

Cranbury Elementary School HVAC and Sustainable System Options



Presented by:
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HVAC System Selection Criteria

Key Factors:

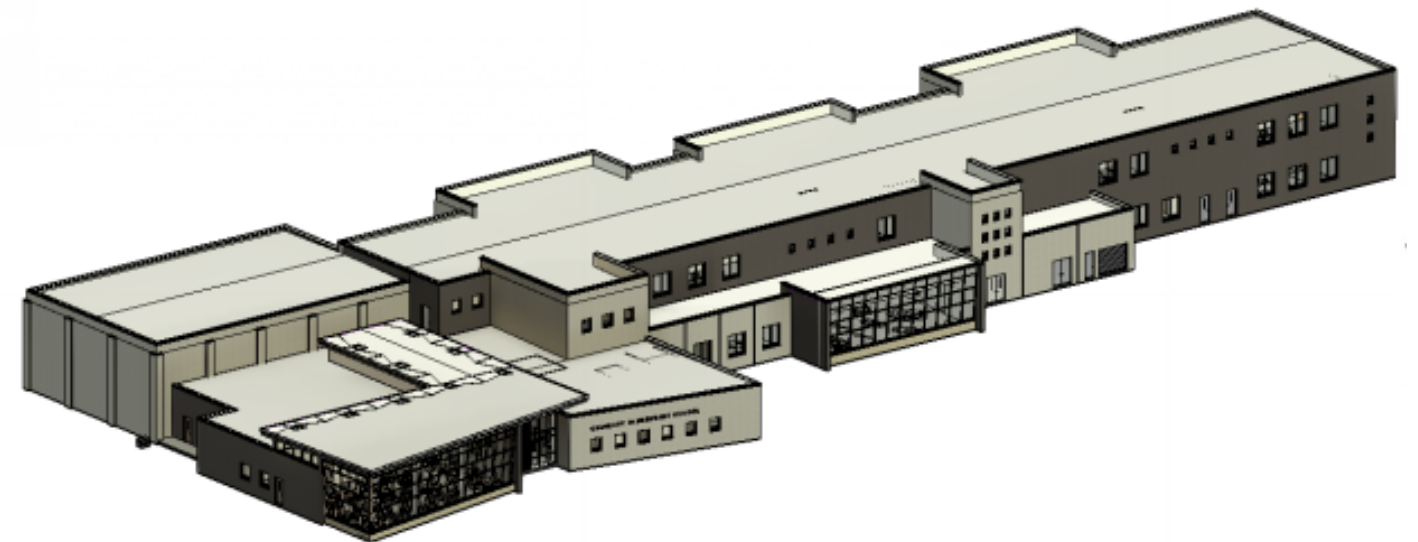
- Occupant Thermal Comfort
- Indoor Air Quality
- System Noise
- Maintenance
- Reliability
- First Cost / Return on Investment
- Energy Efficiency / Environmental Impact



HVAC System Selection Criteria

Building Characteristics

- Size, Shape, Orientation, Envelope Constraints
 - Window U-values and SHGC
 - Wall, roof and floor sections
 - Building sections
- Facility Usage
 - Building Type
 - Hours of operation
 - Occupancy
- Building Properties
 - Specialized Spaces, Functions, and Environmental Considerations



Specific Criteria to Consider for Cranbury

Challenges

- Natural gas not available
- Septic field
- Wetlands
- First cost

Opportunities

- All new building, new thermal envelope



HVAC System Options

1

Heat pumps option:

- VRF Heating & Cooling
- Heat Pump DOAS & AHUs
- Electric Heaters
- No geothermal
- No boiler plant

2

Mostly heat pumps option:

- VRF Heating & Cooling
- Propane boilers
- DX/HW DOAS & AHUs
- No geothermal
- 1,500 MBH boiler plant

3

Geothermal option:

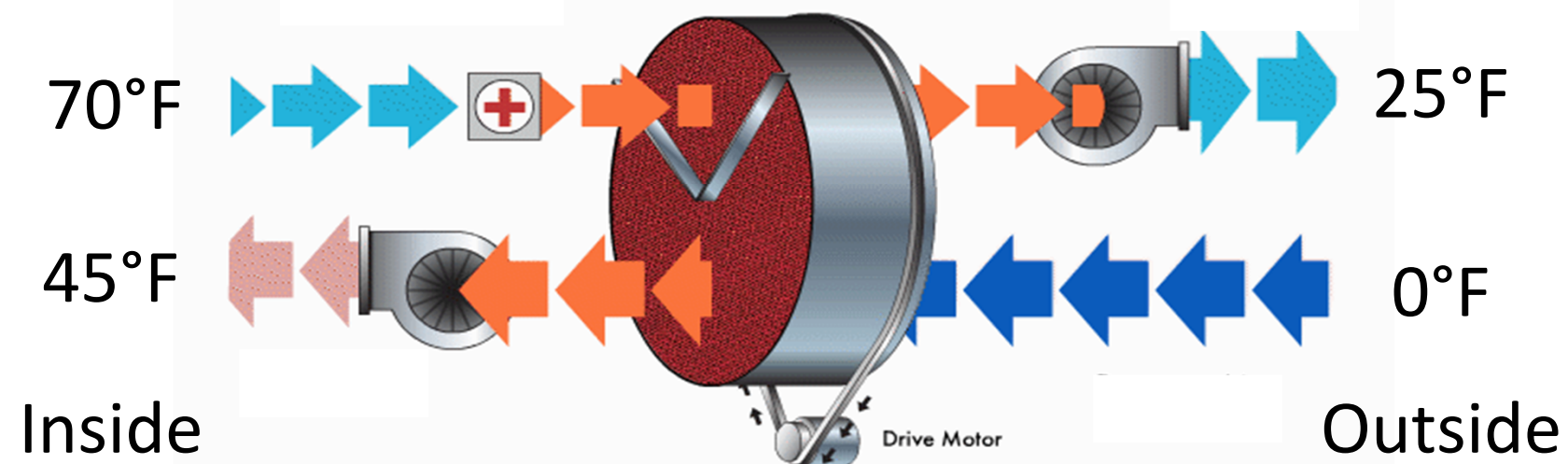
- Full geothermal system
- Chilled beams
- CHW/HW DOAS & AHUs
- 75 bore geo field
- 500 MBH backup boiler



HVAC Systems Common to All Options

Dedicated Outdoor Air System (DOAS)

- Direct ducted ventilation air to each space
- Direct ducted exhaust air from each space
- No mixing of air from different spaces
- Smaller duct systems ~400 CFM per classroom instead of 1,000 CFM
- Total energy recovery



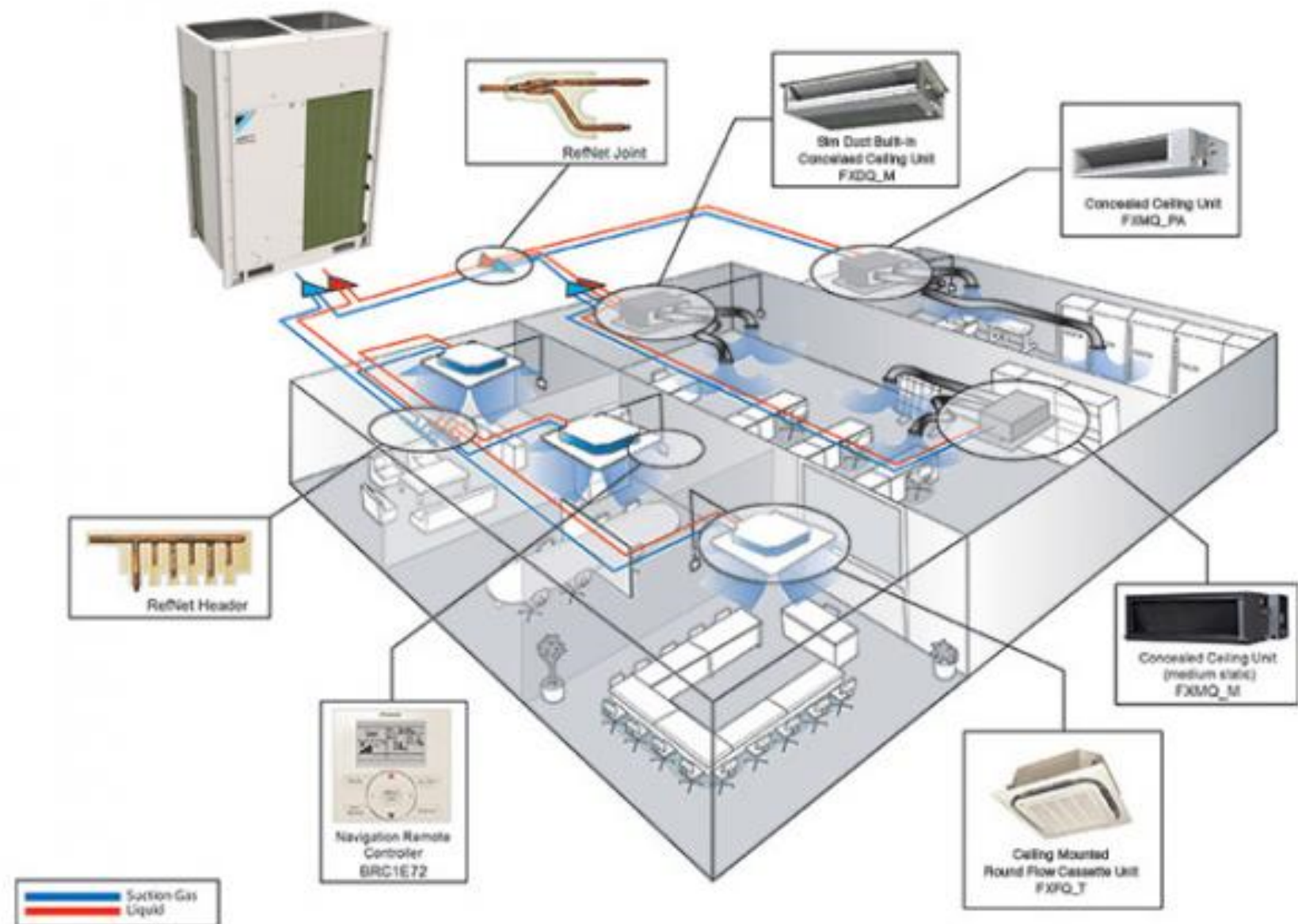
Heat Pumps / Variable Refrigerant Flow (VRF)

Benefits

- Efficiency
- Occupant comfort
- Low noise levels
- Low first cost
- Known to the district

Considerations

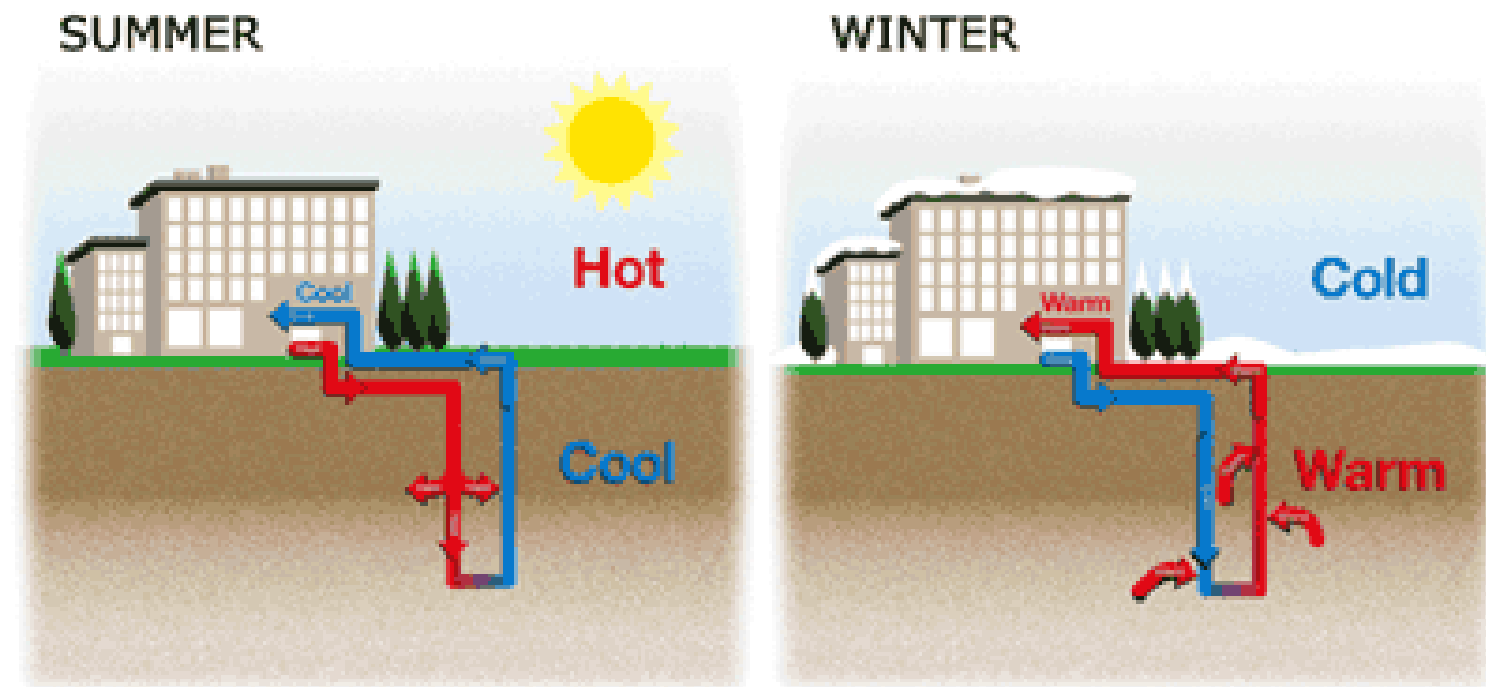
- Distributed compressors
- Proprietary system
- Maintenance



Geothermal

Water-to-water heat pumps

- Create hot and chilled water to distribute throughout the building
- Can create hot and chilled water simultaneously, very efficiently
- Boiler can be added for backup heating



HVAC Options Comparison

1 – Heat Pumps

Air-source VRF for all areas except gym and cafeteria

DOAS with heat pump
cooling/heating/dehumidification

AHUs with heat pump
cooling/heating/dehumidification

Electric cabinet heaters and unit heaters

Benefits:

- Highly efficient heat pumps
- Lower overall site energy usage
- Low first cost

Drawbacks:

- Significant backup power for heating
- Higher energy cost
- Slightly less precise heating control with heat pump DOAS and AHU

2 – Mostly Heat Pumps

Air-source VRF for all areas except gym and cafeteria

DOAS with DX cooling/dehumidification
and hot water heating

AHUs with DX cooling/dehumidification
and hot water heating

Hot water cabinet heaters and unit heaters

Benefits:

- Highly efficient heat pumps for most of building
- Less backup power for heating
- Best heating control with hot water in DOAS and AHUs
- Low energy cost

Drawbacks:

- Requires propane tanks and piping

3 – Geothermal

Geothermal wells

Water-to-water heat pumps making
chilled/hot water

Chilled beams

DOAS with chilled/hot water coils

AHUs with chilled/hot water coils

Hot water cabinet heaters and unit heaters

Benefits:

- All electric
- Lowest overall site energy usage
- Excellent control and comfort

Drawbacks:

- Significant backup power for heating
- Higher first cost



Conceptual Life Cycle Cost Comparison

	1 Heat Pumps	2 Mostly Heat Pumps	3 Geothermal
First cost for HVAC	<u>Lowest</u>	~ 5% more	~ 30% more
Annual energy use	12% more	14% more	<u>Lowest</u>
Annual energy cost	18% more	5% more	<u>Lowest</u>
Approximate Payback	-	~ 7 years	~ 35-40 years



Photovoltaic (PV) System Conceptual Estimates

How much of the total building's power use can we offset?

Heat pumps option annual electricity consumption: **~570 MWh**

Mostly heat pumps option annual electricity consumption: **~520 MWh**

Potential annual PV electricity production: **~136 MWh**



Alternative Energy Options Considered

Fuel cells

- Requires natural gas

Micro-turbines

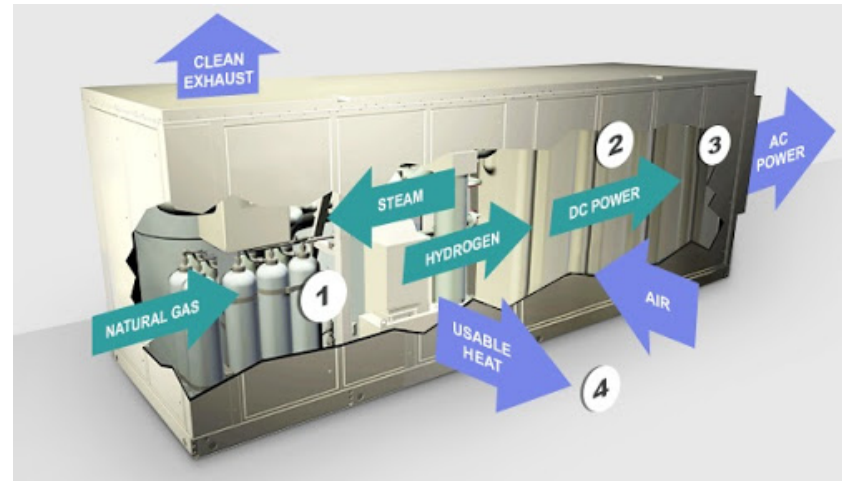
- Requires natural gas

Wind

- Prohibitively expensive

Solar Hot Water

- Roof area better served by PV



Questions?



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