HVAC Systems Overview
LEED and NZE Review

WESTWOOD Public Schools

Hanlon Elementary School
Westwood, MA

October 8, 2020

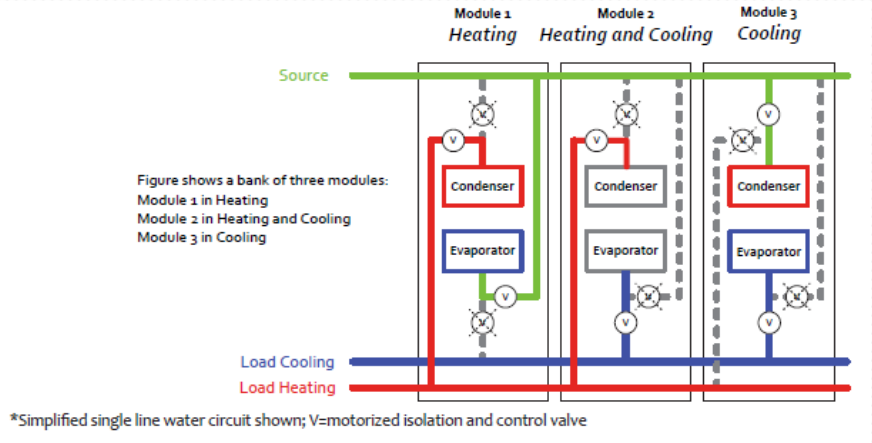
DORE + WHITTIER

Garcia, Galuska & DeSousa
Consulting Engineers Inc.
375 Faunce Corner Road, Suite D, Dartmouth, MA 02747-1258

The Green Engineer
Sustainable Design Consulting

Ground Water Source Heat Recovery Heat Pump Chiller/Heater Plant

Modular Heat Recovery Heat Pump Chillers



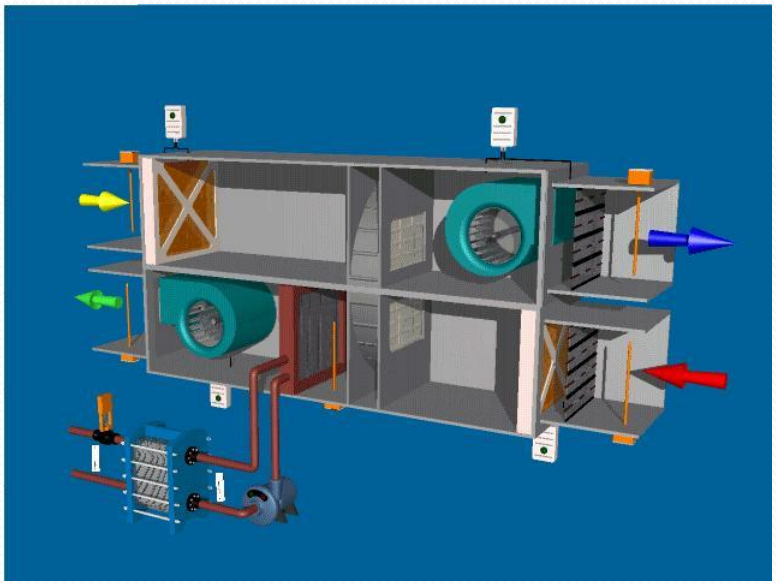
BENEFITS:

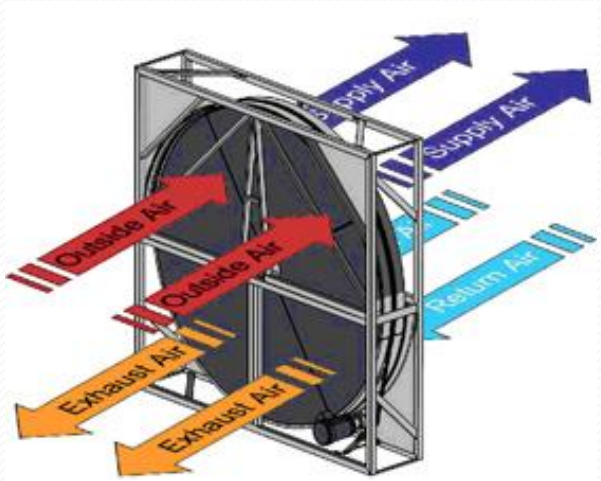
- High-efficiency
- Modular design provides level of redundancy & individual module control
- Heat recovery provides reheat during cooling season
- Maneuverable – All modules fit through 36” door and have low center of gravity with base cutouts for pallet jacks/forklifts
- Durability & Reliability
- Service friendly with easy access to all major components
- Fossil Fuel Free - Zero combustion design

Ground source - Closed Loop Geothermal Well Field

Vertical closed loop wells are used to provide ground source condenser water to heat recovery heat pump chiller plant, which is used to provide hot water heating and chilled water cooling

Air Handling Units for Displacement Systems





Features:

- **Hot Water Heating & Chilled Water Cooling**
- **Variable Speed Airflow Control**
- **Energy Recovery Ventilation**
- **MERV-14 Supply Filtration**
- **CO_2 demand Ventilation Control**
- **Lower Noise Levels – No Compressors or Condenser Fans**

Air Handling Unit Zone Roadmap Level 1

DORE + WHITTIER

DORE + WHITTIER ARCHITECTS, INC.

MASSACHUSETTS
265 MERRIMAC ST, BUILDING 7, 2ND FLOOR
NEWBURYPORT, MA 01950
P: 978-499-2999

VERMONT
212 BATTERY STREET
BURLINGTON, VT 05401
P: 802.863.1428

WESTWOOD HANLON ELEMENTARY SCHOOL

790 GAY STREET
WESTWOOD, MA 02090

PROJECT NUMBER 19-0798

SEAL AND SIGNATURE

REVISIONS

NO.	DATE	TITLE

ISSUE TITLE AND DATE
Project Status
Issue Date

KEY PLAN

ORIENTATION AND SCALE

PROJECT NORTH

SHEET TITLE
HEATING & COOLING ZONES - LEVEL 1

SHEET NUMBER
M0.0

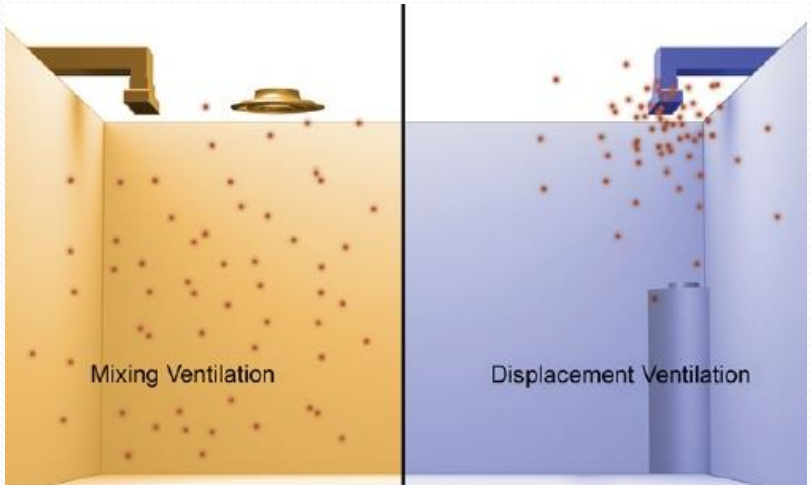
Air Handling Unit Zone Roadmap Level 2

Displacement Ventilation System Benefits

- **High Ventilation Effectiveness & Pollutant Removal**: Supply airflow distributed at slightly lower discharge air temperature, low velocity and low within space to generate an upward "displacement" movement of airflow when the ventilation contacts heat generating sources (i.e. People, Lights, Equipment)

- **Load Reduction** - Results in ***Smaller equipment & systems and lower installed and operating costs*** for Displacement Systems, because only the Occupied Zone is Conditioned.

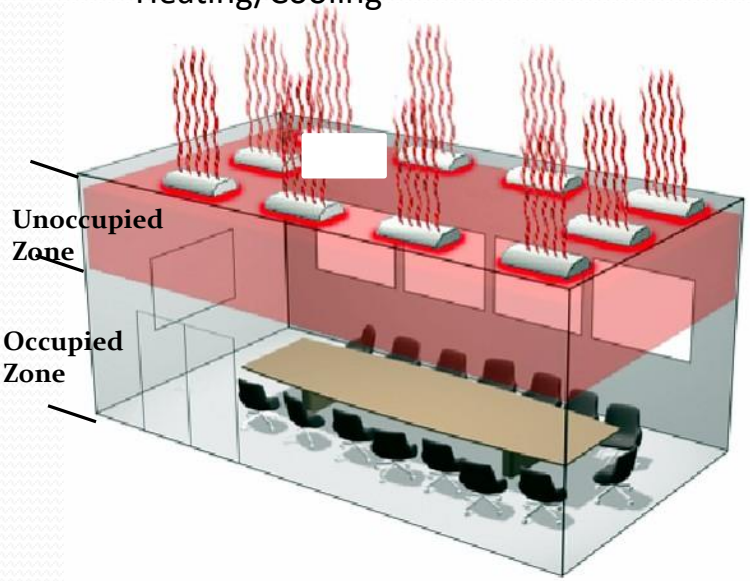
- **Low Noise Operation**



Mixed Systems E_c= 0.8

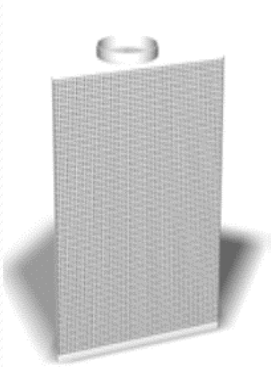
DV Systems E_c=1.2 - 1.4

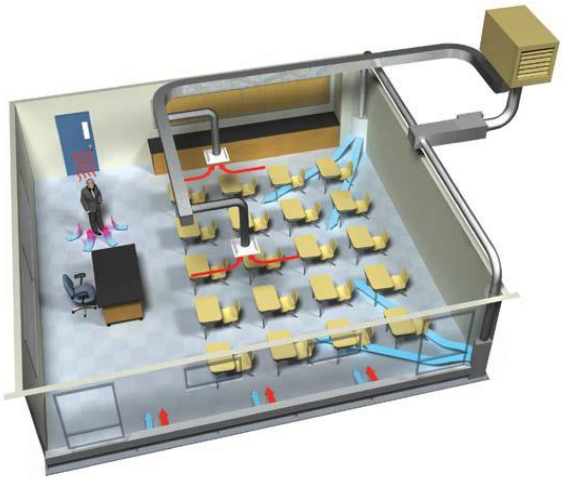
- **Energy Efficient:**
  - Energy Recovery: Transfers energy from the return air stream to the supply air stream to pre-heat or pre-cool the outside air.
  - Variable Air Volume w/ CO2 Demand Control Ventilation: Modulates the airflow to large single zone areas in accordance to space mounted thermostat and CO2 sensors reducing energy consumption due to reduced air changes. CO2 can be over-ridden to provide increased outdoor airflow
  - Perimeter Radiation Heating & Cooling – Allows use of Hydronic Heating / Cooling system for Night Setback and Supplemental Heating/Cooling



Space Level HVAC Systems & Equipment

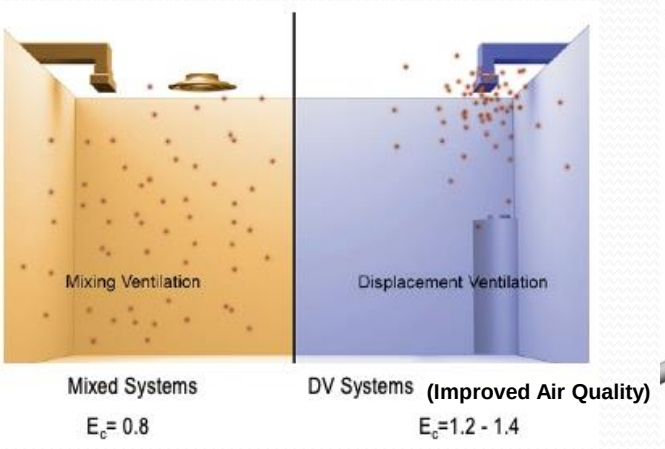
- Wall mounted Combination Thermostat
  - Controls variable air volume box for:
    - Heating
    - Ventilation
    - Cooling
  - Also controls heating/cooling from ceiling mounted radiant panels
  - Slide/incremental adjustment of setpoints:
    - Heating 70 deg F +/- 2 deg F
    - Cooling 75 deg F +/- 2 deg F
  - Space level CO2 and Humidity reading
- Displacement diffuser:
  - Provides supply/ventilation air to the space
  - Supply air will vary based on reading from wall mounted thermostat
- Radiant Heating/Cooling Panels:
  - Provides supplemental heating and cooling.

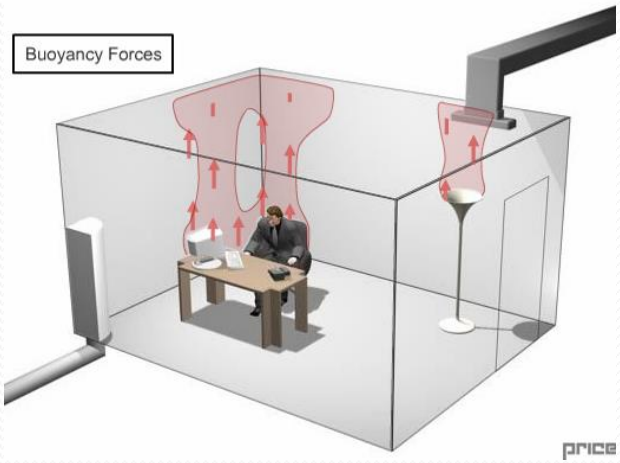




Current Proposed HVAC System Design Benefits for Mitigation of Airborne Pathogens:

- HVAC system provides ventilation rates that meet or exceed ASHRAE 62.1-2016 and International Mechanical Code (IMC) 2018 ventilation requirements.
- Air handling units are capable of 100% outside airflow.
- Air handling unit ventilation distribution systems are provided with MERV-14 filters (ASHRAE recommendation for new School design).
- Classroom areas have displacement ventilation which has increased ventilation effectiveness (20-40% better) versus other overhead mixed air systems.
- Excellent Pollutant Removal: With Displacement Systems, there is no airflow mixing at the space level. Airflow moves upward towards ceiling exhaust point and pollutants are removed from the occupied zone.
- HVAC system controlled by Building Automation system which can schedule occupied/unoccupied periods, over-ride CO2 demand ventilation controls to provide increased fresh air ventilation.
- Other Benefits: Low noise operation; reduced cooling loads & high energy efficiency





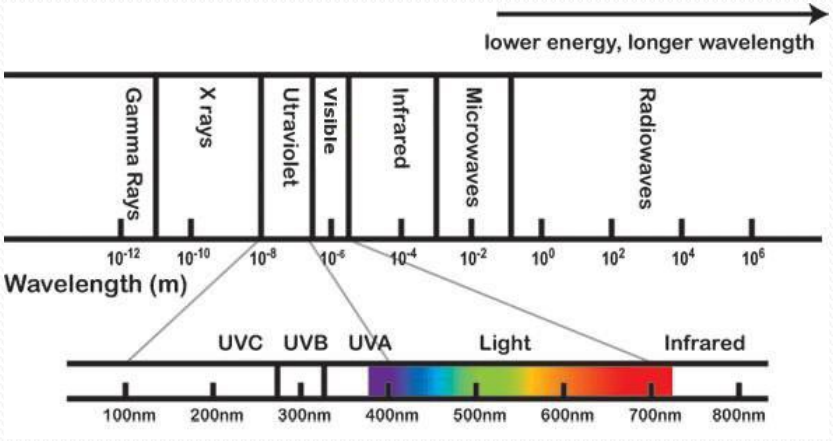
BAS Interface

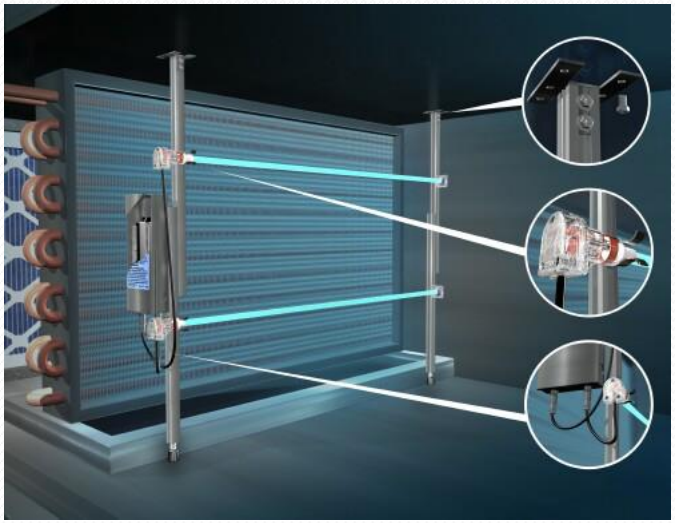
HVAC System – UV-C technology

Potential addition of UV-C system to RTUs

Benefits:

- UV-C has very short wavelengths and is therefore extremely energetic.
- UV-C, aka Germicidal UV, de-activates microorganism DNA/RNA to stop reproduction.
- UV-C system when placed near cooling coils will continuously clean coils, helping to maintain efficiency. Reduces coil cleaning costs.
- Minimum fan energy pressure drop penalty
- Can be unit or duct mounted
- Proven Technology
- Approximate 90%+ kill rate effectiveness when used with high efficiency filter and typical design ventilation airflow rates (CO2 demand controls should be over-ridden)
- Industry Test Data available (ASHRAE Standard 185.1)
- Use with High efficiency filter increases effectiveness (MERV-13 minimum, MERV-14 (preferred by ASHRAE)



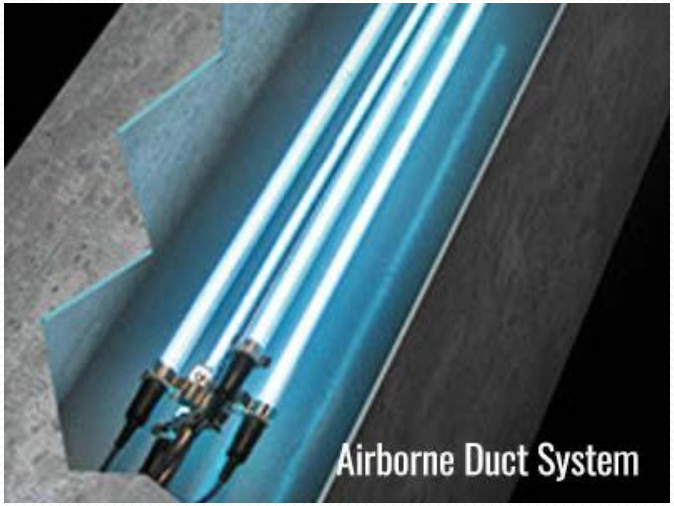


HVAC System – UV-C technology

Potential addition of UV-C system to RTUs

Cons:

- Additional maintenance costs
- Additional precautions must be taken by maintenance staff to avoid exposure to UV-C and Mercury vapor located in emitters
- Under normal operation UV-C system will not expose occupants to UV-C, Mercury vapors or Ozone; However equipment must be properly maintained to ensure safe operation.
- Not all manufacturers are equivalent in terms of technology and efficiency



Costs:

- First Cost = Approximately $0.70 / SF Installed
- Maintenance Cost = Approximately $0.10 / SF for emitter inspection/changes (Emitters last 9000 hours)
- Energy Costs = negligible increase energy cost

Westwood Hanlon LEED

LEED v4 for BD+C: Schools
Project Checklist

Project Name: **Westwood Hanlon ES**
Date: **10.7.20**

Y	?	N				
1	**0**	**0**	**Integrative Process**			**1**
1			Credit	Integrative Process		1
Y	**?**	**N**				
3	**6**	**6**	**Location and Transportation**			**15**
		N	Credit	LEED for Neighborhood Development Location		15
1			Credit	Sensitive Land Protection		1
1	1		Credit	High Priority Site		2
1	1	3	Credit	Surrounding Density and Diverse Uses (RP@4)		5
	2	2	Credit	Access to Quality Transit (RP@1)		4
		1	Credit	Bicycle Facilities		1
	1		Credit	Reduced Parking Footprint		1
	1		Credit	Green Vehicles		1
Y	**?**	**N**				
4	**7**	**1**	**Sustainable Sites**			**12**
Y			Prereq	Construction Activity Pollution Prevention		Required
Y			Prereq	Environmental Site Assessment		Required
1			Credit	Site Assessment		1
	2		Credit	Site Development - Protect or Restore Habitat (RP@2)		2
1			Credit	Open Space		1
	3		Credit	Rainwater Management		3
	2		Credit	Heat Island Reduction		2
1			Credit	Light Pollution Reduction		1
		1	Credit	Site Master Plan		1
1			Credit	Joint Use of Facilities		1
Y	**?**	**N**				
3	**9**	**0**	**Water Efficiency**			**12**
Y			Prereq	Outdoor Water Use Reduction		Required
Y			Prereq	Indoor Water Use Reduction		Required
Y			Prereq	Building-Level Water Metering		Required
1	1		Credit	Outdoor Water Use Reduction		2
2	5		Credit	Indoor Water Use Reduction		7
	2		Credit	Cooling Tower Water Use		2
	1		Credit	Water Metering		1
Y	**?**	**N**				
22	**9**	**0**	**Energy and Atmosphere**			**31**
Y			Prereq	Fundamental Commissioning and Verification		Required
Y			Prereq	Minimum Energy Performance		Required
Y			Prereq	Building-Level Energy Metering		Required
Y			Prereq	Fundamental Refrigerant Management		Required
5	1		Credit	Enhanced Commissioning		6
14	2		Credit	Optimize Energy Performance (RP@8)		16
	1		Credit	Advanced Energy Metering		1
	2		Credit	Demand Response		2
3			Credit	Renewable Energy Production (RP@2)		3
	1		Credit	Enhanced Refrigerant Management		1
	2		Credit	Green Power and Carbon Offsets		2

Y	?	N				
3	**8**	**2**	**Materials and Resources**			**13**
Y			Prereq	Storage and Collection of Recyclables		Required
Y			Prereq	Construction and Demolition Waste Management Planning		Required
	5		Credit	Building Life-Cycle Impact Reduction (RP@2)		5
1	1		Credit	BPDO - Environmental Product Declarations		2
	1	1	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials		2
1		1	Credit	Building Product Disclosure and Optimization - Material Ingredients		2
1	1		Credit	Construction and Demolition Waste Management		2
Y	**?**	**N**				
6	**10**	**0**	**Indoor Environmental Quality**			**16**
Y			Prereq	Minimum Indoor Air Quality Performance		Required
Y			Prereq	Environmental Tobacco Smoke Control		Required
Y			Prereq	Minimum Acoustic Performance		Required
2			Credit	Enhanced Indoor Air Quality Strategies		2
2	1		Credit	Low-Emitting Materials		3
1			Credit	Construction Indoor Air Quality Management Plan		1
	2		Credit	Indoor Air Quality Assessment		2
	1		Credit	Thermal Comfort		1
1	1		Credit	Interior Lighting		2
	3		Credit	Daylight		3
	1		Credit	Quality Views		1
	1		Credit	Acoustic Performance		1
Y	**?**	**N**				
4	**2**	**0**	**Innovation**			**6**
1			Credit	Innovation: Resonsible Purchasing - Lamps		1
1			Credit	Innovation: Economic and GHG Analysis of Mechanical Systems		1
1			Credit	Innovation: Pilot - Integrative Analysis of Building Materials		1
	1		Credit	Innovation: TBD		1
	1		Credit	Innovation: TBD		1
1			Credit	LEED Accredited Professional		1
Y	**?**	**N**				
2	**2**	**0**	**Regional Priority (max of 4 points) Credit Names have been underlined**			**4**
		x	Credit	Surrounding Density and Diverse Uses (RP@4)		
	1		Credit	Access to Quality Transit (RP@1)		1
	1		Credit	Site Development - Protect or Restore Habitat (RP@2)		1
1			Credit	Optimize Energy Performance (RP@8)		1
1			Credit	Renewable Energy Production (RP@2)		1
	x		Credit	Building Life-Cycle Impact Reduction (RP@2)		

48	53	9	**TOTAL**	Possible Points: **110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

48	53	9	**TOTAL**

Certified: 40 to 49 points

The Green Engineer
Sustainable Design Consulting

Westwood Hanlon REC Primer

- RECs put the "Renewable" in Renewable Electricity
- REC = Renewable Energy Certificate are a mechanism to track the production of clean energy and represent the social and environmental benefit of the production of 1 MWh. These can be sold separately from the power itself.
- Electrons produced by a solar panel are no different than electrons produced by a coal-fired power plant or any other electricity generating technology.
- Renewable electricity generators, therefore, produce two distinct market commodities:
  - 1) electricity and
  - 2) RECs.
  - These commodities can be used and/or sold separately or together. The REC instrument embodies the environmental attributes of the underlying electricity generated from a renewable resource.
- Since Ameresco is selling the SRECs generated (or retained as part of SMART program) at Shuttleworth the power delivered to Westwood can no longer be formally considered "green".
- So, to formally claim NZE the town would have to rebuy RECs for the amount of renewable energy claimed.

Sources: https://www.epa.gov/sites/production/files/2017-09/documents/gpp-guidelines-for-making-solar-claims.pdf

What is a REC?

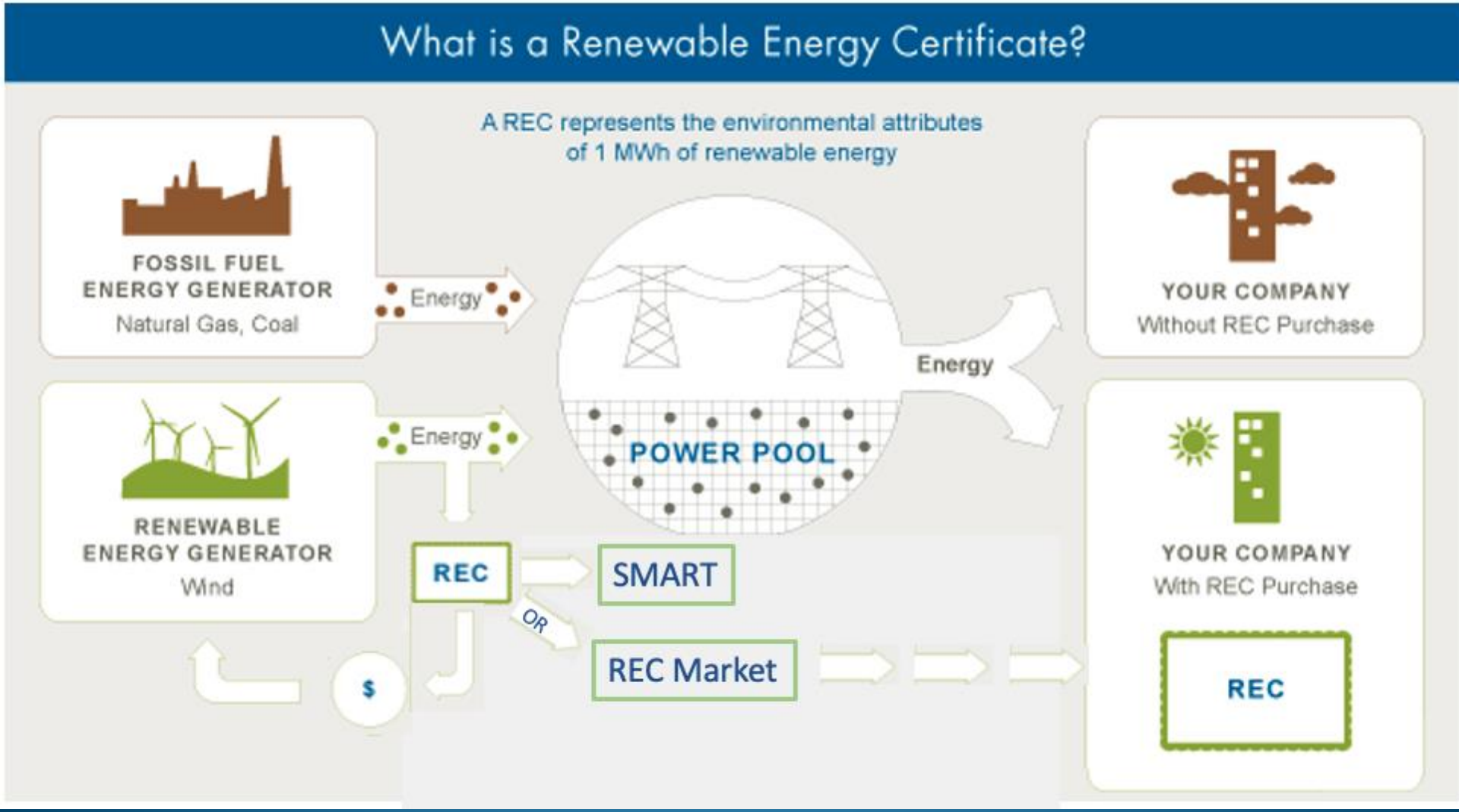
A **REC** is a tradeable, market-based instrument that represents the legal property rights to the "renewable-ness"— or all non-power attributes— of renewable electricity generation.

A REC is issued for every megawatt-hour (MWh) of electricity generated and delivered to the electric grid from a renewable energy resource.

The REC owner has exclusive rights to make claims about "using" or "being powered with" the renewable electricity associated with that REC and thus avoid the double counting of the same generation attributes by another party.

RECs are the instrument used to substantiate the use of renewable electricity for both voluntary and compliance purposes. For voluntary purposes, consumers such as residential households and businesses use RECs to demonstrate claims of using renewable electricity. For compliance purposes, RECs are used to track that utilities are meeting their state-imposed mandates.

Westwood Hanlon REC Arbitrage



Westwood Hanlon REC Arbitrage

- REC arbitrage (also referred to as a REC swap) is a procurement strategy used by electricity consumers to simultaneously meet two objectives:
  1) decrease the cost of their renewable electricity use and
  2) substantiate renewable electricity use and carbon footprint reduction claims.
- The strategy is used by consumers installing self-financed renewable electricity projects or consumers who purchase renewable electricity directly from a renewable electricity project, such as through a power purchase agreement (PPA).
- A prerequisite of REC arbitrage is that there are differences in REC prices.
- State renewable portfolio standard (RPS) policies are a major demand driver for RECs and consequently impact REC prices.

Cost of Buying RECs: Sample to repurchase RECs to offset 100% of electricity use

Tier 2	
Electrical	
kWh/yr	693,790
REC rate* ($/kWh)	$ 0.0012
Replacement $/yr	$ 832.55

Tier 3	
Electrical	
kWh/yr	766,320
REC rate* ($/kWh)	$ 0.0012
Replacement $/yr	$ 919.58

Sources: https://www.epa.gov/sites/production/files/2017-09/documents/gpp-guidelines-for-making-solar-claims.pd

What are Net Zero Energy Buildings?

- Currently, practitioners and policy-makers do not have a consensus-based definition of net zero energy, near net zero energy, or energy positive buildings.
- The most commonly referenced definition was developed by the U.S.DOE in 2015 (see Table 1).
- Although the U.S. Department of Energy's (DOE) and the Massachusetts DOER Zero Net Energy Buildings Task Force's definitions emphasize the use of renewable energy on-site, many stakeholders view off-site renewables as essential to achieving net zero energy given limited roof and open space.
- Emissions-based targets can be more feasible for existing facilities that have already made significant energy efficiency investments and/or have a mix of on- and off-site renewable power.

TABLE 1: Net Zero, Near Net Zero, and Energy Positive Definitiions

NET ZERO ENERGY	NEAR NET ZERO ENERGY	ENERGY POSITIVE
An energy efficient building which generates on-site renewable energy greater than the total amount consumed on-site.[18] —U.S. Department of Energy	**Buildings that may be designed to achieve one or more net zero definitions (e.g. net zero energy or emissions), but may not achieve a net zero energy in operations every year.**[19] —National Renewable Energy Laboratory	**Produce more energy from renewables (on- or off-site) than needed for energy consumption.**[20] —Boston Planning and Development Agency
Note: Some "net zero" definitions allow off-site renewable energy to be purchased to offset on-site use. The U.S. DOE refers to this as Renewable Energy Certificate—Zero Energy Building (REC-ZEB) . Similarly, some definitions consider "net zero carbon" or "net zero emissions" rather than energy use for their performance standard. These standards typically allow for off-site generation.	**Note:** There is no official federal definition of near net zero energy.	**Note:** In practice, some facilities that designate themselves energy positive do not use all building energy loads in their calculations.[21]

Westwood Hanlon NZE Classification

National Renewable Energy Laboratory NZE Classifications: In general, a project can claim to be NZE with either on or off-site PV (assuming RECs are retained or repurchased). They would be considered different "classes" or approaches, but all would be NZE.

NZE Classifications:

Class A – renewables within building footprint – e.g. PV on the roof
Class B – renewables on building site – e.g. parking canopies
Class C – off site renewables – e.g. community solar (where SRECs are retained)
Class D – RECs or renewable energy purchased – e.g. buy RECs and carbon offsets

Source: https://www.nrel.gov/docs/fy10osti/44586.pdf

Westwood Hanlon Energy Performance Requirements

MSBA Requirement: The Project is subject to the MSBA requirements of Project Advisory 41 - Sustainable Building Design Policy for Green Schools. Since the Project is seeking an additional 2% reimbursement from the MSBA, the building will need to demonstrate at least a 20% reduction compared to the base energy code (IECC 2018/ASHRAE 90.1-2016 with MA Amendments). Compliance for this requirement is enforced through the point total under the LEED for Schools v4 EAc Optimize Energy Performance credit which uses ASHRAE 90.1-2010 as the baseline. Our understanding is that projects seeking the additional reimbursement will be required to show at least 14 points (35% reduction compared to 90.1-2010) under the EAc Optimize Energy Performance credit to show equivalency.

Stretch Energy Code Requirement: Since Westwood is a Stretch Code Community, the Project will be subject to ASHRAE 90.1-2013 with updated Massachusetts Amendments and must demonstrate at least a 10% EUI reduction, either in site or source energy, to demonstrate energy code compliance.

Source:
https://www.massschoolbuildings.org/building/advisories/Project_Advisory_41
https://www.mass.gov/doc/780-cmr-ninth-edition-chapter-13-energy-efficiency-amendments-as-of-272020/download