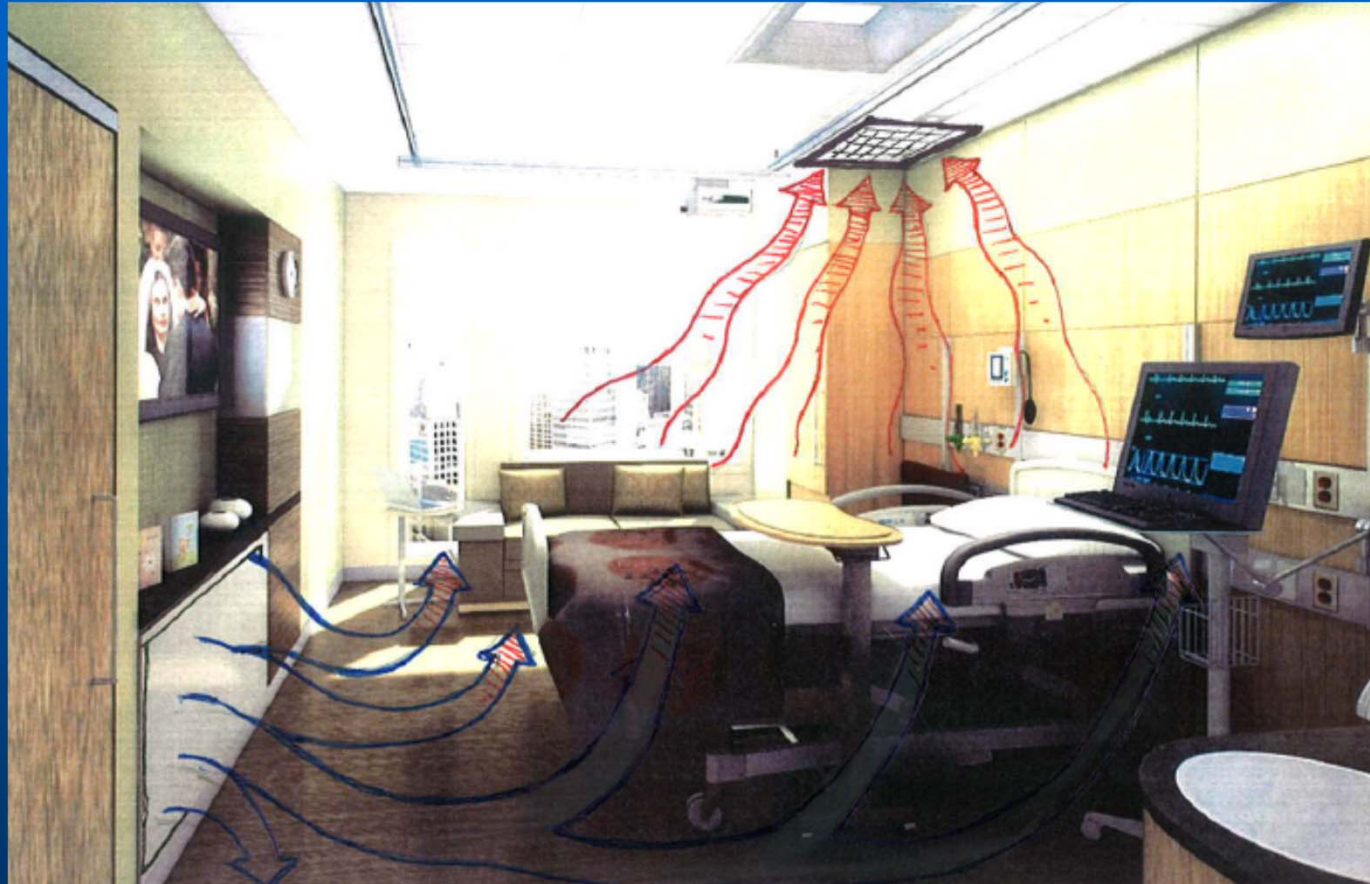
■ Grey Water and Condensate Recovery





California Pacific Medical Center

Displacement Ventilation



Smoke Test Video



Displacement Ventilation

240 CFM @ 7.2 AC/HR

Cooling: 18.0 °C Supply Air

Height	Room	Window	Bath
9'-0"	-	-	-
8'-6"	23.6	24.7	22.2
8'-0"	23.3	23.6	21.9
7'-0"	22.8	23.6	21.9
6'-0"	22.8	22.5	21.7
5'-0"	22.7	22.5	21.8
4'-0"	22.7	22.3	22.2
3'-0"	22.0	21.9	22.2
2'-0"	21.0	21.6	21.3
1'-0"	-	-	-

120 CFM @ 3.6 AC/HR

Cooling: 18.0 °C Supply Air

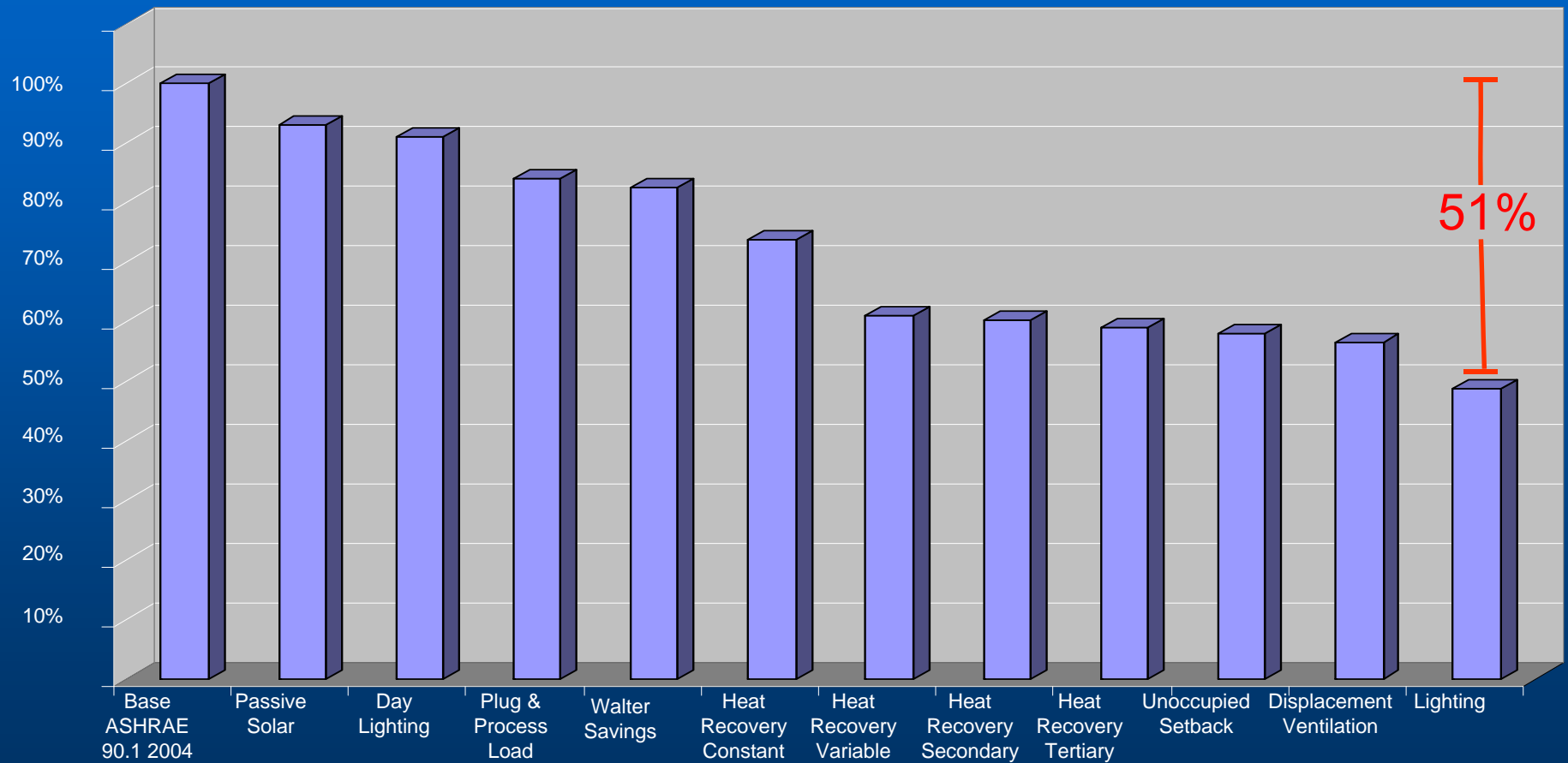
Height	Room	Window	Bath
9'-0"	-	-	-
8'-6"	24.1	24.4	21.1
8'-0"	23.7	24.4	21.3
7'-0"	23.6	23.5	21.6
6'-0"	23.4	23.3	21.9
5'-0"	23.3	23.3	22.2
4'-0"	23.3	23.3	22.2
3'-0"	23.0	23.3	22.3
2'-0"	21.2	20.5	22.5
1'-0"	-	-	-

Room Temperature Profile

Energy Analysis

Annual Energy Reduction

San Francisco

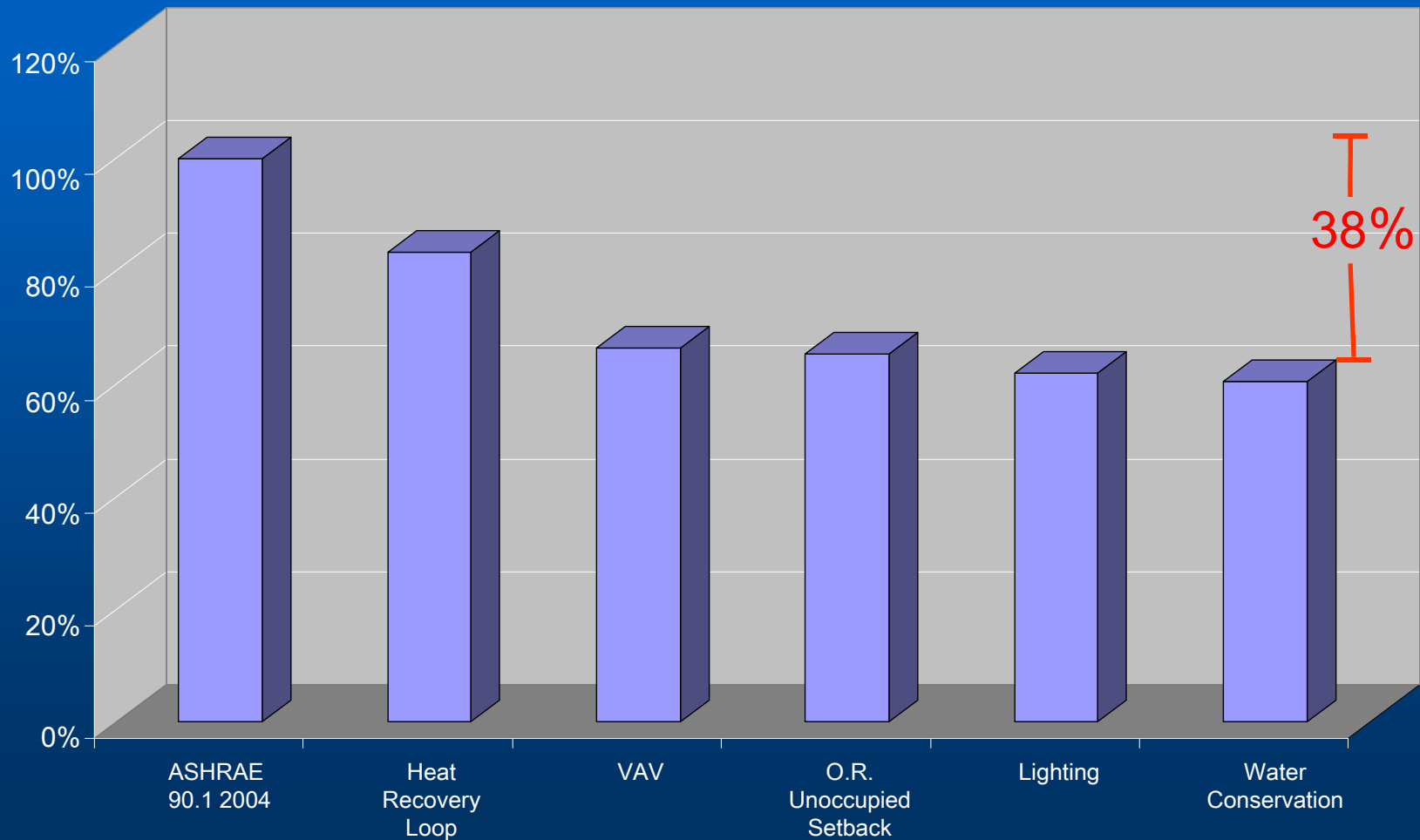




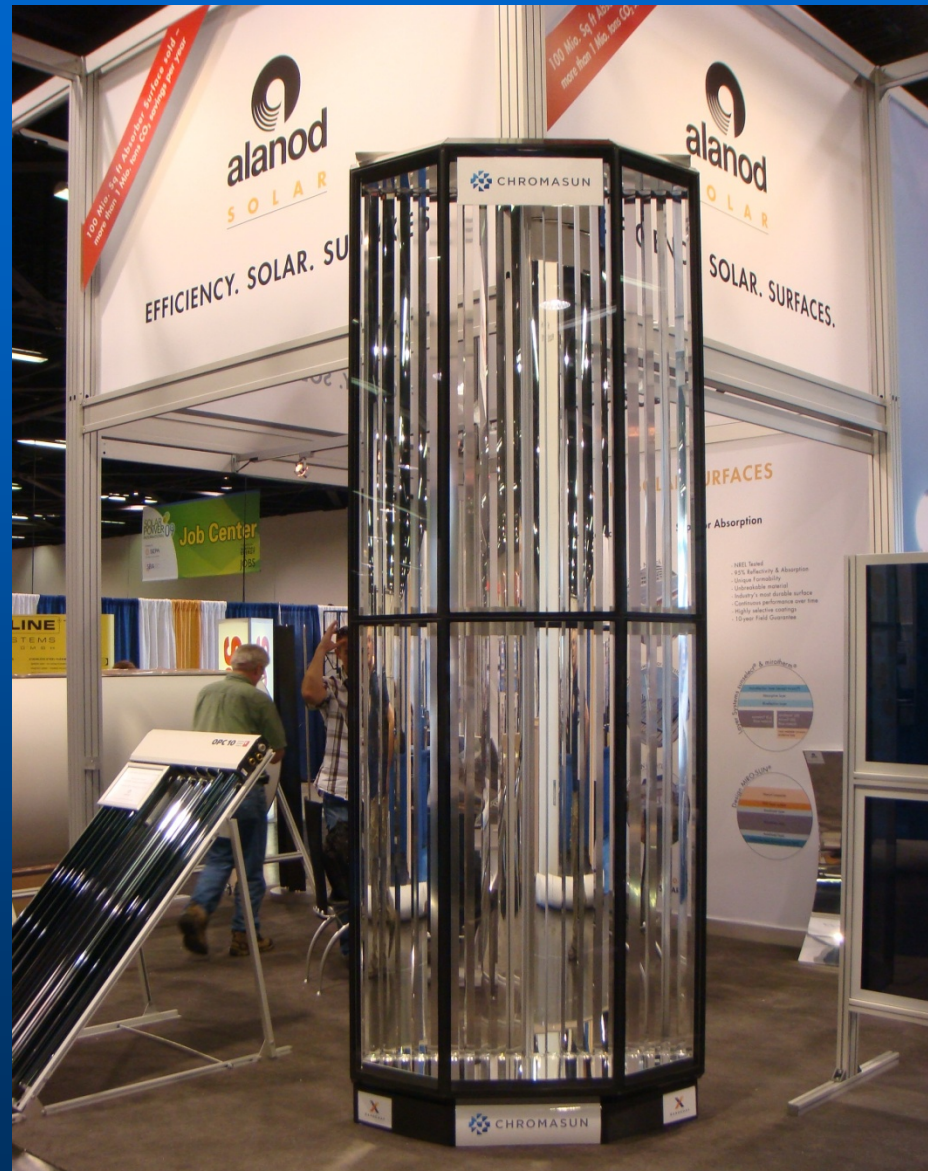
Kaiser Oakland Hospital Replacement

Energy Analysis

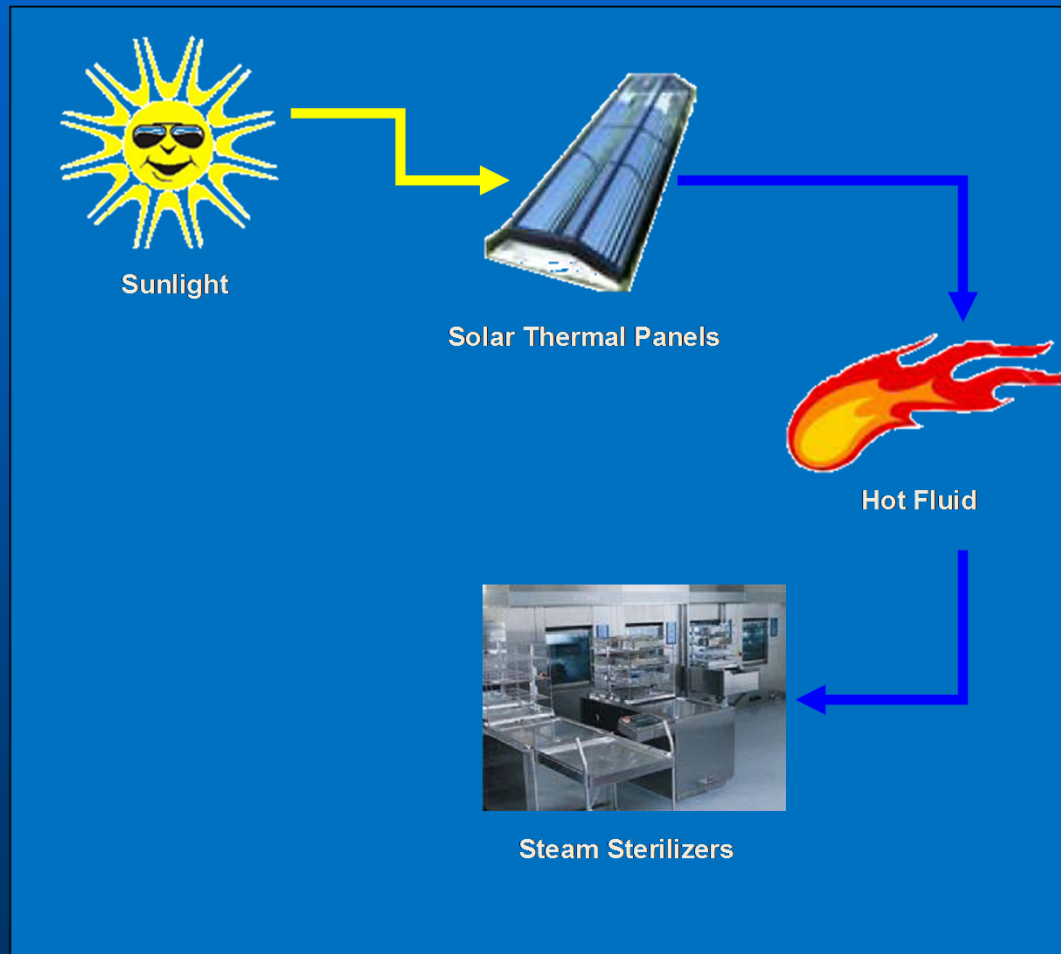
Annual Energy Reduction



Solar Panel with Glass Backing



Steam Solar Panels



Self-Contained Patient Bed



- **Medical Gases**
 - Oxygen Concentrator
 - Medical Vacuum
 - Medical Air
- **Power**
 - New Battery Technology
 - Data Analysis Tools
 - Remote Display and Controls
- **Environmental Controls**
 - Heating
 - Ventilating
 - Cooling

Something To Think About

- How will NZEB reshape our buildings?
- How can we integrate available technologies into our buildings?
- What renewable technologies are available and can we make them feasible?
- What can we do to achieve the NZEB by 2025?

Together we can achieve

**Net-Zero Energy,
High-Performance
Green Hospital Buildings**