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Making It All Work: Important Aspects of HVAC Zero Energy Design

SMNR 49: The Process for Zero Energy K-12 Schools: The Next Series of ASHRAE Advanced Energy Design Guides

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LEARNING OBJECTIVES

- Describe a process for creating a zero energy school
- Apply a set of Energy Use Intensity targets to achieve a zero energy school
- Provide an overview of the Advanced Energy Design Guide for Zero Energy Schools
- Describe the interactions between envelope, lighting, plug loads and HVAC design and the integrated roles that architects and engineers should follow to achieve low-energy design

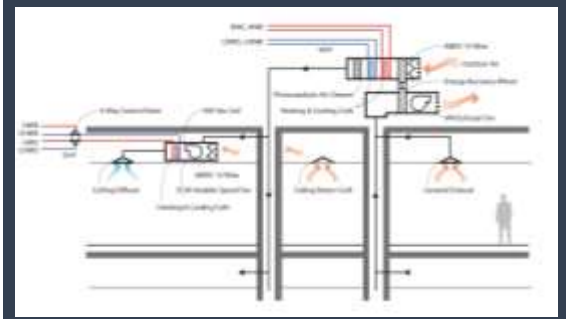
INTEGRATED DESIGN

- Reduced Heating and Cooling Loads
  - Architecture
  - Program
- Utilize Environmental Resources
  - Daylighting
  - Natural Free Cooling/Ventilation
- Improve Efficiency of Active Systems
  - Optimized HVAC Systems
  - Optimized Lighting Systems
- Utilize Renewable Energy Resources
  - Photovoltaics
  - Wind

HVAC

- Maximize full and part load efficiency.
- Demand controlled ventilation.
- Separate ventilation/dehumidification and temperature control.
- Air-to-air energy recovery.
- Transport conditioning with refrigerant or water, not air.
- Exploit natural conditioning sources.
- Condition people, not spaces.
- Eliminate reheat.
- Rightsize systems and components; quantify uncertainties; avoid blanket safety factors.

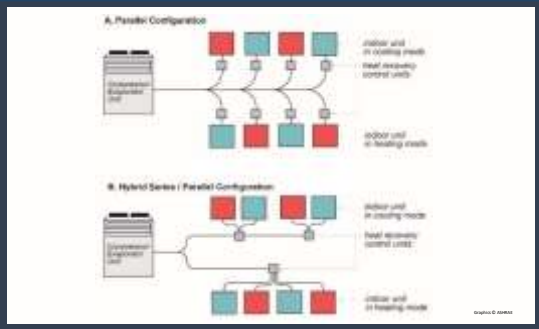
HVAC: DEDICATED OUTDOOR AIR SYSTEMS



HVAC: WATER CHILLER AND DEDICATED OUTDOOR AIR SYSTEM (DOAS) PERFORMANCE REQUIREMENTS

Dedicated outdoor air systems (DOAS) for all systems	
Exhaust -air energy recovery in DOAS **	A (humid) and C (marine) zones: 72% enthalpy reduction B (dry-zone): 72% dry-bulb reduction
DOAS ventilation control	DCV with VSD
Chillers with Air Handlers and DOAS	
Air cooled chiller efficiency **	Comply or exceed ASHRAE 189.1-2017 Path B ≥9.78 EER, and ≥ 15.8 IPLV
Water cooled chiller efficiency **	Comply or exceed ASHRAE 189.1-2017 Path B
Compressor capacity control	multi-stage or variable speed driven compressor
Boiler Efficiency *	Condensing boiler, 92% efficiency

HVAC: VARIABLE REFRIGERANT FLOW (VRF) MULTI-SPLIT HEAT PUMPS



HVAC: AIR SOURCE HEAT PUMP PERFORMANCE REQUIREMENTS

VRF heat pump with DOAS	
Air Cooled VRF multisplit with heat recovery (cooling mode) **	Comply or exceed ASHRAE 189.1-2017 <65,000 Btu/h; 15.0 SEER; 12.5 EER ≥65,000 Btu/h and <135,000 Btu/h; 11.1 EER; 14.4 IEER ≥135,000 Btu/h and <240,000 Btu/h; 10.7 EER; 13.7 IEER <240,000 Btu/h; 10.1 EER; 12.5 IEER
Air Cooled VRF multisplit with heat recovery (heating mode) **	Comply or exceed ASHRAE 189.1-2017 <65,000 Btu/h; 8.5 HSPF ≥65,000 Btu/h and <135,000 Btu/h; 3.4 COP ≥135,000 Btu/h; 3.2 COP

GROUND COUPLED HEAT PUMP

Use water-to-water heat pumps for kitchen service hot water to help achieve annual thermal balance with the ground mass

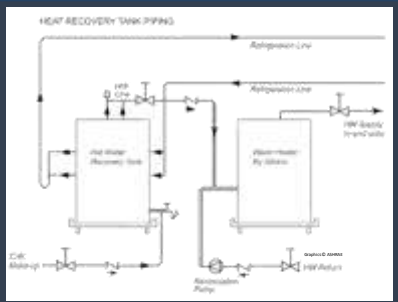
HVAC: WSHP AND GSHP PERFORMANCE REQUIREMENTS

Use VSD pumps, automatic shut-off valves for heat pumps and intelligent controls to minimize pump energy consumption

SERVICE WATER HEATING

- Use heat recovery and/or heat pump or gas-fired large tank type systems for larger uses (kitchens).
- Locate small tank type electric heaters immediately adjacent to distributed small uses (hand wash sinks).
- Minimize jacket losses; avoid recirculation pumps for instant delivery.
- Insulate hot water pipes.
- Utilize water-sense appliances.
- Consider chemical sanitizing to enable reduction in dishwasher water temperature.

SERVICE WATER HEATING



Heat Recovery from Refrigeration for domestic water preheat

COMMERCIAL REFRIGERATION

- Select most efficient packaged refrigeration equipment.
- Specify ECM condenser and evaporator fans.
- Maximize part load efficiency with floating head pressure and variable setpoint control.
- Maximize insulation for walk-in and reach-in cooler and freezer boxes.
- Specify automatic door closers and effective door seals for walk-in.
- Maximize floor insulation for site-built boxes.

COMMERCIAL REFRIGERATION

KITCHEN EQUIPMENT

HEAT THE FOOD AND NOT THE ROOM.

- Maximize heat and emissions capture by proper location of cooking appliances.
- Use convection combi-ovens with highly insulated cabinets.
- Use directly heated and insulated tureens.
- Use inductive cooktops with small pans only.
- Use warming tables with recirculating water.
- No open grilles.
- No open deep fat fryers.
- No gas-fired or electric resistance cooktops.

LESS HEAT AND SMOKE MEANS LESS EXHAUST AND MAKE-UP AIRFLOW.

KITCHEN EQUIPMENT

RENEWABLE ENERGY SYSTEMS

AEDG IS NOT A RENEWABLE ENERGY SYSTEMS DESIGN GUIDE

- Size array based on optimized building EUI.
- Configure roof for warranty-sensitive installation of photovoltaic panels.
- Locate panels for best orientation and avoidance of shadowing.
- Configure electrical distribution system to accept power input from PV system.
- Negotiate power contract with local utility.
- Anticipate “unanticipated” factors that reduce production

RENEWABLE ENERGY SYSTEMS

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