

*Moving Towards*  
**Net-Zero Energy Hospital Buildings**

Presented by  
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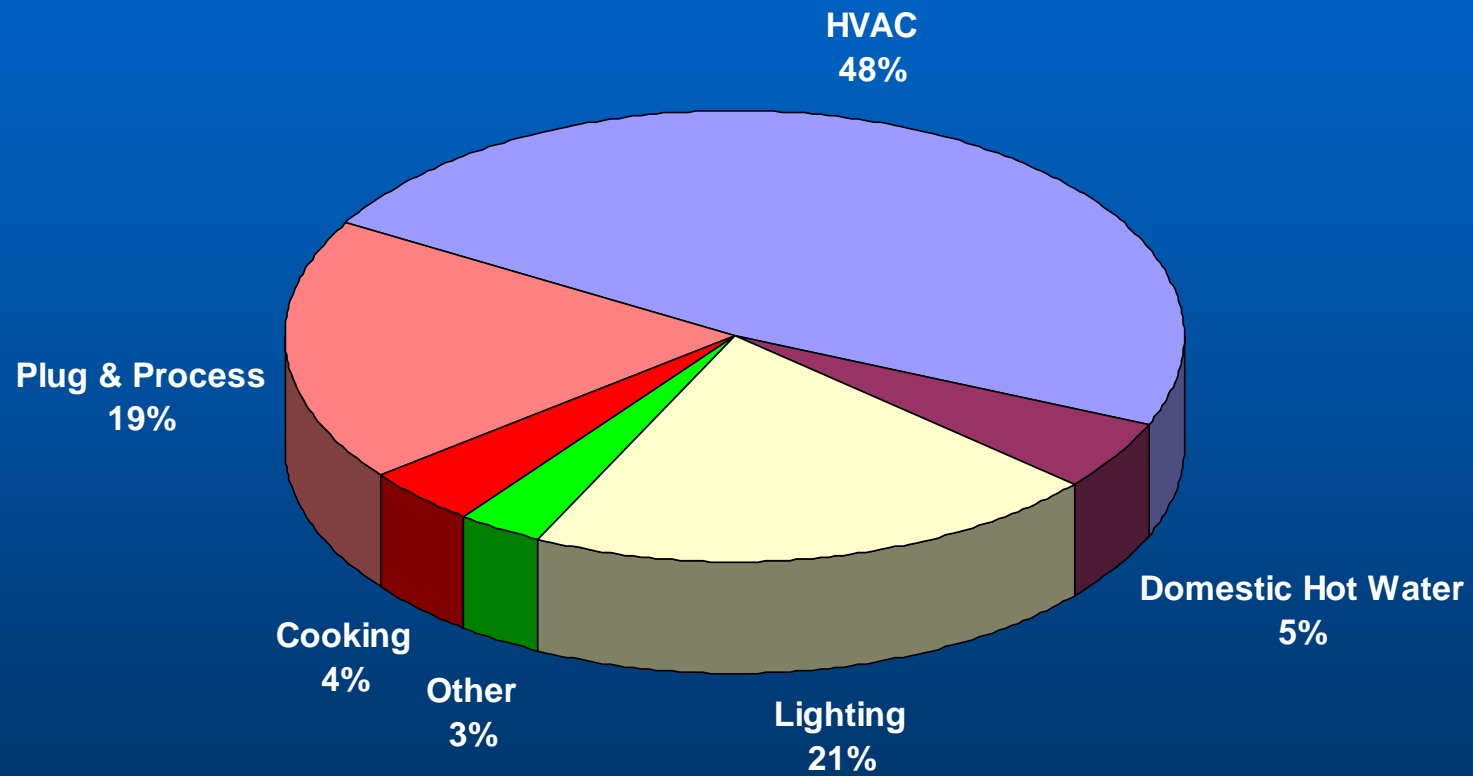
# Building Life Cycle

- 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)
<b>Innovative Design</b>					
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
<b>Sub-Total</b>	<b>54.0%</b>	<b>56.0%</b>	<b>50.0%</b>	<b>60.0%</b>	<b>2-3</b>
<b>On-site Renewable Energy</b>					
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
<b>Sub-Total</b>	<b>26.0%</b>	<b>24.0%</b>	<b>30.0%</b>	<b>20.0%</b>	<b>5-10</b>
<b>Off-site Renewable Energy</b>					
Purchase from Utility Company	20.0%	20.0%	20.0%	20.0%	N/A
<b>TOTAL:</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	

# 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**  
Abu Dhabi, UAE

**Client:** Mubadala  
Abu Dhabi, UAE

**Scope:** 360-490 Bed  
4.8 Million sf

**Completion:** 2013



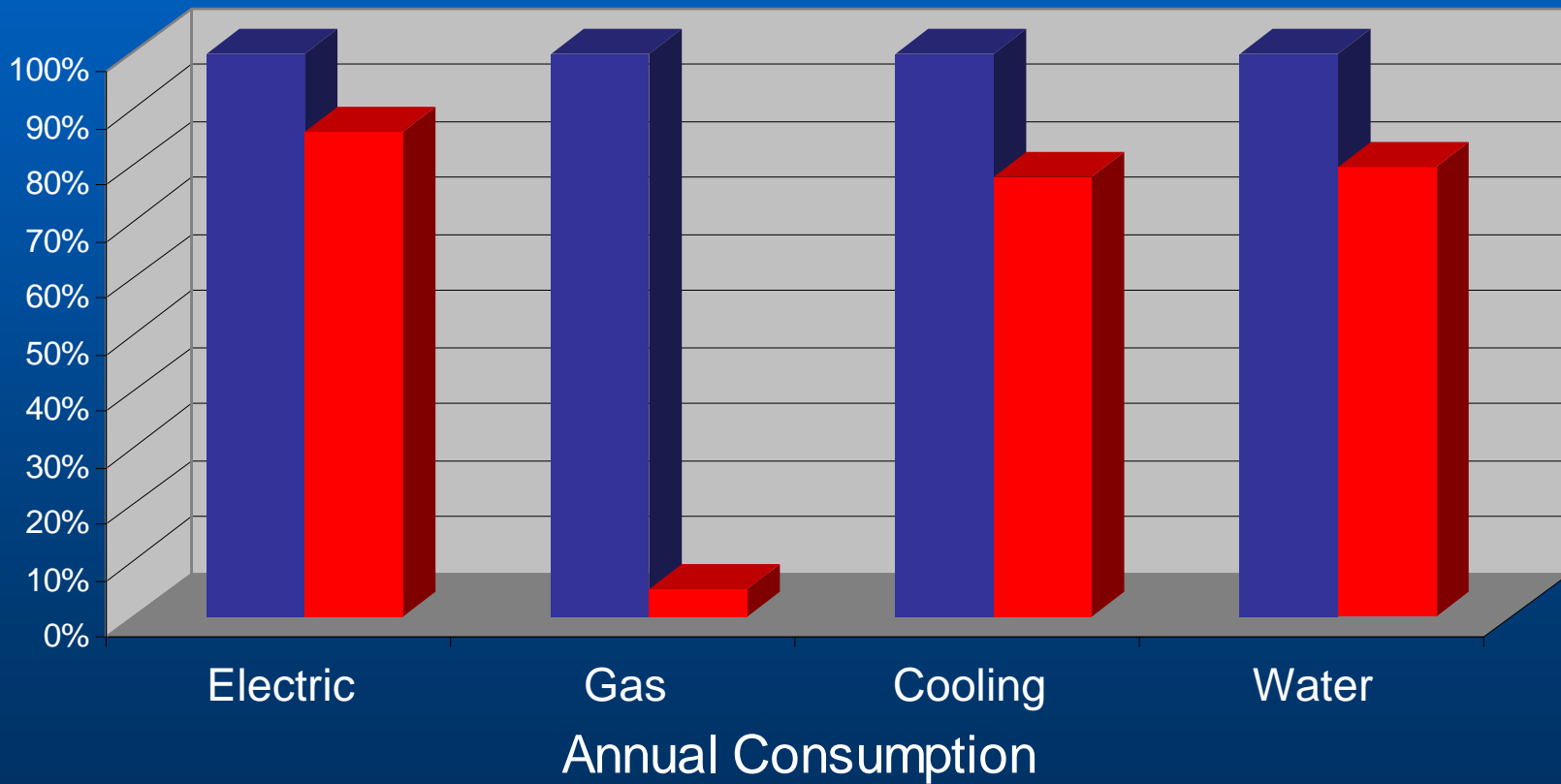
# Unique UAE Design Conditions

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

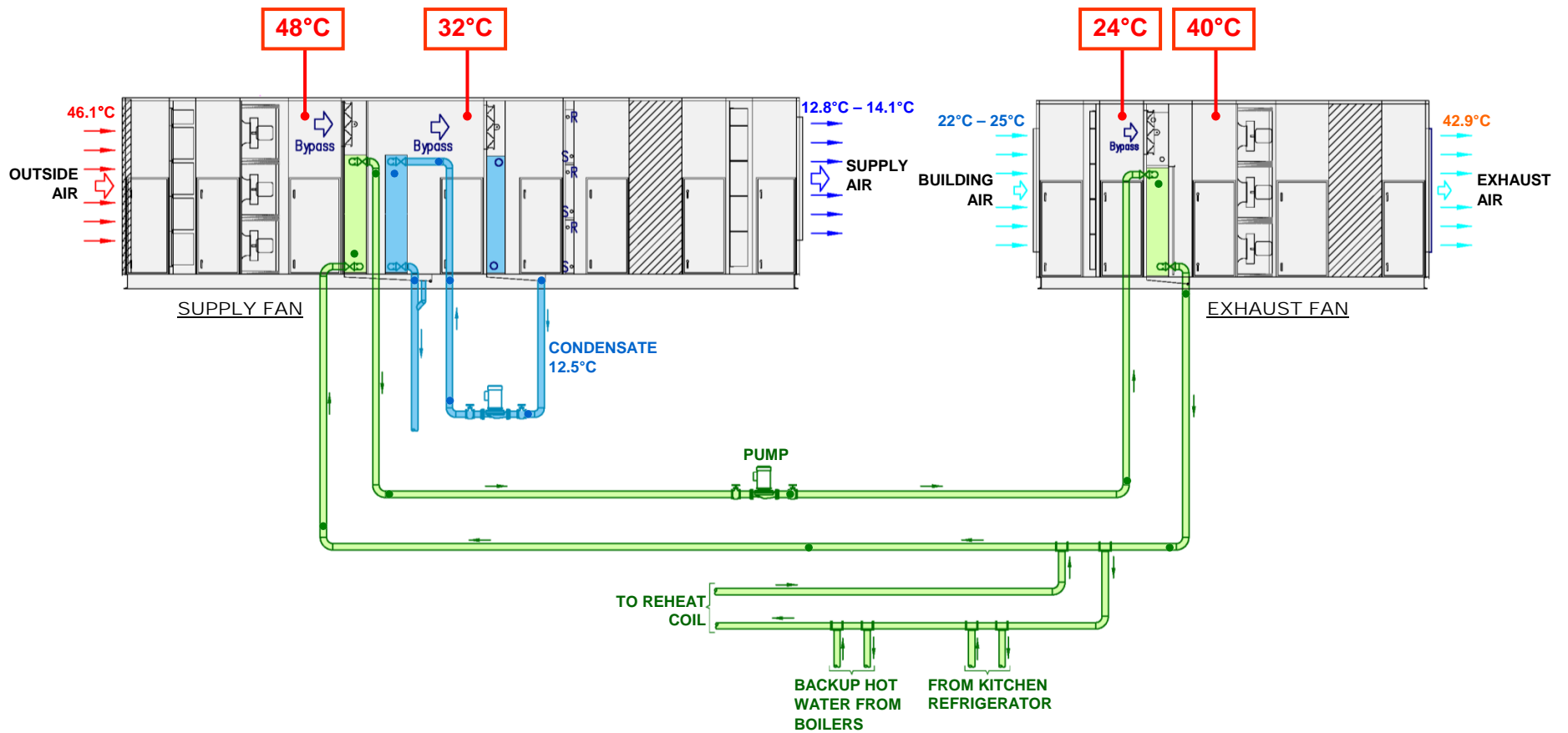
# HVAC System Options

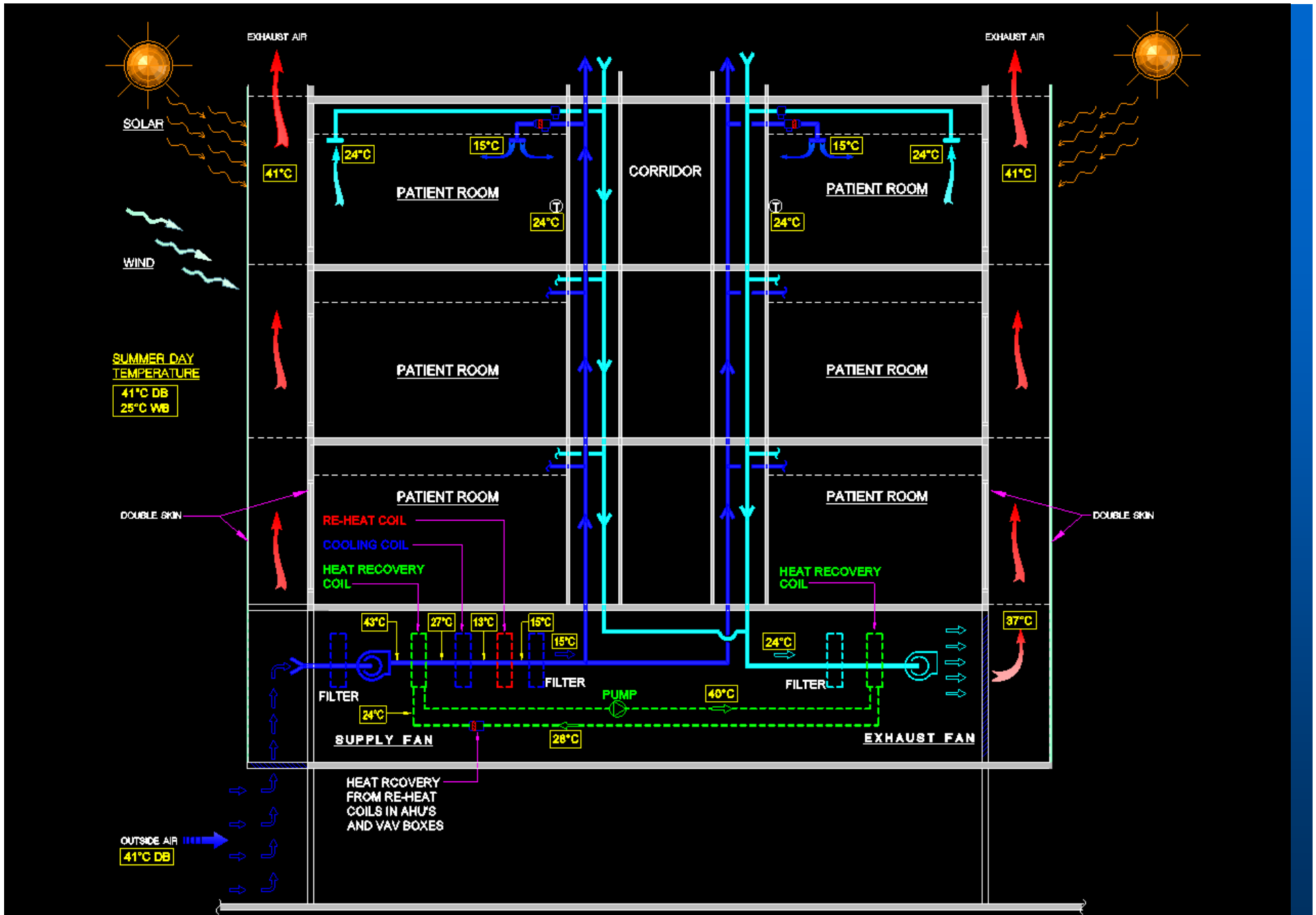
■ Return Air Constant Volume

■ 100% Outside Air Variable Volume

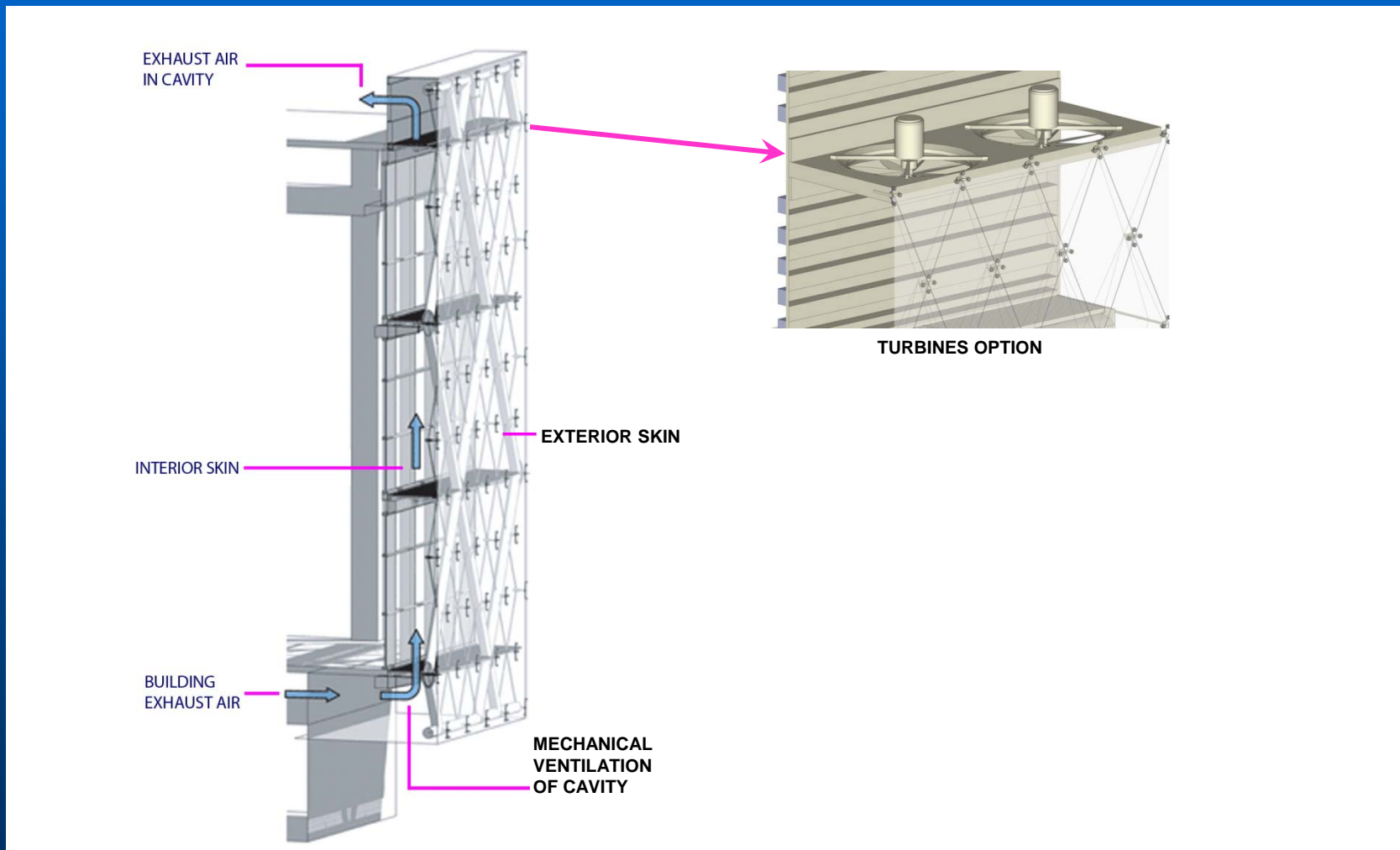


# Heat Recovery



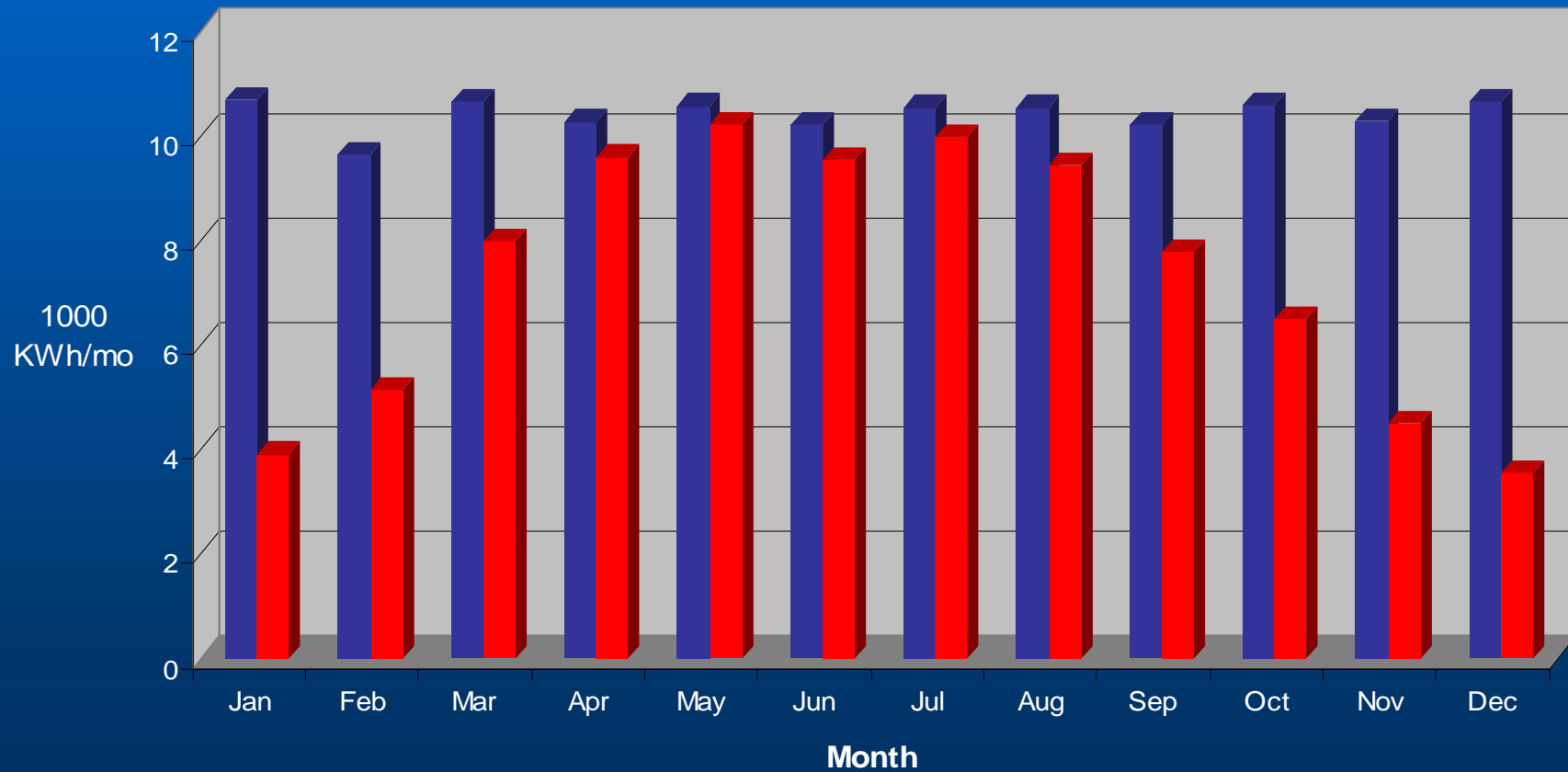


# Curtain Wall



# Solar Hot Water

■ Domestic water heating demand      ■ Domestic water heating by solar

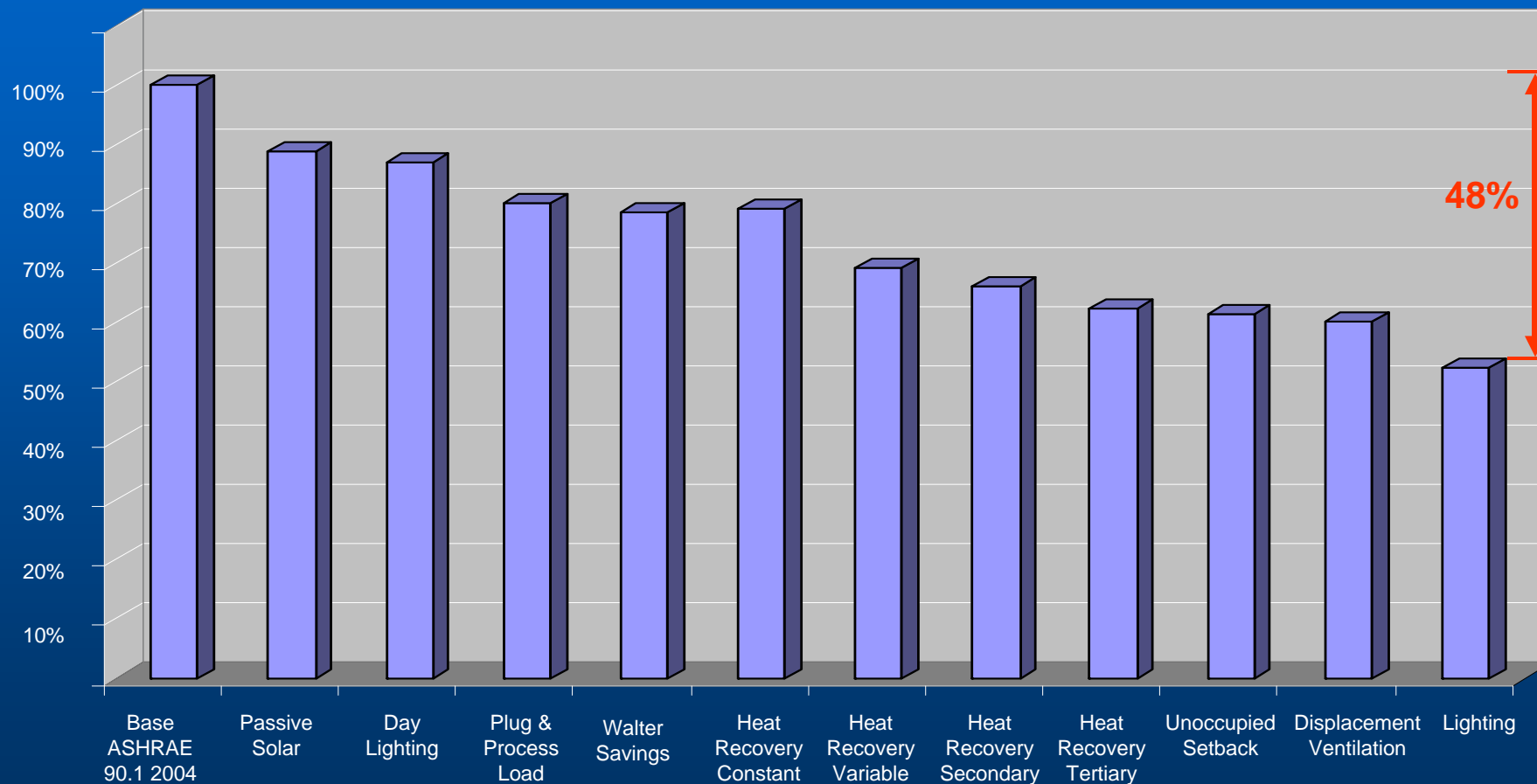




# Energy Analysis

## Annual Energy Reduction

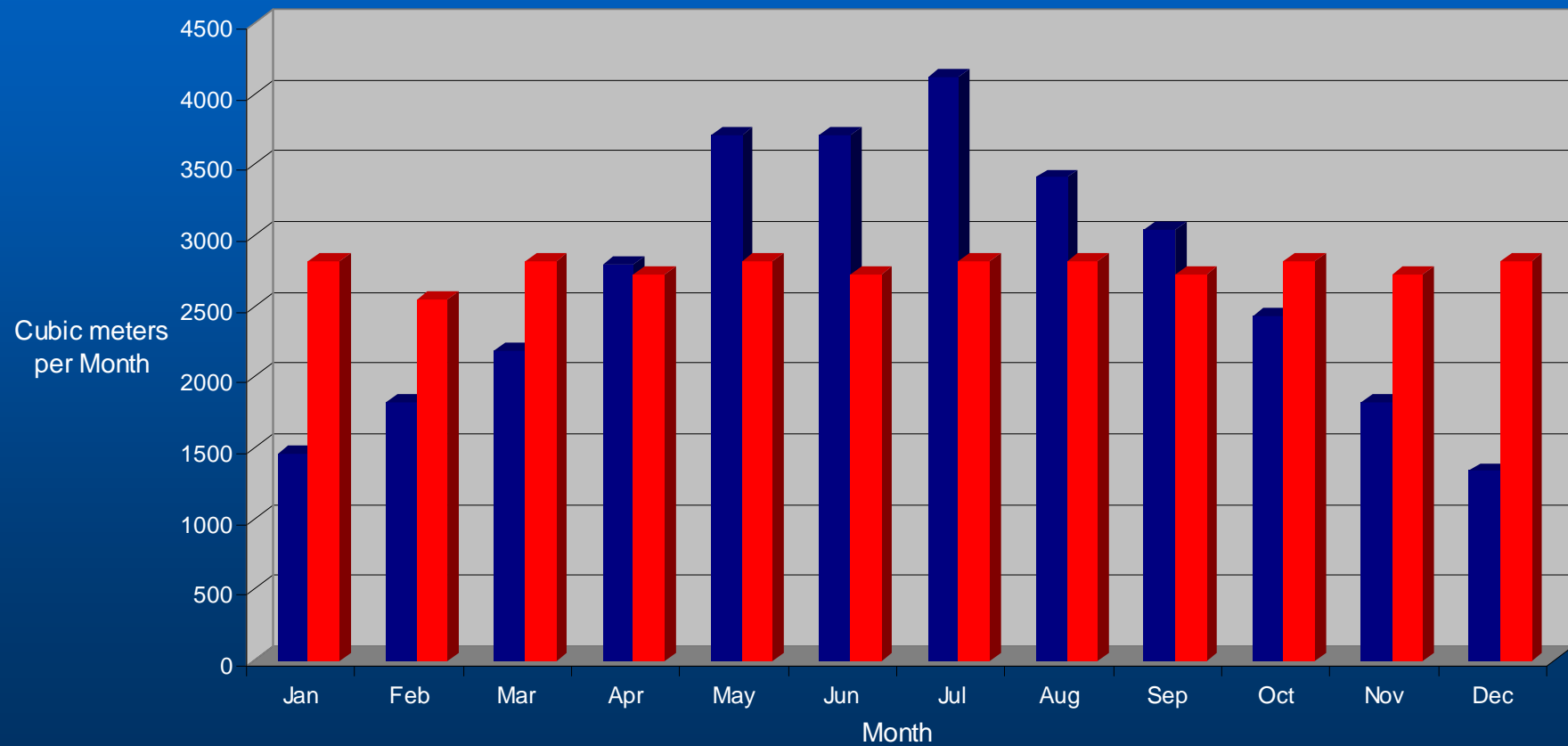
### Abu Dhabi



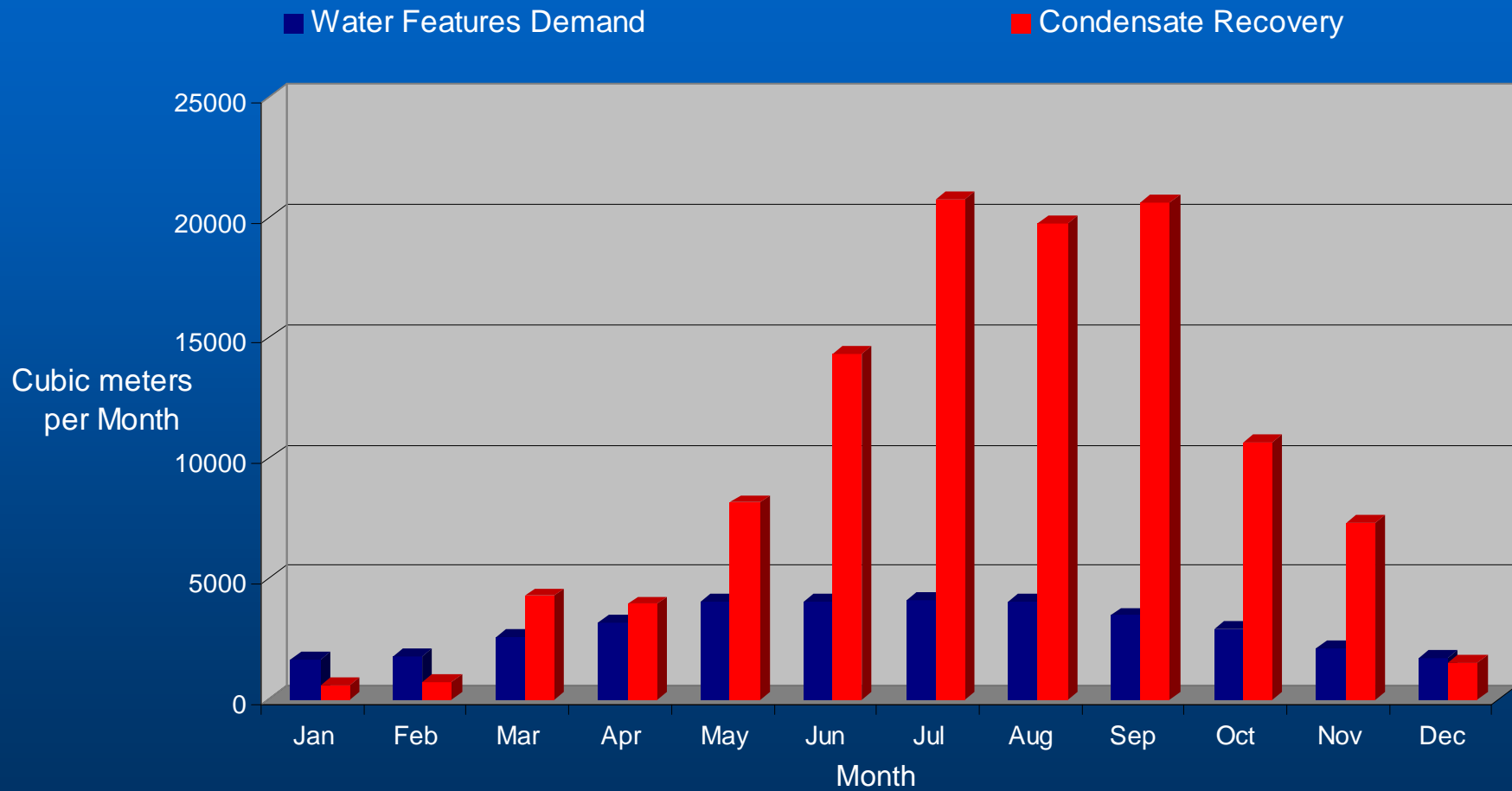
# Grey Water Recovery

■ Irrigation Demand

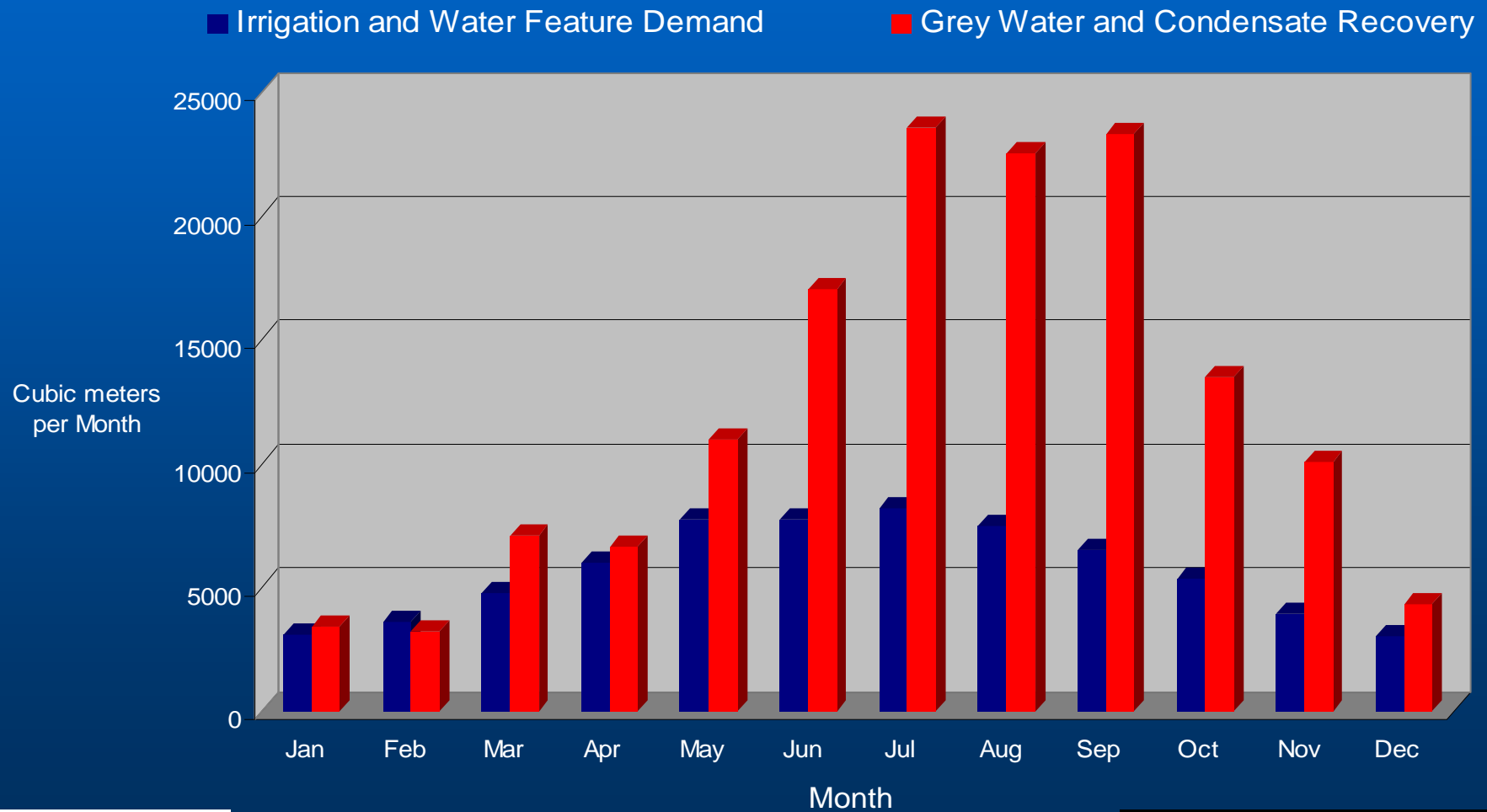
■ Grey Water Recovery



# Condensate Water Recovery



# Reclaimed Water (Grey Water and Condensate)



**California Pacific Medical Center  
San Francisco, California**

**Client:** Sutter Medical Group  
San Francisco, California

**Scope:** 550 Bed Women & Childrens  
Acute Care Hospital  
1.2 million sq. ft.

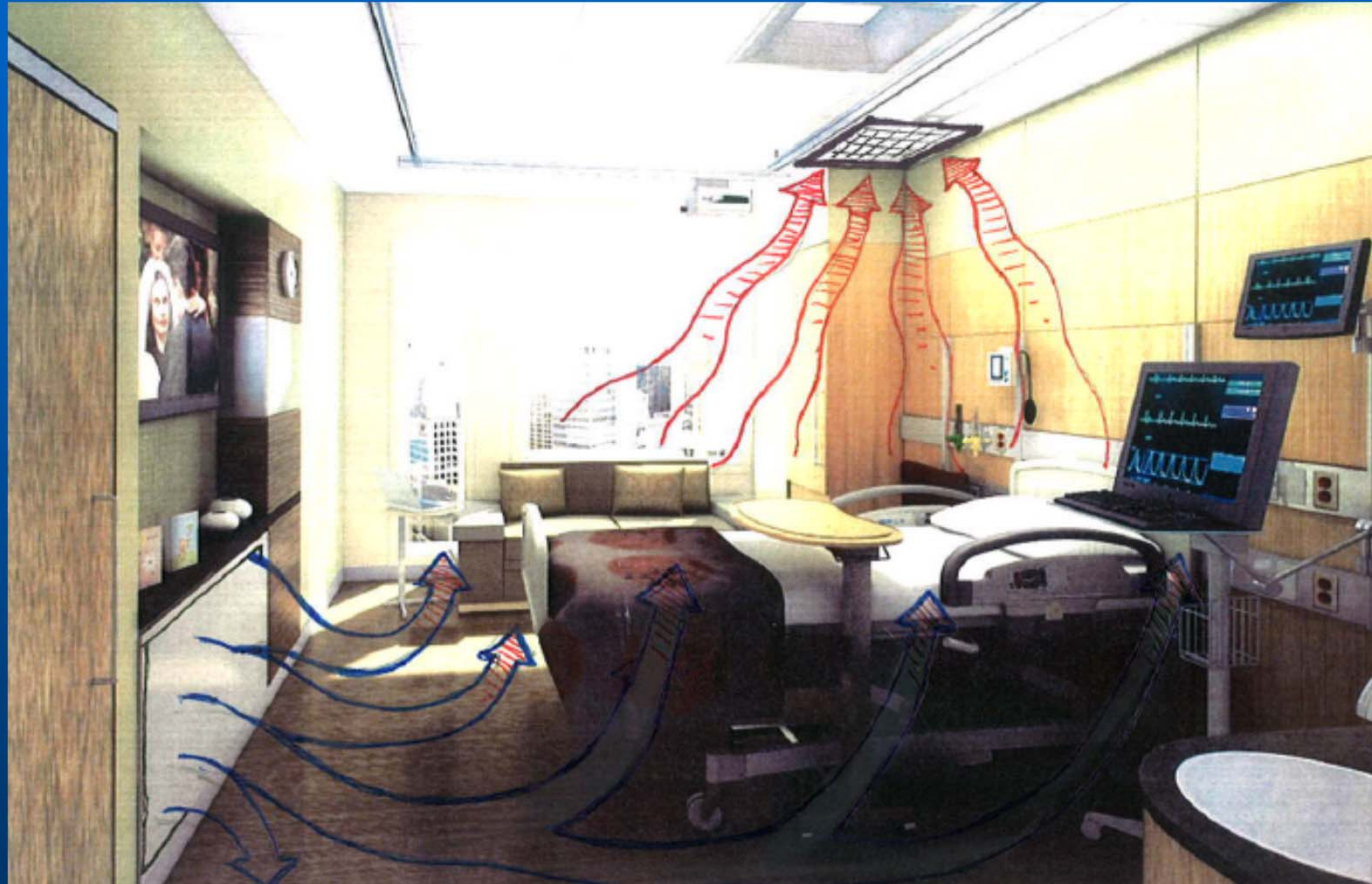
**Completion:** 2012



# Smoke Test Video



# Displacement Ventilation





# 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"	-	-	-

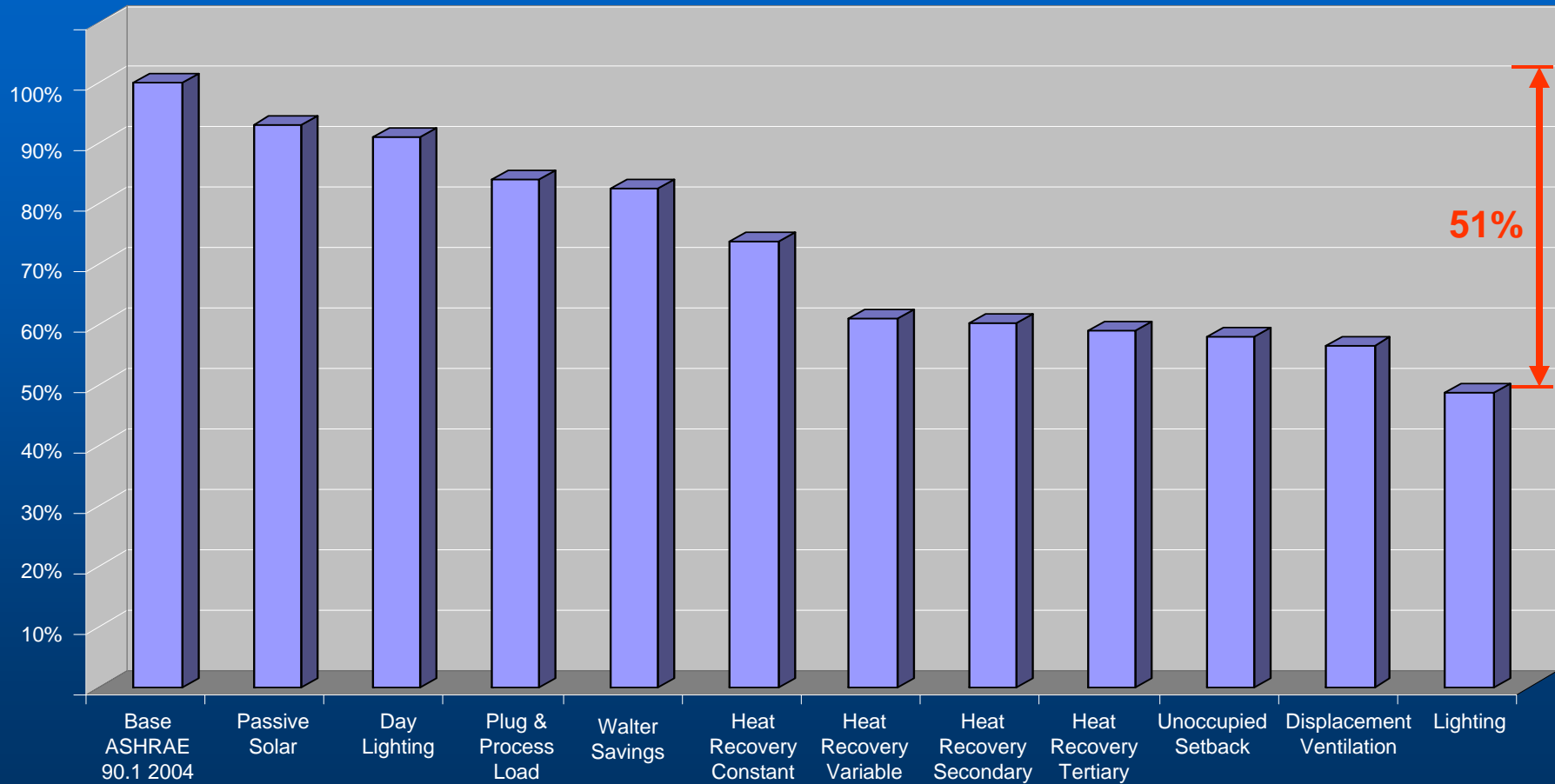
## Room Temperature Profile



# Energy Analysis

## Annual Energy Reduction

### San Francisco



**Kaiser Oakland Hospital Replacement  
Oakland, California**

**Client:** Kaiser Permanente  
Oakland, California

**Scope:** New Hospital, Central Utility Plant,  
Medical Office Building, Service  
Building and two (2) Parking Garages  
1.2 million sq. ft.

**Budget:** \$950 Million Construction Cost

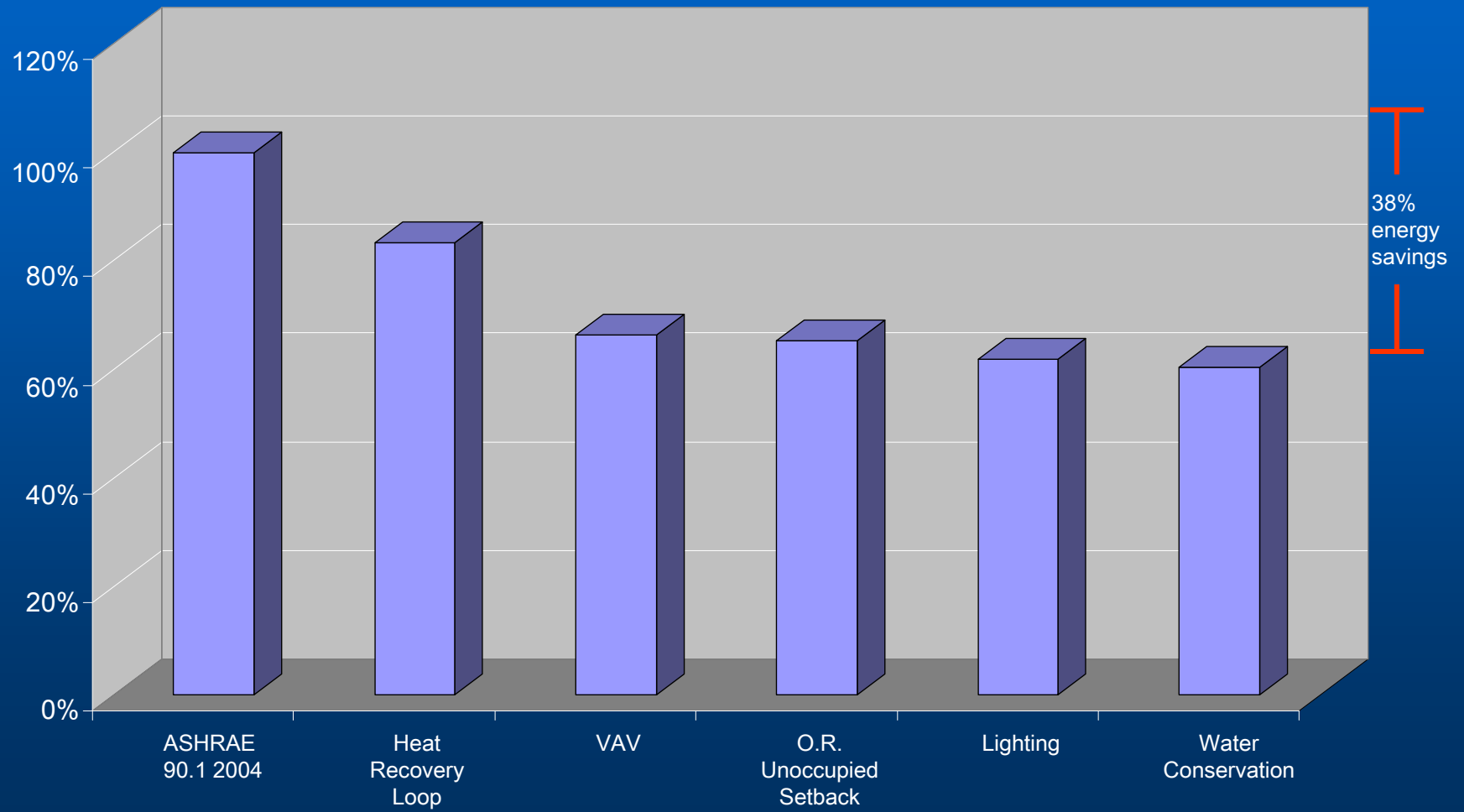
**Completion:** 2009 – MOB  
2014 – Hospital



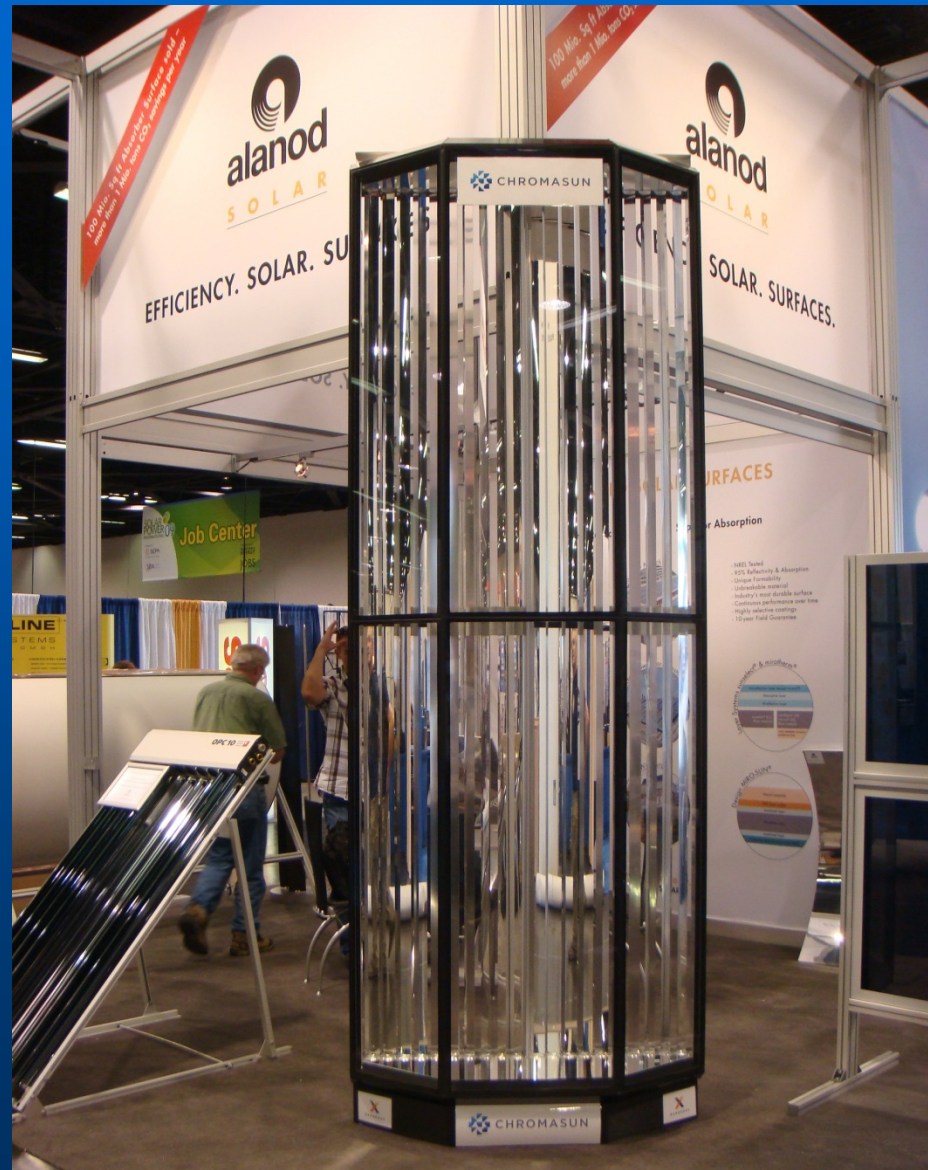
# Energy Analysis

## Annual Energy Reduction

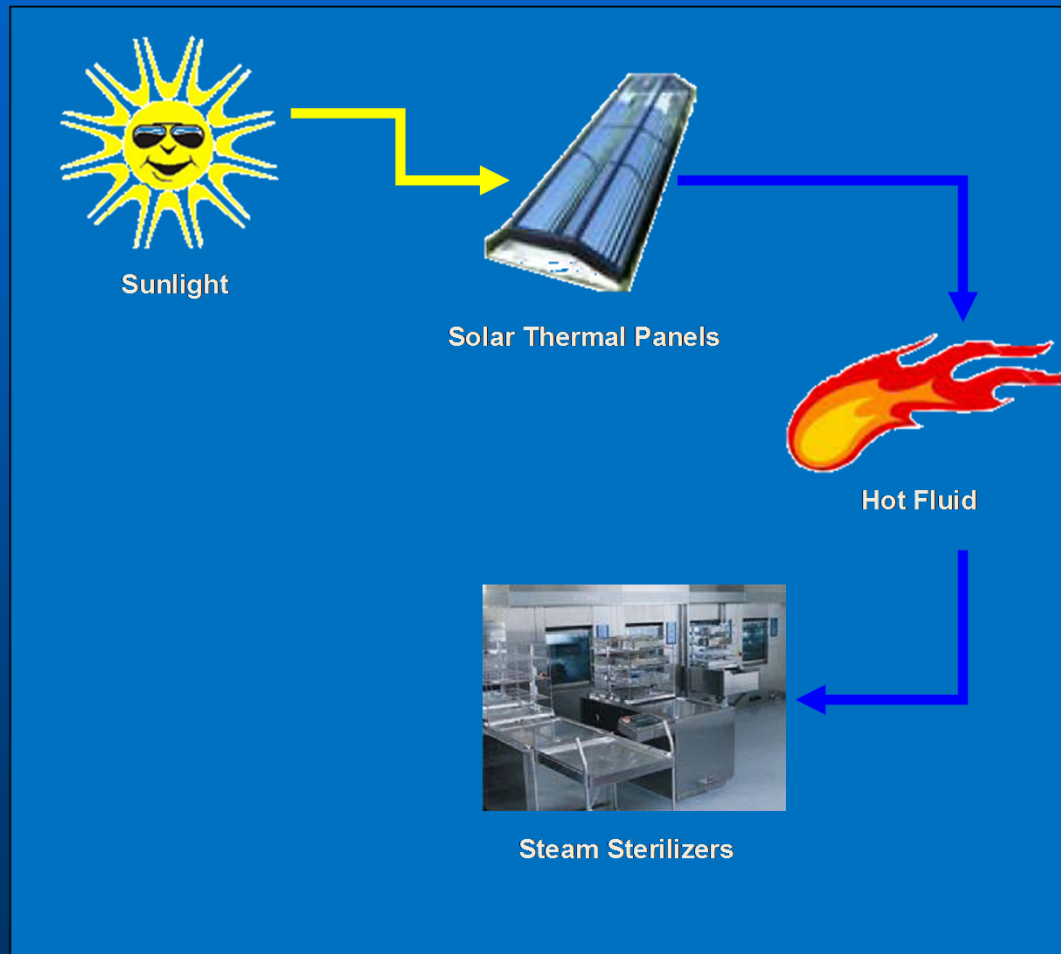
### Oakland, CA



# Solar Panel with Glass Backing

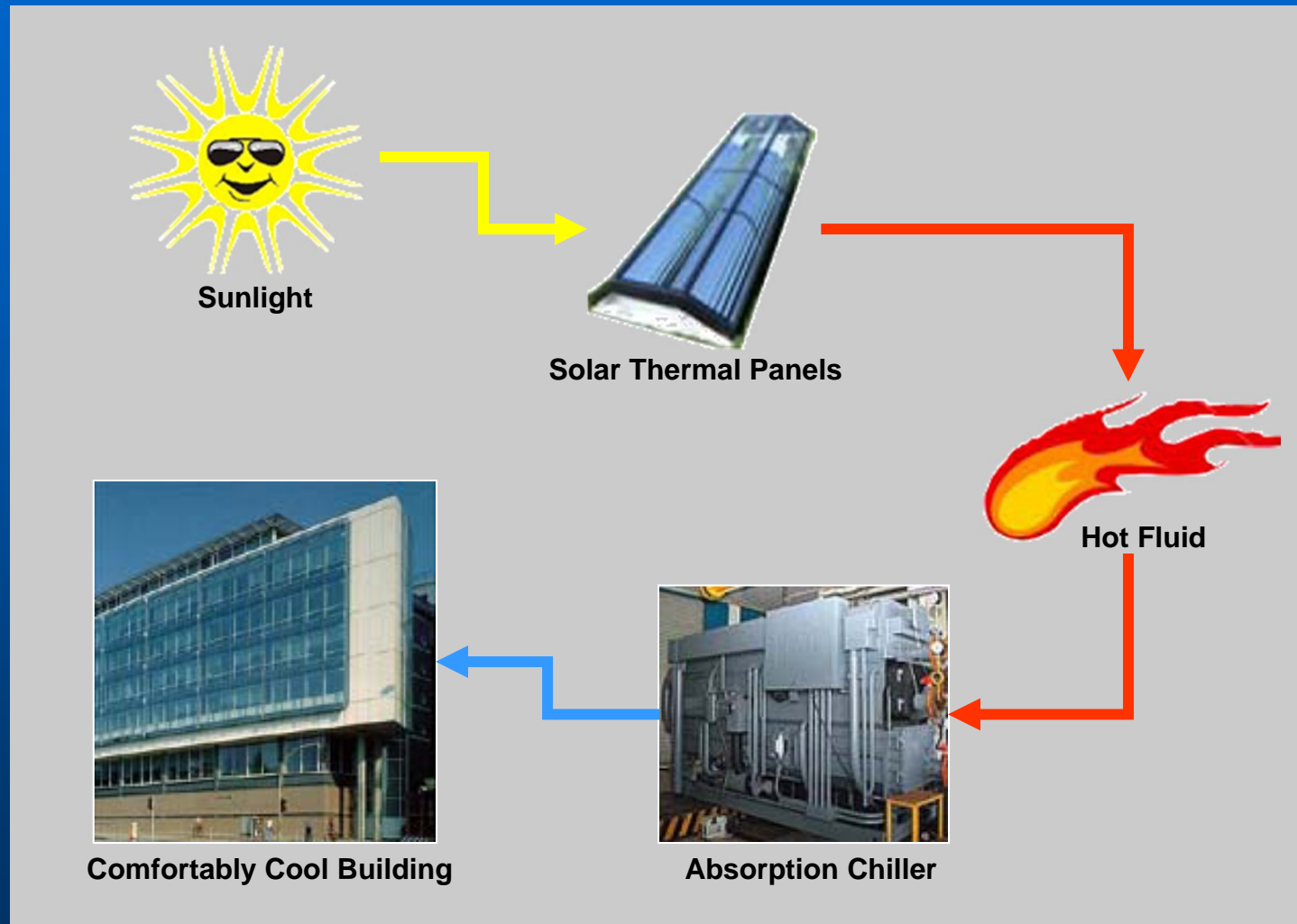


# Steam Solar Panels





# Cooling with 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**