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HIGH PERFORMANCE SYSTEMS FOR EDUCATIONAL FACILITIES

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EDUCATIONAL FACILITIES
IN CRISIS

- Rapidly escalating energy costs are consuming capital resources better employed for educational purposes
- High levels of background noise interfere with learning
- IAQ problems threaten health and contribute to high absenteeism

DESIGN DEFICIENCIES PLAGUING SCHOOLS

- High levels of insulation, lower lighting densities, and more efficient office equipment are changing building load characteristics.
- Tight buildings don't breath by themselves. Ventilation must be provided by HVAC systems.
- Ventilation has displaced cooling as the dominant design variable in new school construction.
- These represent profound changes for HVAC design

DESIGN STANDARDS FOR SCHOOLS

- Ventilation requirements - ASHRAE 62.1-2002
  - 15 cfm per student
  - Ventilation effectiveness factor
  - 100% outdoor systems
- Energy efficiency - AHRAE 90.1-2001
- Permissible noise levels - ANSI S-12.60-2002
  - 35 dB A limit in classrooms

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SO, WHY ARE HVAC SYSTEMS SO PROBLEMATIC IN SCHOOLS?

CLASSICAL HVAC SYSTEMS ARE NOT UP TO THE CHALLENGE

- Ventilation introduced through a mixing process
  - Inefficient, thermodynamically indistinguishable from infiltration
  - Reduces system efficiency
    - Limits effectiveness of energy recovery
    - Prevents application of process synergism
  - Increases total air delivery rates required to meet space ventilation requirements
    - Typically uses terminal reheat to maintain comfort in over-ventilated spaces
    - Terminal reheat is an energy wasting function
  - Makes ventilation management
    - Expensive due to increased system and control complexity
    - Difficult or impossible to accomplish without expensive controls
    - Unreliable in actual use
  - Increases exposure to IAQ litigation

CLASSICAL HVAC SYSTEMS ARE NOT UP TO THE CHALLENGE

- Ineffective humidity control - summer and winter
  - Promotes low winter humidity conditions
    - Promotes respiratory problems
    - Requires expenditure of virgin energy resources to provide winter humidity control
  - Without reheat, produces high summer relative humidity conditions
    - Promotes growth of mold and mildew
  - With reheat, consumes excessive energy to maintain acceptable summer relative humidity conditions

CLASSICAL HVAC SYSTEMS ARE NOT UP TO THE CHALLENGE

- Requires greater energy consumption
  - Central air conditioning basic configuration causes a bias toward cooling
  - Requires up to 5 times more hours of refrigeration use
- Limits energy conservation potential
  - Unable to make use of low-grade internally generated heat from lights, equipment and people
  - Unable to use displacement ventilation
  - Unable to make use of available latent energy potential
  - Requires higher air delivery rates

EVOLVING SOLUTIONS

- Separate ventilation and thermal control functions
- Humidity control prevents biological growth
- Indirect evaporative cooling displaces refrigeration for 80% of cooling loads
- Thermal storage saves money

STRATEGY
HIGH PERFORMANCE HVAC DESIGNS

- Separation of heating, cooling and ventilation functions
- Efficiently process ventilation
- Effectively manage ventilation
- Minimize impact of mechanical refrigeration
  - EER's in the 40's are possible
  - SEER's in the 70's are possible
  - Thermal storage flattens electrical demand
- Maximize periods of near zero energy usage
- Control building pressurization
  - Keep moisture from condensing inside the walls
  - Control infiltration

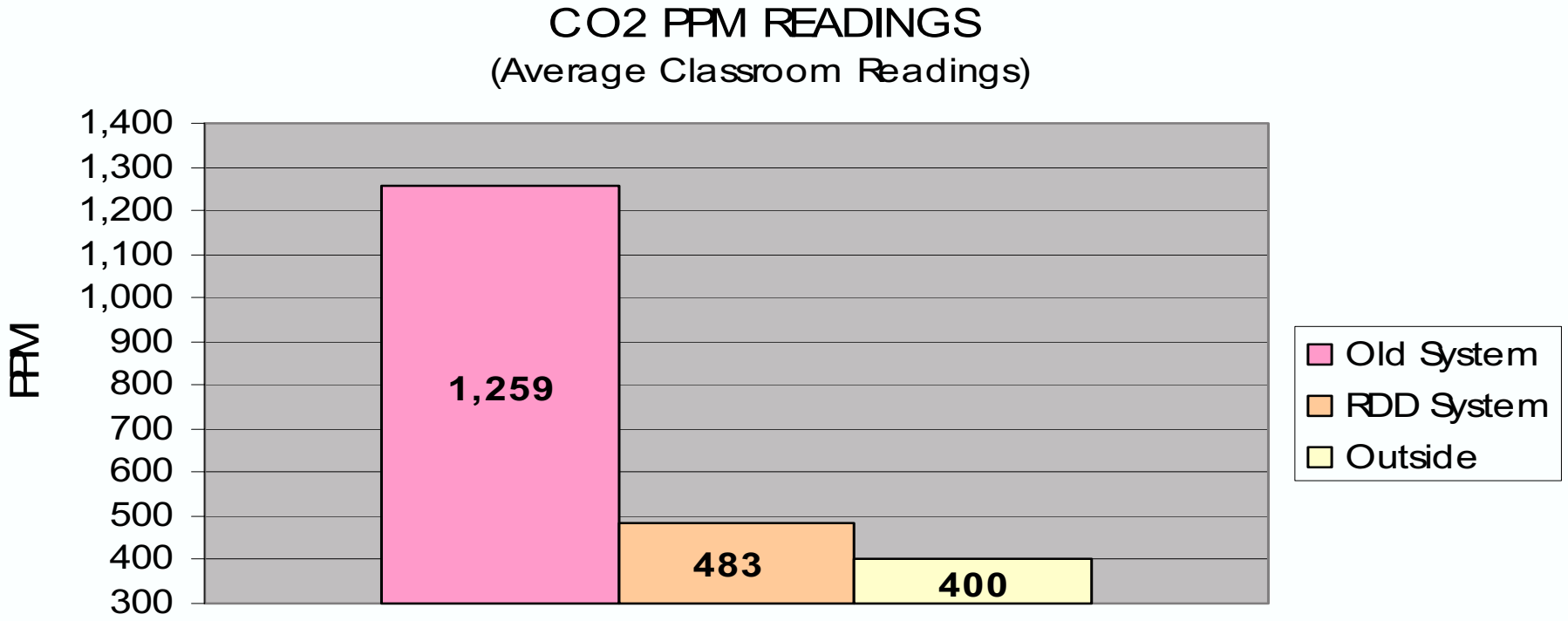
HIGH PERMORMANCE
HVAC TECHNIQUES

- Separating thermal control and ventilation functions
  - Dual path ventilation
  - Displacement ventilation
- Full range, multi-stage energy recovery
  - Efficient processing of 100% outside air for ventilation
  - Prioritizes use of recover energy assets before virgin fuels
  - Permits synergism to be created between technologies
  - Multi-function equipment which reduce first costs
  - Amplifies recovery potential for cooling and heating
- Thermal storage
  - Minimizes refrigeration plant size
  - Reduces electrical demand

CASE STUDY ONE

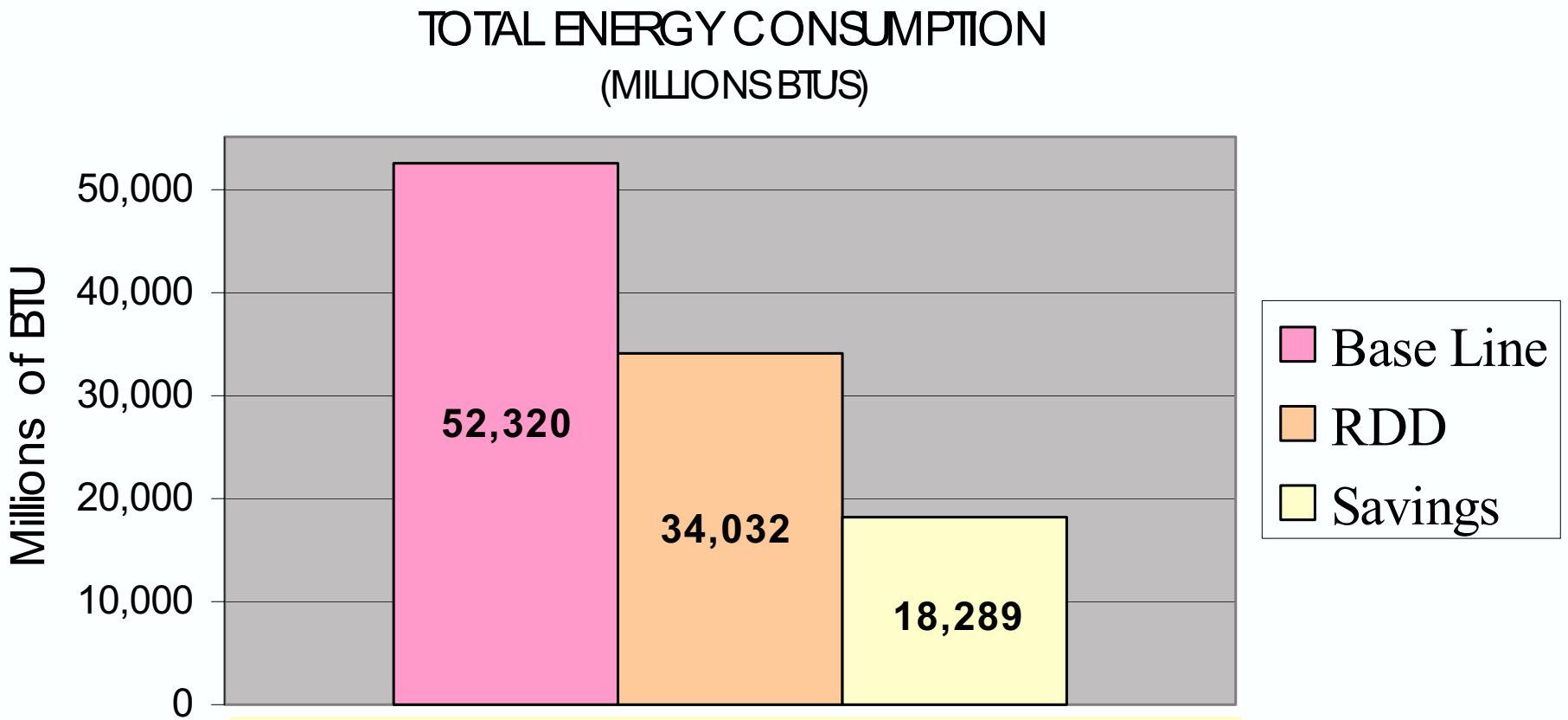
WAUSAU WEST

INDOOR AIR QUALITY



260% CO_2 Reduction

CASE STUDY ONE
WAUSAW WEST
TOTAL ENERGY CONSUMPTION

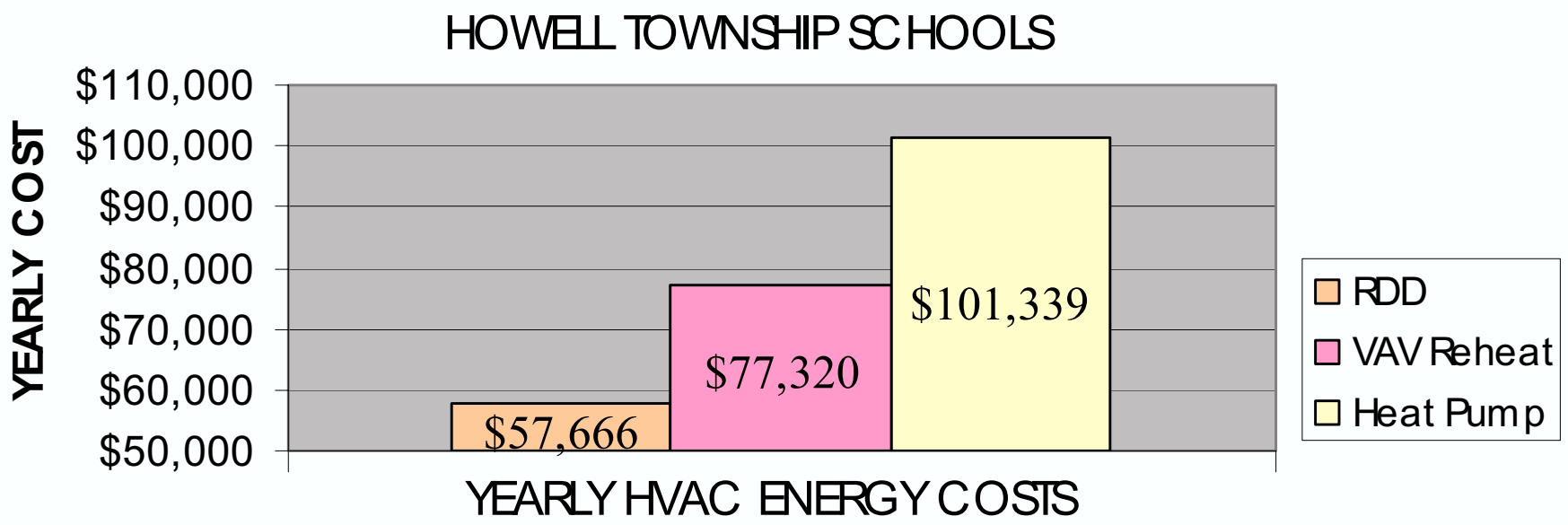


35% Energy Reduction

CASE STUDY TWO

HOWELL SCHOOLS

YEARLY HVAC ENGERY COSTS



25% to 45% Energy Reduction

CLINTONVILLE ENERGY USE SUMMARY

UTILITY USE ANALYSIS			
CLIENT		Clintonville	
FACILITY		High School	
AREA		212000	(SF)
ELECTRICITY USED (Kwh)		2042666	(kWH)
NATURAL GAS USED (Therms)		109801	(Therms)
GROSS ENERGY USE (Kwh)		5259806	(kWH)
GROSS ENERGY USE (Therms)		179517	(Therms)
GROSS ENERGY USE		84678	(Btu/SF/yr)
ELECTRICITY COST		$ 116,125	($/yr)
NATURAL GAS COST		$ 74,002	($/yr)
GROSS ENERGY COSTS		$ 190,128	($/yr)
GROSS ELECTRICAL ENERGY COSTS		$ 0.5478	($/SF/yr)
GROSS NATURAL GAS ENERGY COSTS		$ 0.3491	($/SF/yr)
GROSS ENERGY COSTS		$ 0.8968	($/SF/yr)
POOL ENERGY USE (Kwh)			(Kwh)
ESTIMATED POOL WATER HEATING ENERGY USE (Therms)		32080	(Therms)
ESTIMATED POOL WATER HEATING COST		$ 21,621	($/yr)
ESTIMATED POOL WATER HEATING COST		$ 0.1020	($/SF/yr)
ENERGY USE (kWH)		939945	(kWH)
ENERGY USE (THERMS)		32071	(Therms)
POOL WATER HEATING ENERGY USE (Btu/SF)		15132	(Btu/SF/yr)
NET BUILDING ELECTRICAL ENERGY USE		2042666	(kWH)
NET BUILDING NATURAL GAS ENERGY USE		77721	(Therms)
NET BUILDING ENERGY USE		$ 168,507	($/yr)
NET BUILDING ELECTRICAL ENERGY COSTS		$ 116,125	($/SF/yr)
NET BUILDING NATURAL GAS ENERGY COSTS		$ 52,381	($/SF/yr)
NET BUILDING ENERGY COSTS		$ 0.7948	($/SF/yr)
NET BUILDING ENERGY USE (W/SF)		20377	(W/SF/yr)
NET BUILDING ENERGY USE (Btu/SF)		69550	(Btu/SF/yr)

DIRECT ENERGY USE COMPARISON
ORRS vs. SCHOOL "A"

	School Energy Use Analysis							February 17, 2004	
	School:	**Sq. Ft.**			One KWH =	3412.142	BTU		
	Rockton MS	**99,771**							
	School A	**117,000**							
				Energy Use					
	Rockton				School A				
	Gas - Therms	Electric - KWH	Gas - Cost	Electric - Cost	Gas - Therms	Electric - KWH	Gas - Cost	Electric - Cost	
Totals:	36,663	614,600	$27,347.78	$36,048.07	118,612	1,962,400	$95,651.06	$120,611.88	
Total BTU:	3,666,300,000	2,097,102,473			11,861,200,000	6,695,987,461			
Total For Building:		5,763,402,473		$63,395.85		18,557,187,461		$216,262.94	
Total BTU per Sq Ft per year:		57,766				158,608			
Total cost per Sq Ft per year:				$0.6354				$1.8484	