Whitman Middle School

School Building Committee // March 28, 2023

Agenda

// Schematic Design (SD) Activities & Milestones
// Intro. to Project Delivery Methods
// Intro. to Net-Zero Energy (NZE) & Sustainable Design
// Upcoming Events

SD Activities & Milestones

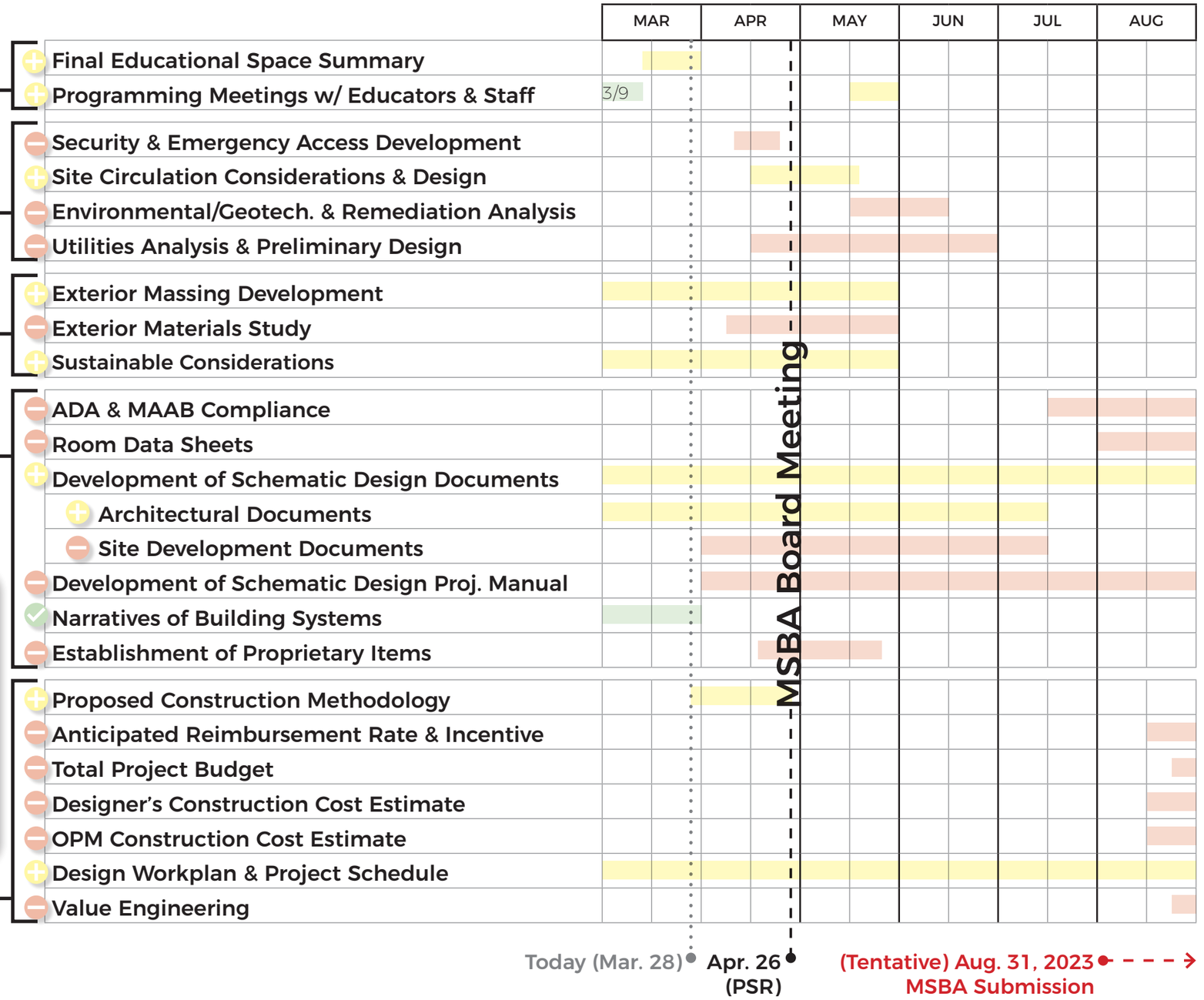
Step 3 Schematic Design (SD) Submission

Apr. - Oct. 2023

- Final Design Program
- Site Evaluations
- Develop Exterior Design Aesthetic
- Development of Schematic Design Documents
- Independent Cost Estimates

2023 Notable Dates (Proposed):

Apr. 13 // Community Forum
Apr. ?? // Building Committee
May. ?? // Building Committee
Jun. ?? // Building Committee
July ?? // Building Committee
Aug. 31 // MSBA SD Submission
Oct. 25 // MSBA Board Meeting



Completed
Initiated
Pending

SBC Meeting

Intro. to Project Delivery Methods

Slides to be provided and presented by Colliers, the OPM

Intro. to NZE & Sustainable Design

AN INDUSTRY LEADER:

Whitman-Hanson Regional High School is currently a featured Case Study on Mass Save's Education (K-12) web page!

mass save®

Energy Efficiency **Case Study**

Brought to you by National Grid

Whitman-Hanson Regional High School

Project Summary

The Whitman–Hanson Regional High School in Whitman, Massachusetts was interested in learning how they could build a state-of-the-art school building utilizing sustainable design principles. Partnering with National Grid, a Sponsor of Mass Save, Whitman was able to design a building that offered:

High Performance Building Envelope Features

- High performance glazing

Efficient Mechanical Equipment and Systems

- Variable air volume (VAV) HVAC distribution system with optimized controls
- Variable flow hot/chilled water pumping system
- Demand control for kitchen exhaust hoods
- Optimized chiller plant with chilled-water supply temperature reset control
- Demand control ventilation in gym, cafeteria and auditorium with CO2 sensors
- High efficiency gas boilers

High Efficiency Lighting Systems and Controls

- Direct/indirect pendant lighting fixtures
- Reduced lighting power densities
- Daylight harvesting controls

Other "Green" and Renewable Systems Technologies

- 49.5 kW photovoltaic power generation system
- Storm water recovery system
- Site design that reuses existing parking lots and athletic fields to minimize the impact on open space
- Full life-cycle cost analysis, including utilization of DOE-2 simulation to predict energy performance and incorporate integrated engineering principles

Mass Save as a Strategic Partner

Whether you are building a new manufacturing facility, upgrading old, inefficient equipment or manage a property in need of energy improvements, the Sponsors of Mass Save will help you identify cost-effective energy efficiency improvements, provide technical assistance, and offer financial incentives in addition to interest-free loans to help kick-start your company's next big project. To learn about these and other commercial and industrial energy efficiency programs available, visit **MassSave.com/Business**.

Solution

An integrated approach utilizing resources from electric and gas utilities as well as the Massachusetts Technology Collaborative (MTC)

Mass Save Sponsor Incentives

$43,631

Annual Electric Savings

577,037 kWh

Carbon Reduction

5,789 tons

About Whitman-Hanson Regional High School

Whitman–Hanson Regional High School serves approximately 1,250 students in grades 9-12 and is fully accredited by the New England Association of Schools and Colleges. The Whitman-Hanson Regional High School Community is committed to the intellectual, ethical, emotional, and social development of students as well as to their physical well-being.

Energy Goals & How to Achieve Them

CLIMATE ACTION:

In March 2021, the Massachusetts signed the "Climate Legislation to Reduce Greenhouse Gas Emissions" committing the state to Net-Zero emissions by 2050. It establishes:

// Increased protections for environmental justice

// Interim goals for emissions reductions

// Voluntary energy efficient building codes

// Procurement of 2,400 megawatts of wind energy by 2027 for MA

Nearly 40% of all CO_2 pollution comes from power plants burning fossil fuels

1 Eliminate Fossil Fuels

Fossil fuels are non-renewable resources; there is a finite amount that will **eventually deplete**. The burning of fossil fuels increases a building or site's carbon footprint, a source of **climate change**.

2 Reduce Demand

Reducing demand is another way of practicing **sustainability**, or meeting the needs of the present without compromising the needs of the future. Maintain **ecological balance** by only using as much energy as required.

3 Produce Electricity On-Site

Producing electricity on site is more attainable today than ever before, for both **technology** and **cost**. Schools with this capability are great **resources** for communities and the municipality at large.

Additionally, the MA Board of Building Regulations & Standards (BBRS), is required to update its building code every three years to be consistent with the International Energy Conservation Code (IECC).

Energy Goals & How to Achieve Them

STRETCH CODE UPDATES:

In July 2023, the new Stretch Code updates will automatically go into effect for all communities that have previously adopted the Stretch Code.

// Primarily includes new limits on the energy used for building heating and cooling systems

// Exterior envelope requirements for continuous insulation & reduction/ elimination of thermal bridging

// Projects 5 stories or less must be solar ready (involves leaving at least 40% of roof area available for future PV and installation of electrical conduits)

// To achieve Net-Zero Energy, renewable production must be on site (ownership vs. a PPA does not matter; just need to prove installation of the system)

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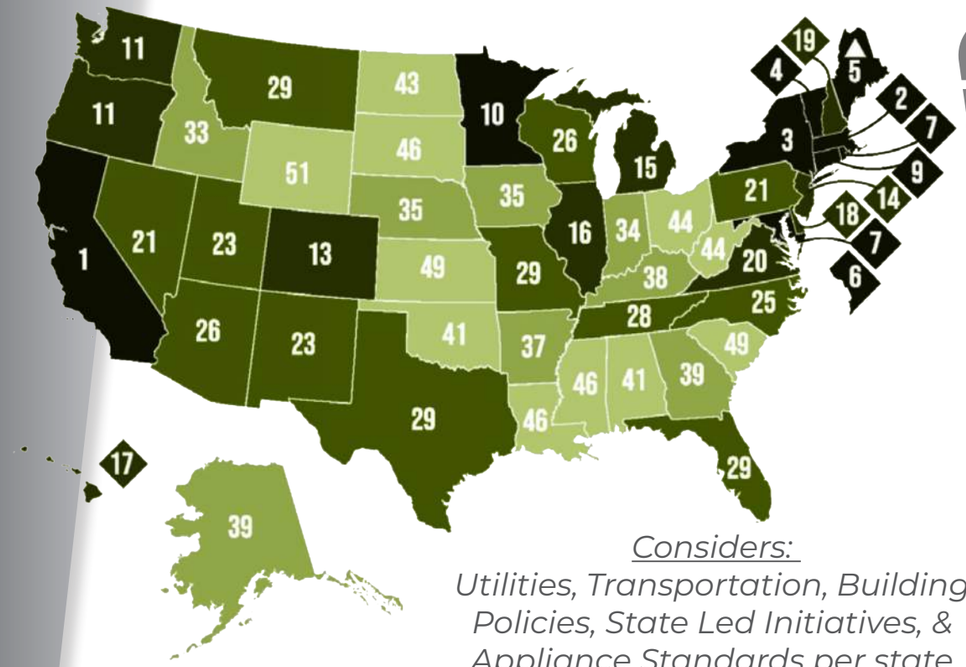
Whitman: A Green Community

2022 US Scorecard for Energy Efficiency

American Council for an Energy-Efficient Economy (ACEEE)



Considers:
Utilities, Transportation, Building Policies, State Led Initiatives, & Appliance Standards per state

- Ranks 1-10
- Ranks 11-20
- Ranks 21-30
- Ranks 31-40
- Ranks 41-50
- ☆ Rising States

MA Stretch Energy Code Adoption by Community

Adopting the Stretch Code is making a commitment to build beyond "base" building energy code to improve energy performance

// Cost-effective construction that is **more energy efficient** than the base energy code

// May choose to adopt the stretch code in lieu of the base building energy code

- Adopted the MA Stretch Code (79%)
- Unadopted the MA Stretch Code (21%)

2!

US Scorecard for Energy Efficiency

Whitman adopted the Stretch Code in **2016** and is a designated **Green Community** by the Dept. of Energy Resources (DOER)

TEDI EUI NZE

THERMAL ENERGY DEMAND INTENSITY

A measure of envelope performance, air infiltration, & ventilation energy recovery

New Stretch Code energy efficiency measurement tool

HEATING TEDI (kBtu/sf/year)
vs.
COOLING TEDI (kBtu/sf/year)

Size of School	Heating TEDI Limit	Cooling TEDI Limit
> 125,000 sf	2.2	12
75,000 sf - 125,000 sf	2.7 - $4e^{-6}$ x sf	2.7 - $1.6e^{-4}$ x sf
< 75,000 sf	2.4	20

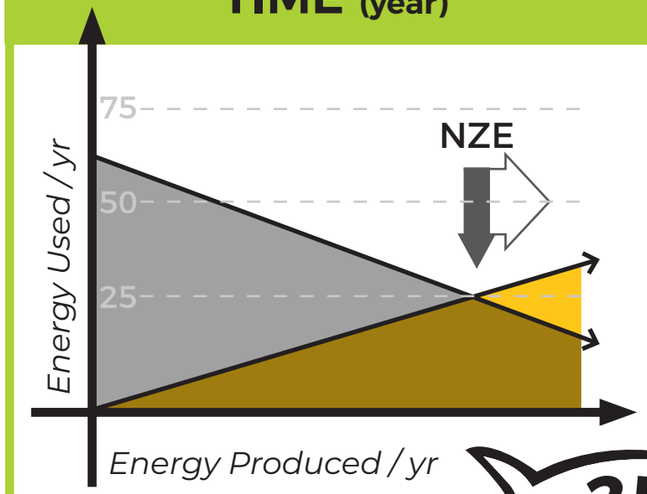
Energy delivered to the building (heating) vs.
Energy removed (cooling)

ENERGY USE INTENSITY

A measurement of a building's **energy efficiency** calculated as:

ENERGY USED (kBtu)* / AREA (SF)

TIME (year)

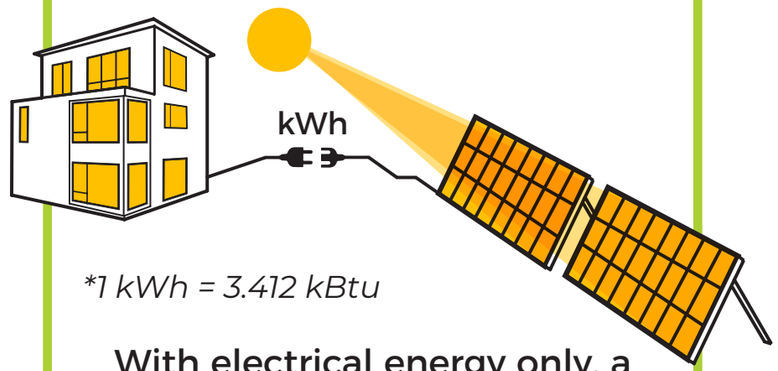


25: *Typical target EUI to achieve NZE*

NET-ZERO ENERGY

When the total amount of **energy used** by the building annually is less than or equal to the amount of renewable **energy produced** on site

ENERGY USED ON SITE (kWh)*
less than ≤ *or equal to*
ENERGY PRODUCED ON SITE (kWh)



**1 kWh = 3.412 kBtu*

With electrical energy only, a building can eliminate fossil fuel use entirely

→ TEDI is "demand" while EUI is "consumption" ←

A Built Example of Net Zero Energy

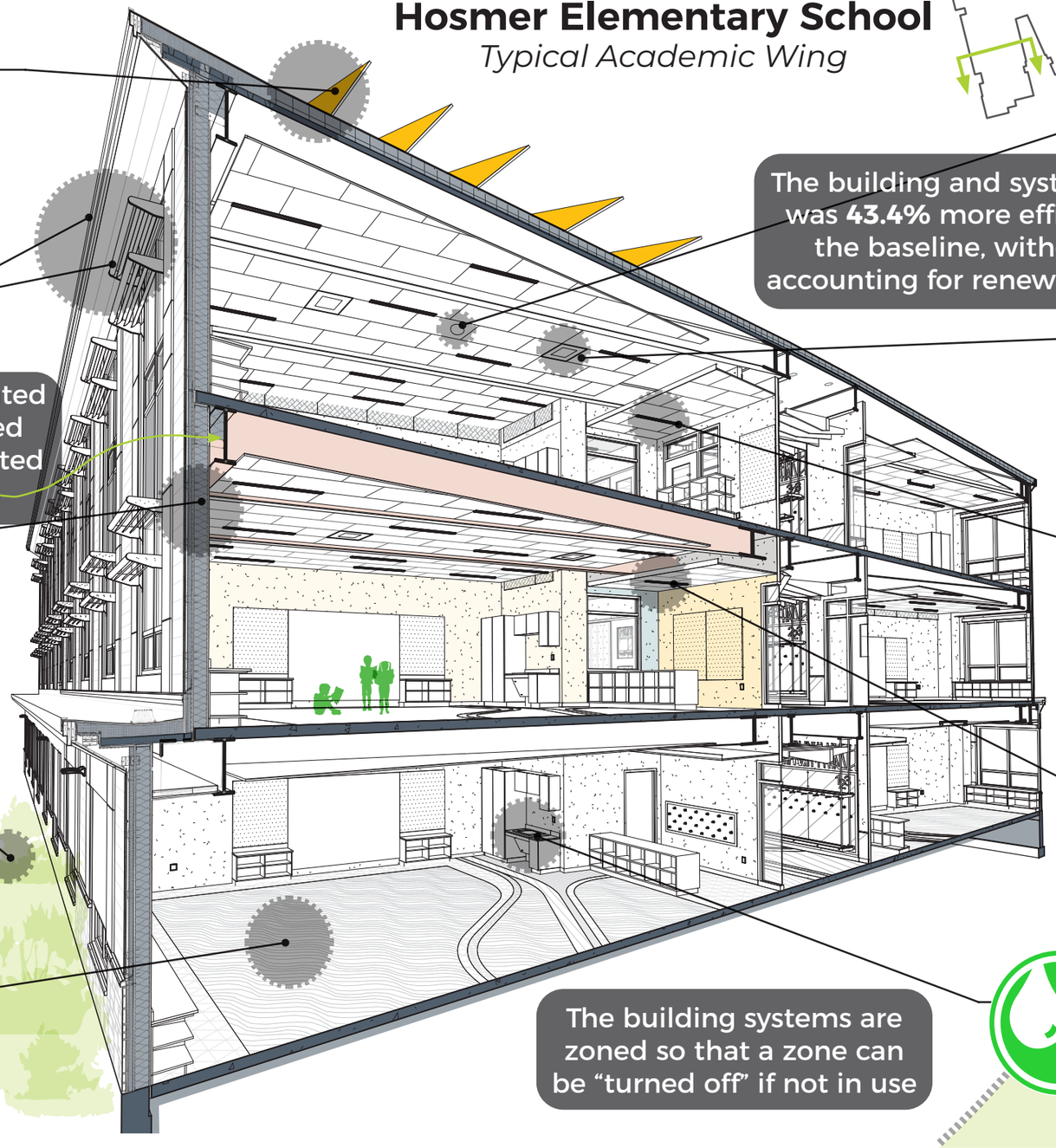
Hosmer Elementary School is of similar size to Whitman Middle School

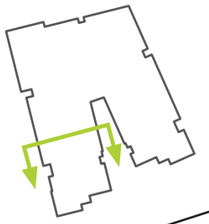
Completed in 2022, this 142,500 sf Net-Zero Energy Building in Watertown, MA serves 790 students daily and has an EUI of 22.4

PV System Summary
DC System Size = 796.8 KW DC
AC System Size = 687.0 KVA (.687 MW)

Hosmer Elementary School

Typical Academic Wing





Renewable Energy Production:

Photo-voltaic arrays on the roof and site generate enough energy for operation

Passive Solar Control:

Building oriented for best daylighting with sunshades and overhangs for control

Enhanced Envelope:

Continuous rigid insulation from slab to roof w/ batt insul. also within walls

Native Plantings:

Reduces heat island effect & requires less watering

Natural & Recycled Materials:

Such as aluminum composite metal panels, natural wood & stone, and linoleum flooring

Structure located inside allowed for uninterrupted insulation

The building and systems design was **43.4%** more efficient than the baseline, without even accounting for renewable energy!

The building systems are zoned so that a zone can be “turned off” if not in use

CO_2 Occupancy Control:

Signals to the rooftop units to modulate outside air dampers for fresh ventilation in the space

Air-Source Heat Pumps:

(2) four-way VRF cassettes per classroom provide the heat/air conditioning required

High-Efficiency LED Lighting:

The lighting power density (LPD) is 0.424 W/sf; that’s nearly half of the typical baseline, 0.783 W/sf

Occupancy Sensing:

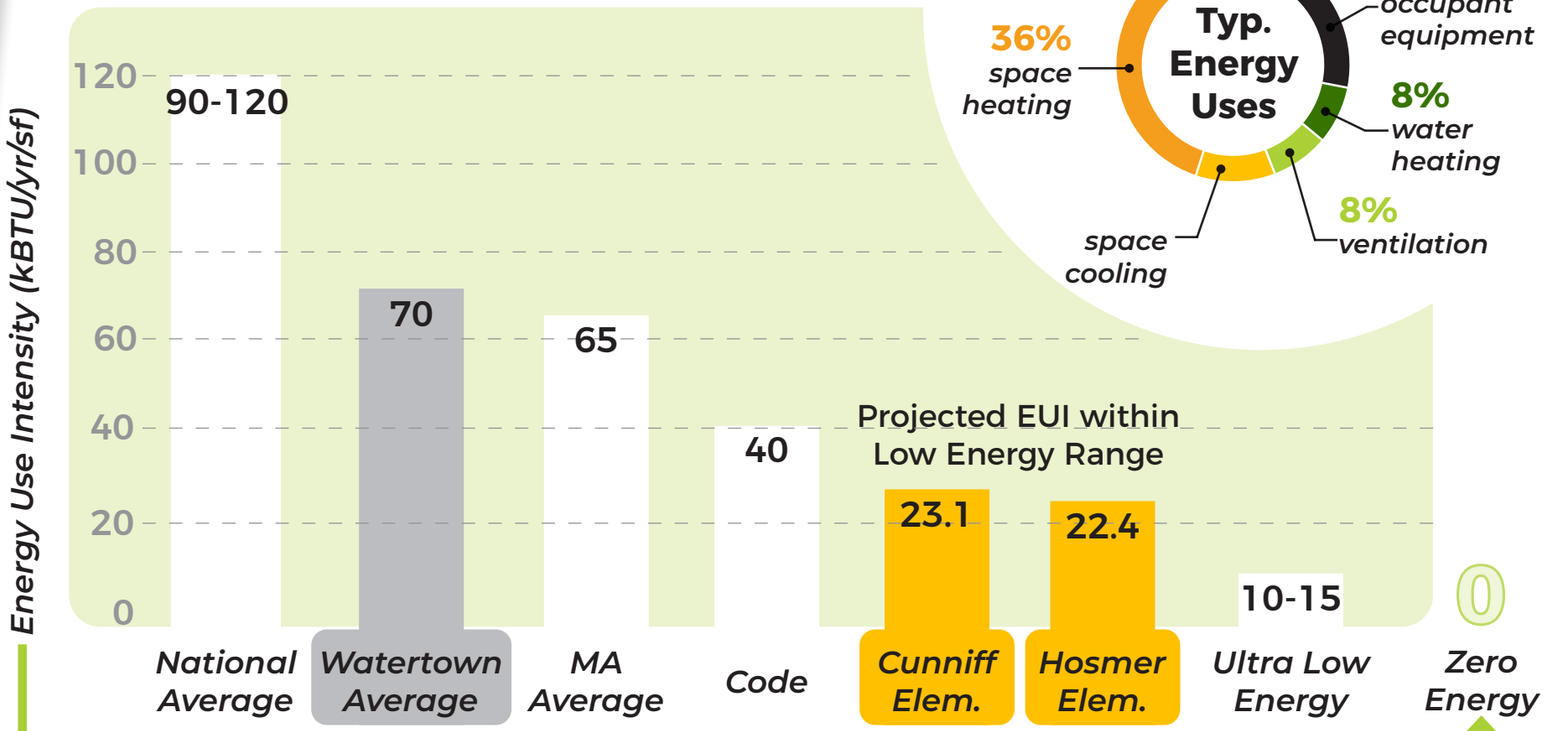
Turns lights on/off automatically depending on if the room is occupied; prevents wasted electricity when the lights are left on

Low-Flow Water Fixtures:

All toilets, urinals, sinks, lavatories, and drinking fountains are WaterSense, using the lowest allowable flow for water conservation

Reducing Energy Use

EUI Comparisons



	Building Energy Data	Cunniff (NZE)	Hosmer (NZE)
A	TOTAL SITE ENERGY USE PER YEAR (in kWh)	558,280 kWh	936,871 kWh
B	TOTAL SITE ENERGY PRODUCED (in kWh)	560,000 kWh	937,700 kWh
C	TOTAL SITE ENERGY USE PER YEAR (in kBtu/yr)	1,904,851 kBtu/yr	3,196,604 kBtu/yr
D	BUILDING AREA (in SF)	82,355 SF	142,445 SF
E	ENERGY USE INTENSITY (C÷D)	23.1 kBtu/yr/SF	22.4 kBtu/yr/SF

Benefits

ENVIRONMENTAL:

// Eliminated use of fossil fuels
// Reduced Carbon Footprint
// Meets needs of the present without compromising needs of the future

EDUCATIONAL:

// Educated in “living laboratories”
// Understanding of environmental stewardship early on
// Engaged occupants & community by using the building as a teaching tool

HEALTH:

// Improved well-being through connections to outdoors & daylight
// Improved occupant performance by providing thermal comfort controls
// Lowered absenteeism

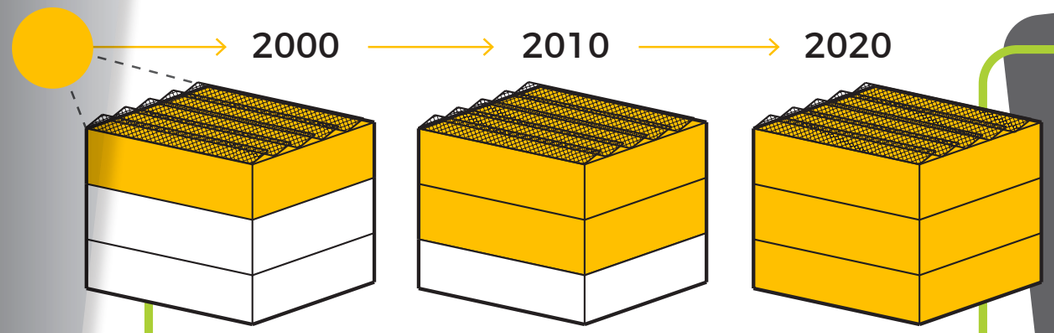
Cost:

// Lowered operating costs
// Lowered energy bills
// Maximized utility rebates
// Reduced exposure to the volatility of shifting energy prices

Renewable Energy Technology

Evolution of Energy Production

Photo-voltaic (PV) efficiency is trending upward



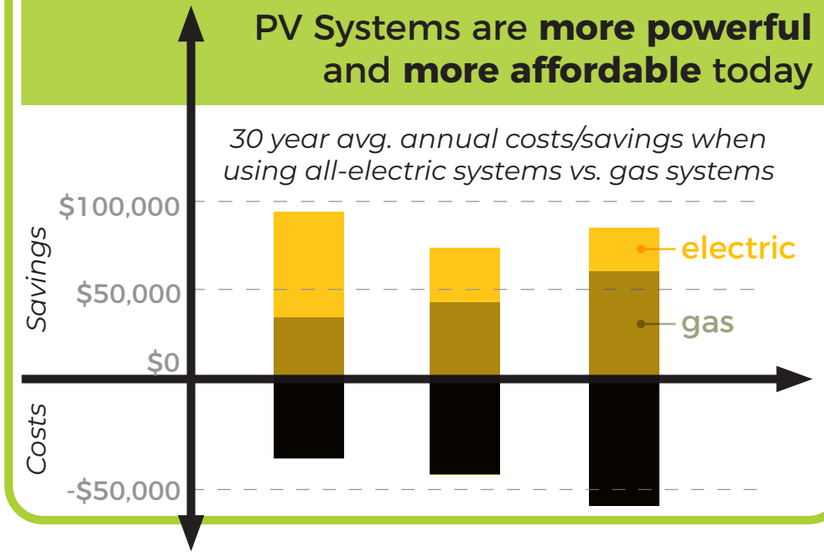
$$$ / watt
200 watts/panel

$$ / watt
300 watts/panel

$ / watt
450 watts/panel

PV Systems are **more powerful** and **more affordable** today

30 year avg. annual costs/savings when using all-electric systems vs. gas systems



Steps to achieve NZE:

1 Select a method of electricity generation using **renewable energy** (practical in MA):

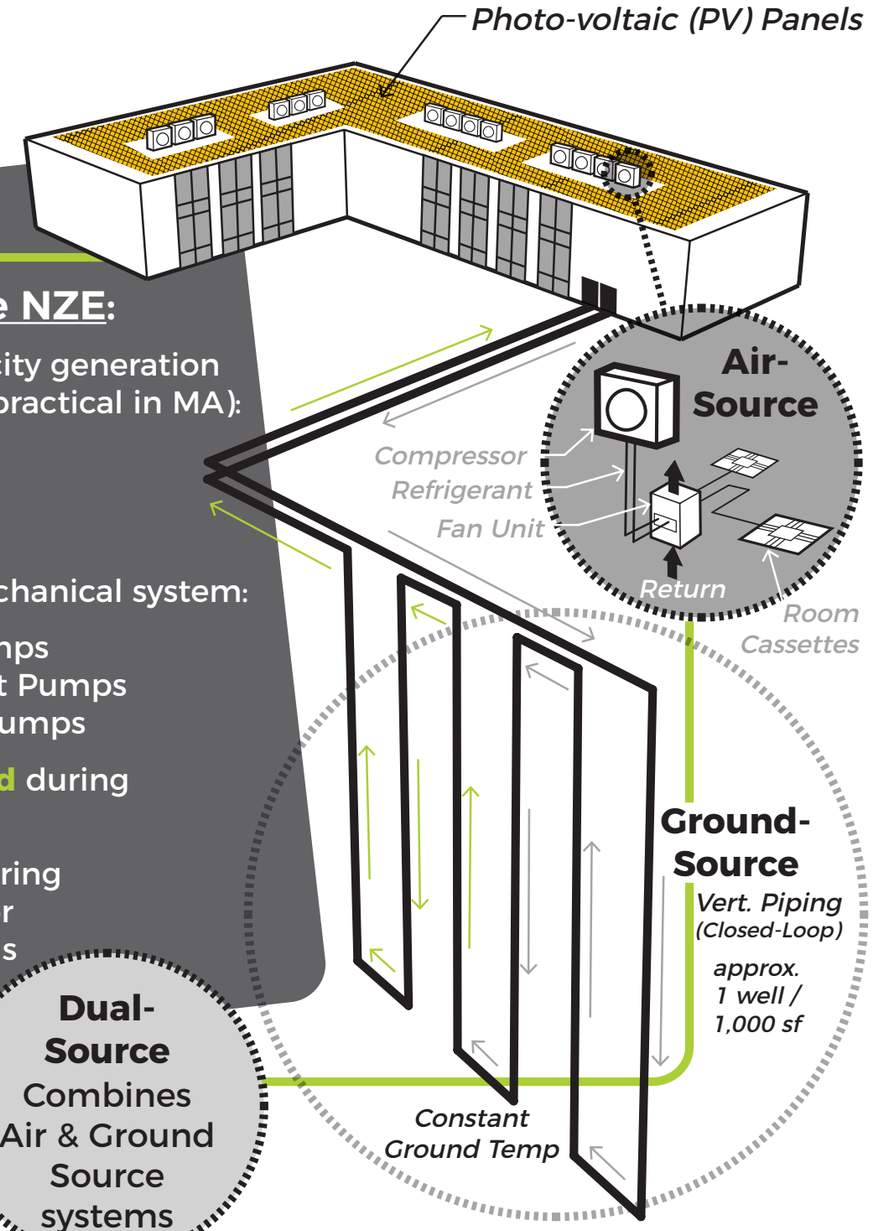
- Solar
- Geothermal
- Wind

2 Select an **all-electric** mechanical system:

- Air-Source Heat Pumps
- Ground-Source Heat Pumps
- Dual-Source Heat Pumps

3 Monitor/**reduce demand** during operations

- Metering & Monitoring
- Occupant Behavior
- Reduce Plug Loads

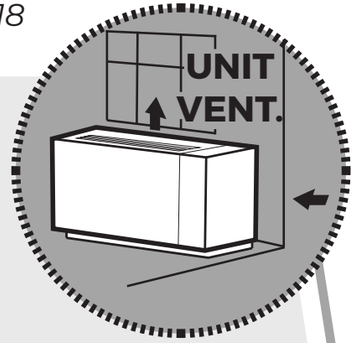


Dual-Source
Combines Air & Ground Source systems

Comparison of HVAC Systems

Code Compliant System

Meets IECC 2018



COMPONENTS:

// Classroom Unit Ventilators at exterior walls
// Gas-Fired Boilers
// Packaged Rooftop Units

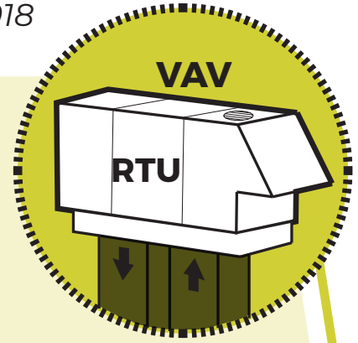
CONSIDERATIONS:

// Will not achieve LEED Certification
// Uses fossil fuels

$55-$60 /sf
Unit Ventilator System

LEED Certified System

Meets IECC 2018



COMPONENTS:

// Variable Air Volume (VAV) and/ or Chilled Beams
// Rooftop Energy Recovery (ERV) Units
// High-Efficiency Gas-Fired Condensing Boilers
// Large Ductwork Distribution System

CONSIDERATIONS:

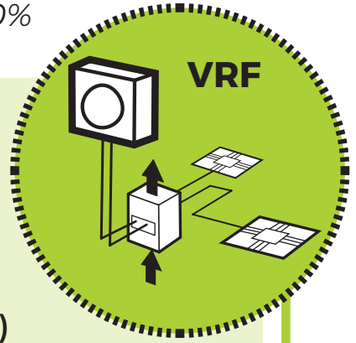
// LEED v4 requires ASHRAE 90.1 2013
// Uses fossil fuels

$63-$68 /sf
VAV System

$75-$80 /sf
Chilled Beams

LEED Certified & NZE System

Exceeds IECC 2018 by 20%



COMPONENTS:

// Variable Refrigerant Flow (VRF)
// Energy Recovery (ERV) Units for ventilation
// Small ductwork distribution for ventilation air
// Optional: RTUs for large spaces

CONSIDERATIONS:

// Helps achieve an EUI of 25 or less
// Quiet, efficient, and simple
// All-electric system

$65-$75 /sf
VRF System
(Air Source)

$100+ /sf
VRF System
(Ground Source)

Life-Cycle Payback per HVAC System

SAMPLE project with an area of 177,360 sf *

	A	B	C	D	E	F	G	H	I	J	K	L	M
HVAC System	**Gross Capital Cost ($$)**	**Annual Electric Use (kWh)**	**Annual Gas Use (MBtu)**	**Annual Electric Cost ($$)**	**Annual Gas Cost ($$)**	**Total Utility Cost ($$)**	**Annual Utility Cost/SF ($$/sf)**	**Annual EUI (kBtu/sf)**	**Annual O&M Cost ($$)**	**15-year Replace. Cost ($$)**	**Combined Annual Expense ($$)**	**Combined Expense Savings ($$)**	**Total Life-Cycle Savings ($$)**
VAV with Gas-Fired Boilers *Code-Compliant*	$10.6 mil	2,020,046	2865	$242,405	$36,501	$278,456	$1.57	55.1	$46,710	$175,000	$325,166	-	-
VAV with Gas-Fired Boilers *High-Efficiency, Exceeds Code*	$9.1 mil	1,239,201	1,824	$148,704	$22,954	$171,658	$0.97	34.2	$37,460	$175,000	$209,118	$116,048	$4.6 mil
VRF with Ground-Source Heat Pumps *w/ Supplemental Electric Boiler*	$12.2 mil	1,426,301	0	$171,124	$0	$171,124	$0.97	27.5	$36,960	$0	$208,084	$117,082	$3.2 mil
VRF with Ground-Source Heat Pumps	$12.8 mil	1,409,139	0	$169,097	$0	$169,097	$0.96	27.2	$35,460	$0	$204,557	$120,609	$2.7 mil
VRF with Air-Source Heat Pumps	$6.6 mil	1,299,531	0	$155,944	$0	$155,944	$0.88	25.0	$34,000	$0	$189,944	$135,222	$4.1 mil

**The above sample project uses values from 2021. A comparitive analysis would be conducted specific to WMS using current values.*

Assistance Programs for Added Savings: Utility Co's

Click for more info. → *Memorandum of Understanding for* [Path 1](): Zero Net Energy/ Deep Energy Savings

ELIGIBILITY REQUIREMENTS:

// Project teams **must commit to a GOAL** of either zero net energy, zero net energy ready, or Passive House (as a path to net zero)

// Must target an **EUI of 25.0** or less

✓ // Customer must engage Mass Save Sponsor(s) during the project's feasibility or conceptual design phases, but before 50% Schematic Design

Project team reached out to NGrid Sponsor on March 13, 2023

✓ // Projects must have a minimum of 20,000 square feet of comfort conditioned (heated and cooled) space

// Projects must anticipate year-round occupancy

For K-12 schools, this requirement includes a minimum of 4 weeks of anticipated summer use in classroom areas

// Building must be separately metered (not on same utility meters as other buildings)

Utility Company
Assistance Programs:

mass save

Mass Save Path 1 Incentives

Customer Incentives

K-12 Schools	Site EUI Range	Incentives				
		Payable at end of Construction		Payable at end of 1 yr. post occupancy		
		Construction Incentive $/sf	Heat Pump Adder*	Post Occ. Inc. $/sf	Adder for getting under ZNE EUI target	Certification Incentive
Tier 2 (high schools only)	26-29	$1.50	Air Source Heat Pumps: $800/ton	$ 1.50	Not applicable	$3,000
Tier 1 - Net Zero Level (all Schools)	25 or less	$2.00	Variable Refrigerant Flow (VRF): $1200/ton Ground Source Heat Pumps: $4500/ton		$0.05/ EUI point reduction/sf	

Utility companies have their own financial incentives for a variety of building types

Renewable Energy:
Revenue for the amount of renewable energy produced on site annually

Performance Lighting:
Revenue for reduction in Lighting Power Density below code

Electric Vehicle Charging:
Revenue for connected charger

Assistance Programs for Added Savings: DOER

Dept. of Environmental Resources (DOER)

Click for more info. → **SMART: Solar Massachusetts Renewable Target Program**

ELIGIBILITY REQUIREMENTS & ITEMS OF NOTE:

// Reflects State goals of generating 3,200 MW of solar

✓ // Must be interconnected by one of (3) investor owned utility companies in MA: Eversource, **National Grid**, or Unitil

Each utility has established blocks that decline in incentive rates between each block

// The amount of time a facility may receive compensation under the tariff is based on:

/ Size of renewable energy system
/ Utility Company
/ Capacity block location

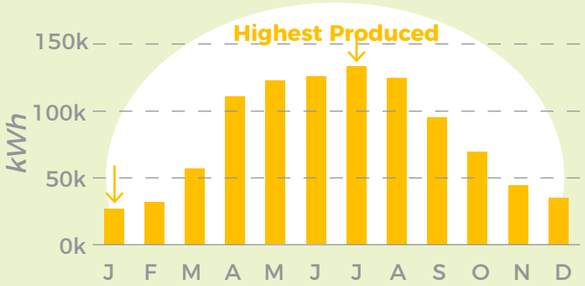
// As of July 2020, to participate in the SMART Program an Energy Storage System (ESS) is required if solar production exceeds 500 kW DC

// The Capacity Block Compensation Rate includes the cost of electricity, so it rolls the value of net metering and the value of the SMART program incentive into one

State of Massachusetts
Solar Incentive Programs:

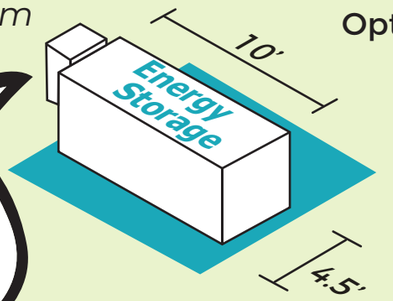
What is the SMART Program?

A long-term sustainable solar incentive program to encourage development of solar technology



← **Net Metering:**
Credit received in months where school produces more electricity than used (summer) & 10% of Peak Demand shed during Demand Response

ESS: *Energy Storage System*



Contains lithium ion battery modules, a management system, and a fire suppression system

Rate Adders

Optional to generate a larger compensation rate

// Location Based Adders
// Off-taker Based Adders
// Energy Storage Adder
// Solar Tracking Adder

How Everything Comes Together

RENEWABLE ENERGY SYSTEM:

// The building is **not directly served** by the renewable energy produced; this still goes to the grid before the grid distributes it back to the building for power

// Similarly, power from the ESS is not directly supplied to the building, it goes to the grid

The stored power contributes to Massachusetts overall, not just the municipality, but the financial return drives the incentive

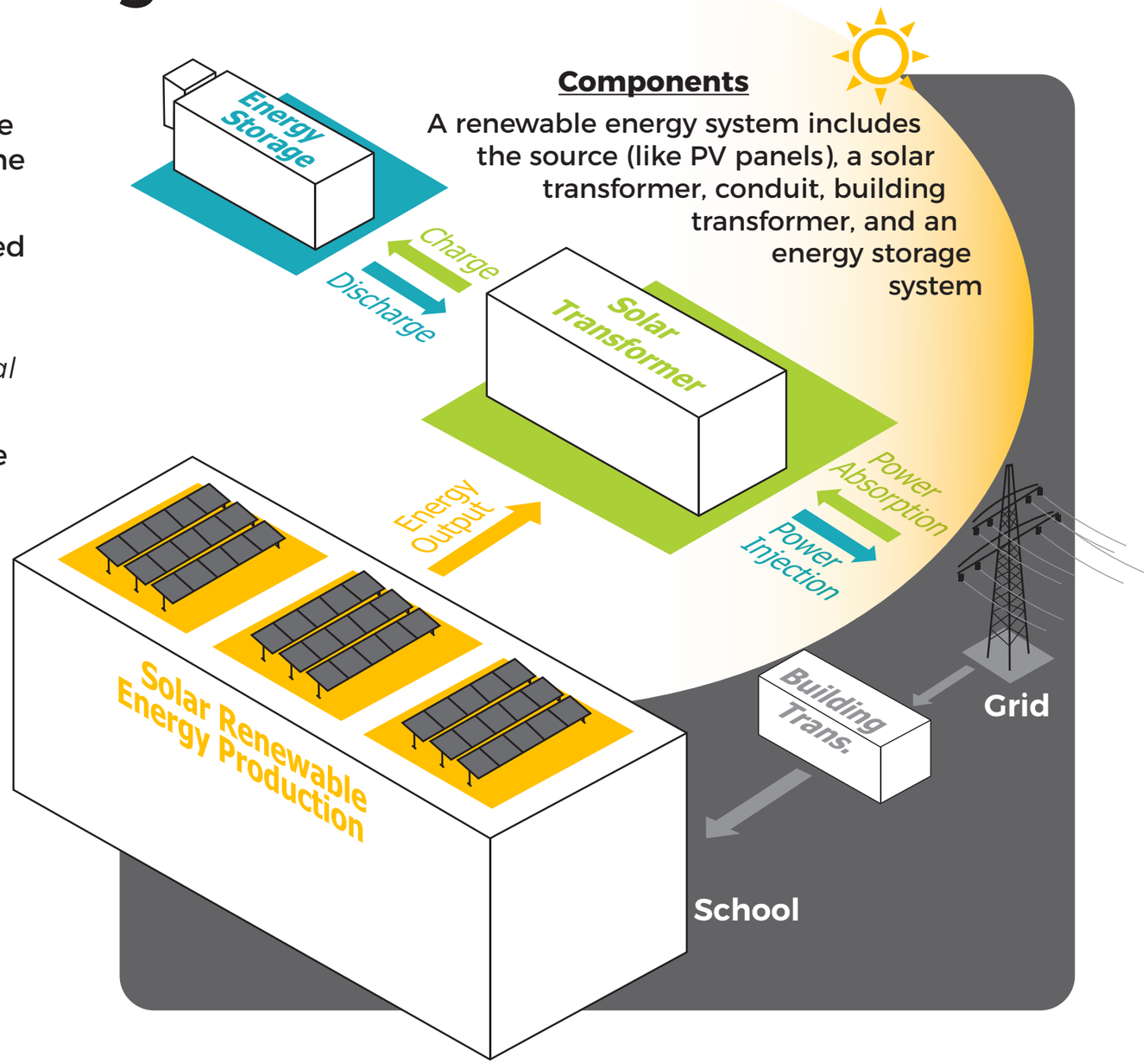
// The ESS is **not a substitute** for the **generator** on site because stored electricity from the ESS cannot be directly sent to the building

// National Grid will determine if nearby electrical service is capable of taking the medium voltage that would be produced by a renewable energy system at Whitman Middle School

This will be determined by an Interconnection Study in later phases of the project

WMS SBC Energy Goal Commitment

We recommend the WMS SBC vote on an **energy commitment goal** for the school project at the next meeting



Energy Goals

1 Eliminate Fossil Fuels

2 Reduce Demand

3 Produce Electricity On-Site

Glossary of Terms

fos·sil fu·el *noun*
Depletable/non-renewable energy sources such as coal, oil, and natural gas

green·house gas *noun*
A gas that contributes to the greenhouse effect by absorbing solar heat and trapping it in the earth's lower atmosphere

car·bon foot·print *noun*
The total greenhouse gas emissions caused directly by a site (school building and its occupants, for example)

sus·tain·a·ble de·vel·op·ment *noun*
Meet needs of the present w/out compromising needs of the future; avoiding the depletion of natural resources to maintain ecological balance

life cy·cle cost *noun*
The total cost of ownership, including initial expenses and maintenance, over the life of an asset

en·er·gy use in·ten·si·ty *noun*
A measurement of a building's annual energy efficiency

re·new·a·ble en·er·gy *noun*
[electrical] energy from a source that is not depleted when used (examples: solar, wind, hydro, geothermal, hydrogen, biomass)

net ze·ro en·er·gy *noun*
The total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site

net pos·i·tive en·er·gy *noun*
The total amount of energy used by the building on an annual basis is less than the amount of renewable energy created on the site

Upcoming Events

Dates & Content

Community Forum #4

THURSDAY

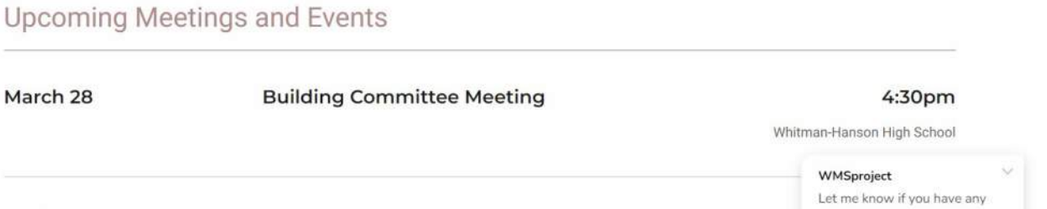
APR 13, 2023

Whitman Middle School Cafeteria @ 6:30 pm

[For all interested Community Members]

Access the project website directly to stay informed

www.wmsproject.org



Questions?

Thank you