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# PERFORMANCE CONTRACTING PANEL DISCUSSION

REV 2024 Conference

# BIOMASS BOILER SYSTEMS

Mark Froling
Froling Energy

FRÖLING ENERGY

## Mechanical Contractor

Focused on the Installation of High Efficiency, Low Emissions Commercial Biomass Boiler Systems

## Dry Wood Fuel Producer & Delivery Service

Of PDCs—Screened Dried Wood Chips
25% Moisture Content, Delivered by Blower Truck


FRÖLING ENERGY

# For 15 years we have focused on Installing Wood Pellet & Chip Boiler Systems in Schools and other Commercial Buildings

Bellows Falls Middle School

Mill River Union HS, Colchester

Green Street School, Brattleboro

Sharon Elementary School

FROLING ENERGY

# 3 Wood Fuels for Automated Heating Available in Vermont, NH, Maine and Massachusetts

## Wood Pellets

Manufactured at 12 locations
in New England

## Screened Dried Wood Chips


Froling Energy makes them. Others will in future.

## Green Wood Chips

Available from many local logging companies and regional distributors

FRÖLING ENERGY

**Current Annual Heating Fuel Costs**
*Compare by Energy Unit (MMBTU)*

| | |
|---|---|
| **HEATING OIL** | $28/MMBTU at $3.33/Gal |
| **PELLETS** | $22/MMBTU at $306/Ton |
| **DRIED CHIPS** | $16/MMBTU at 165/ton |
| **GREEN CHIPS** | $12/MMBTU at $75/Ton |

# Wood Pellets

7% moisture content

Precisely controlled small size Flows like water.

Bole Wood—minimal bark

Most compact BTU storage

Assured Quality

## Delivery by Blower Truck

## Fuel Storage Options

# Screened Dried Wood Chips

25% moisture content  Screened:  Nothing bigger than a matchbook

Bole Wood—minimal bark

Assured Quality

## Delivery by Blower Truck


## Fuel Storage Options

# Green Wood Chips

35% to 50% moisture content

Chip size and % bark vary. Rocks/debris possible

Quality is determined by price & Vendor  (Buyer Beware!)

**Delivery by Live Floor Truck into a Pit**

## Fuel Storage Options

# Commercial Project: **Motivations**

Sustainability Goals

Reduce Heating Fuel Costs

Replace Aging Boilers & Leaky Oil Tanks

Desire to Support Region's Forest Economy

Improve Heat Distribution/Comfort

Central control system: None/Outdated

Additions & Renovations being Planned

Rural Choices:  Oil, Propane or Wood?

**Rutland Intermediate School**

**Dummerston School**

# Commercial Project: **Common Traits**

Big Buildings—30 to 100+ years old

Architecturally difficult for deep energy retrofits

Big Heating Fuel Users

Central Heat Distribution Systems

Well ventilated—or need to be!

Redundant Boilers

Require High Temperature Heat (160-190 F)

Steam Heat!

**Academy School, Brattleboro**

**Bellows Falls Middle School**

# Commercial Project: **Challenges**

Small Boiler Room—no space!

*Can a new boiler building be justified?*

*Where might it be located?*

Tight Access into Boiler Room for Big Boilers

No room for a Buffer Tank

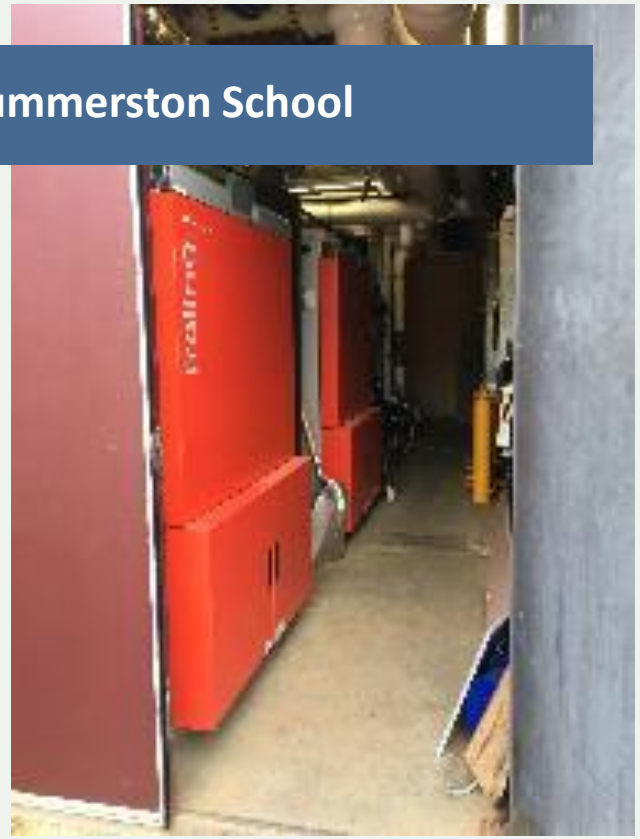
Multiple chimney flues required

Can Silo be near enough to Boiler Room?

Multiple Boiler Rooms heat different areas

Can they be tied together?

**Dummerston School**



**Stafford Tech in Rutland**

# Commercial Project: Funding

<u>Two Major Methods:</u>

**Local Bond Issue**

- Approved by public vote

**Energy Performance Contractor**

- Approved by public vote
- But with a much more attractive financial picture—Revenue Neutral

Mill River Union High School

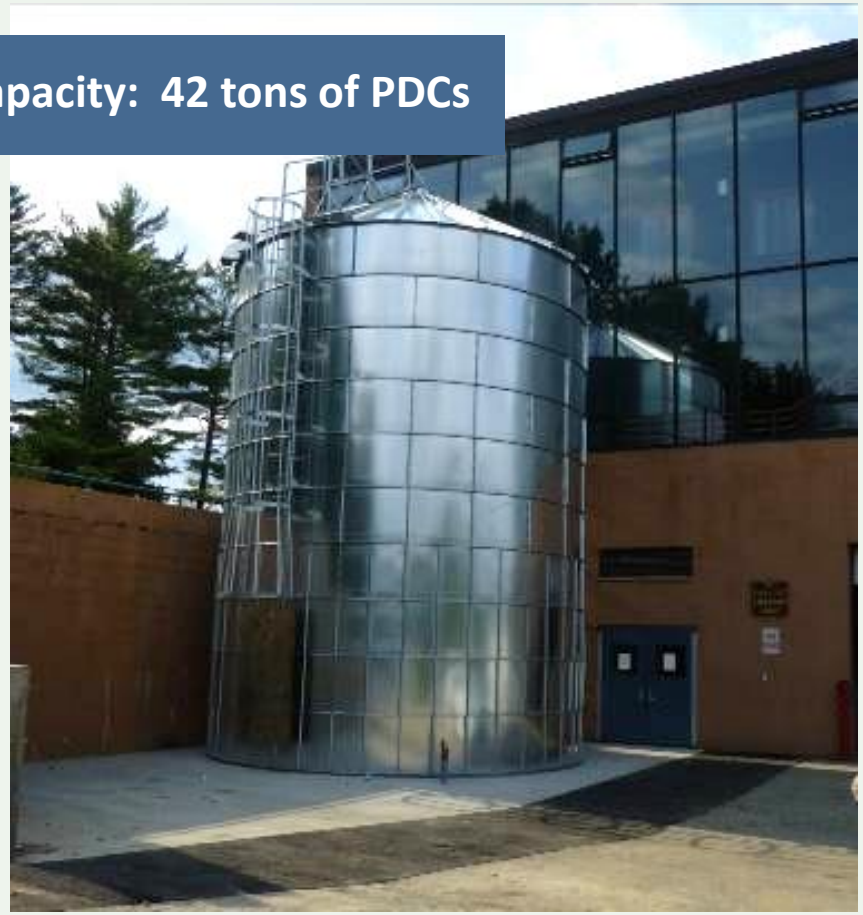
Stafford Tech in Rutland

FRÖLING ENERGY

# Plymouth Regional High School

## Plymouth, NH

**Silo Capacity: 42 tons of PDCs**



**Boiler Output: 2.45 Million BTU/Hr**

FROLING ENERGY

# John Stark High School

## Weare, NH

- Averaged 38,000 Gal/Yr and $133,000/Yr
- After Conversion with Froling & EEI
- Now Averaging 250 Ton/@ 165 $41,250


**Dry Chip Boiler Output:**
**1.7 Million BTU/Hr**

**Silo Capacity:**
**42 tons of PDCs = 3,900 Gal Oil**

FRÖLING ENERGY

# Otter Valley Union High School

## Brandon, VT

**Prior Fuel Use: 60,000gal/yr**
**$210,000yr**
**Now,Pellet and Fuel Costs:**
**$140,000yr**

**2 Existing Boiler Rooms with multiple Oil-fired boilers.**
**Pellet Boiler system was put into a new 3rd boiler room**

FRÖLING ENERGY

# Otter Valley Union High School

## Brandon, VT


**Viessmann Pyrot 540 KW boiler**
has 1,843,000 BTU/hr peak output
Features: Flue gas recirculation, Pneumatic tube cleaning

**3 – 300 Gallon Buffer Tanks in Parallel**

FRÖLING ENERGY

# St. Johnsbury School

## St. Johnsbury, VT

New brick boiler building matches school

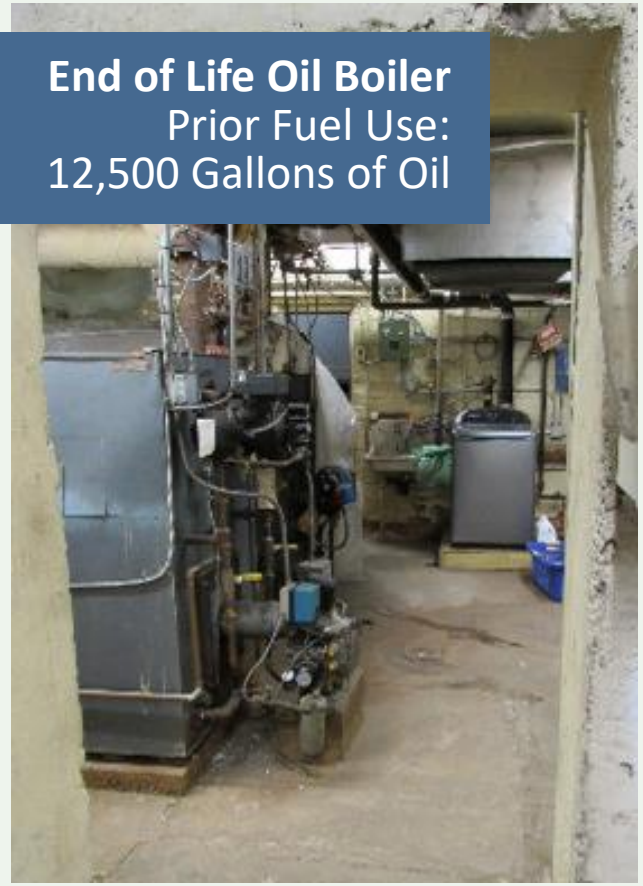
Schmid UTSK 500 KW Boiler: 1.6 Million BTU/Hr

**Silo holds 42 tons of Dried Chips**
Equals 3,930 gal #2 Oil

FRÖLING ENERGY

# Green Street School
## Brattleboro, VT

**End of Life Oil Boiler**
Prior Fuel Use:
12,500 Gallons of Oil



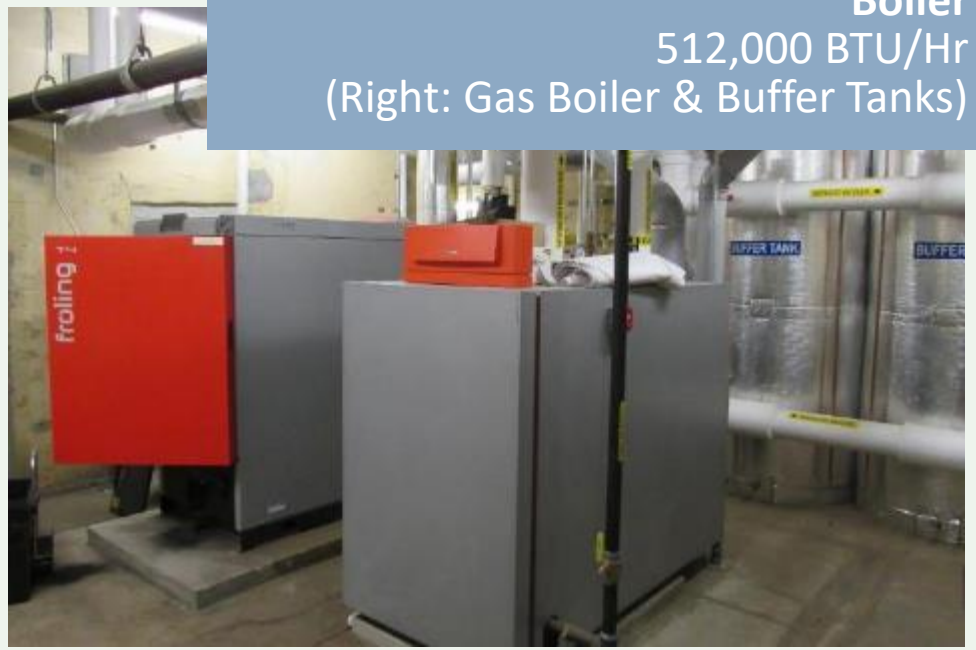
**Steam Heat**
Original Coal Boiler was still in place but disconnected

**1924 Building**
**30,700 Sq Ft Area**

FROLING ENERGY

# Green Street School
## Brattleboro, VT

**Froling T4-150 Dried Chip/Pellet Boiler**
512,000 BTU/Hr
(Right: Gas Boiler & Buffer Tanks)




**Interior Silo holds**
**12 tons of Dried wood chips**

**New Fuel Use:**

83 tons of Dried Wood Chips
4,000 Gallons of LP

A 15% reduction in fuel use

FROLING ENERGY

# Mill River Union High School

## North Clarendon, VT


**Average Prior Heating Fuel Use:**
47,000 Gallons of Oil per year at $164,000

**New Annual Fuel Use:**
350 Tons of dried chips + 5,000G at $75,275

**Difficult access into boiler room**

FRÖLING ENERGY

# Mill River Union High School

## North Clarendon, VT

**New HB Smith LP-Fired Steam Boiler**
Output: 2.4 Million BTU/Hr

**New Schmid UTSK Dried Chip Steam Boiler**
Output: 1.87 Million BTU/Hr

**Dried Chip feed auger to boiler**

FRÖLING ENERGY

# Mill River Union High School

## North Clarendon, VT


Sweeper arm at bottom of silo

Augers feed dried chips from silo into the boiler

# BUILDING AUTOMATION SYSTEMS

Chris Clorite
Control Technologies Inc

# CHRIS CLORITE
# SALES ENGINEER

25 years HVAC experience from a service technician to working at an Engineering firm as a mechanical design engineer.

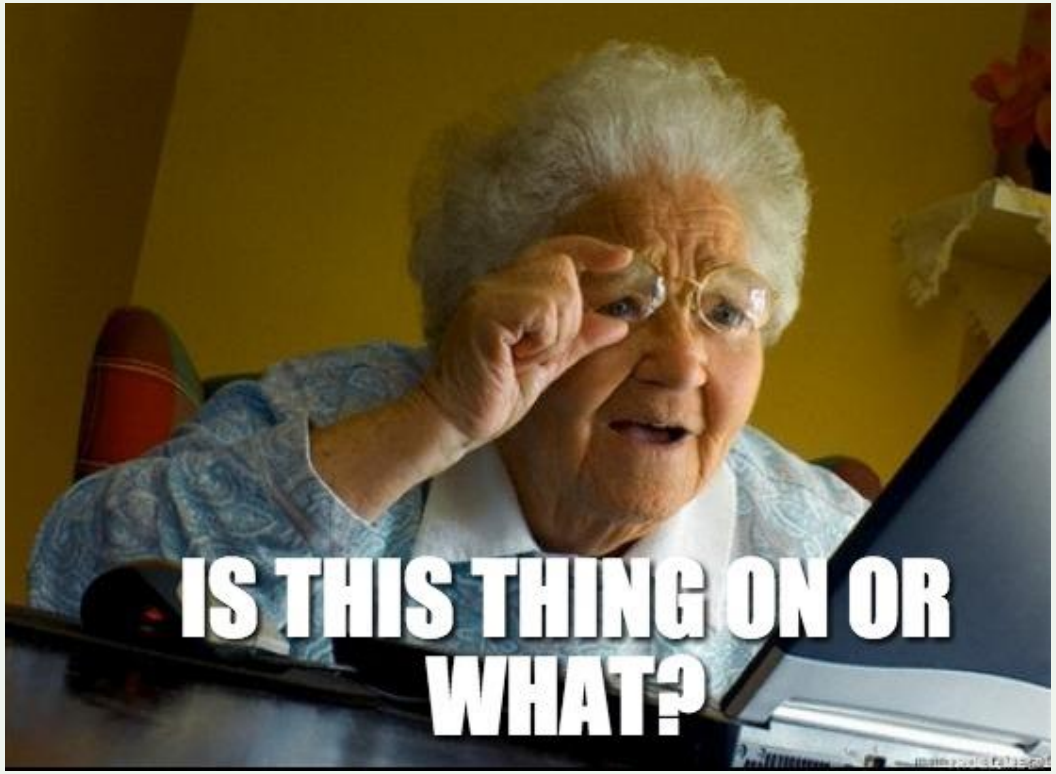
Most of my career has been at Control Technologies Inc. where I have been a DDC Engineer, Project Manager, and most recently Sales Associate

# Building Automation Controls
## What do controls people really do?

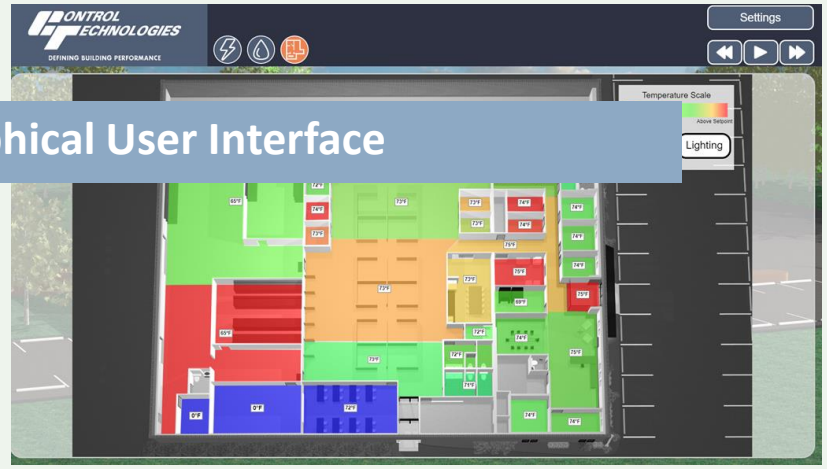
Turn things on/off
Move things back/forth

Based on information collected throughout the building

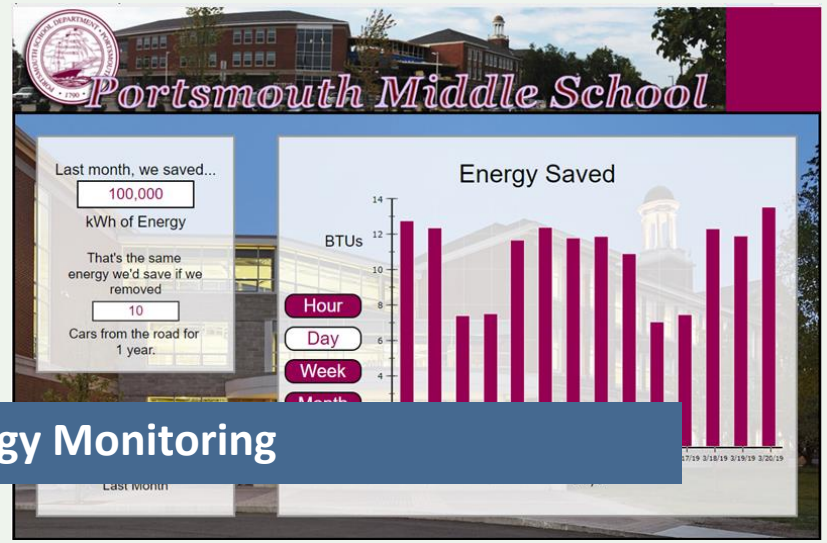
Simplifies operation of complex systems



# The control system provides real time information

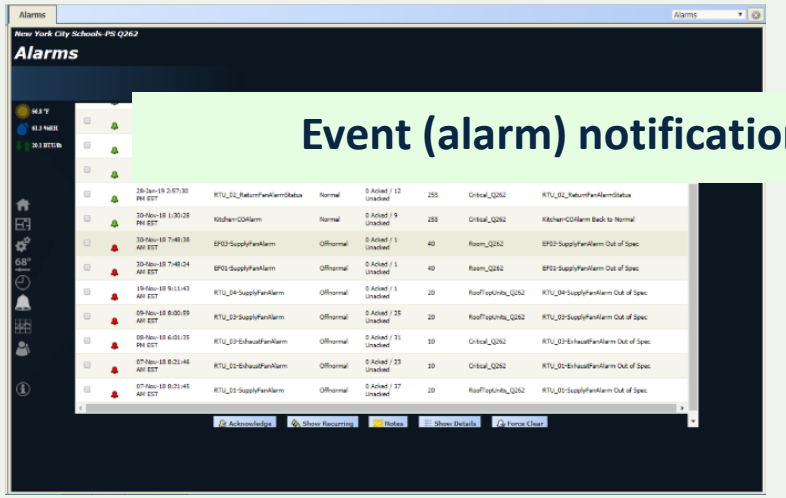



Graphical User Interface



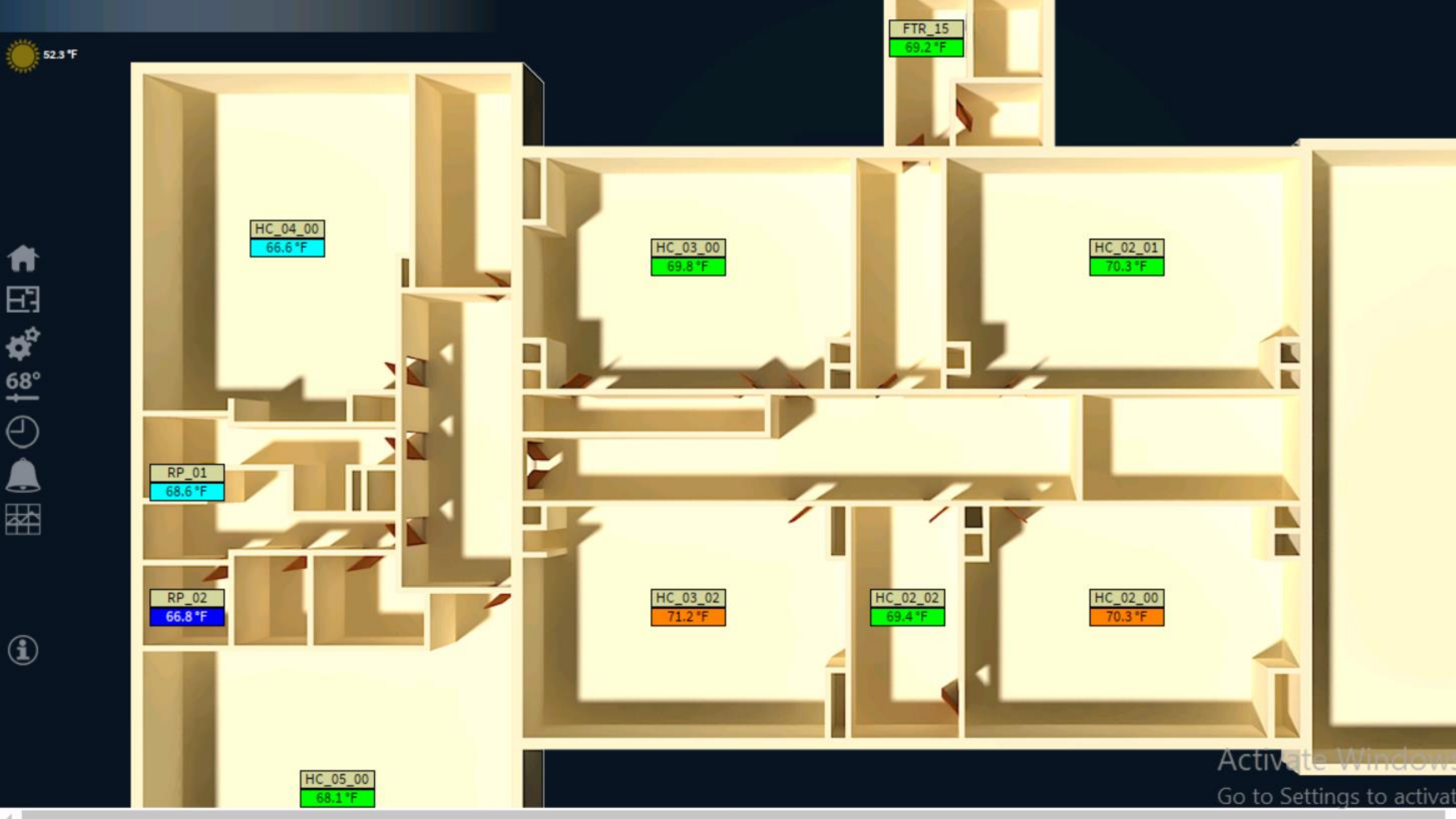

Energy Monitoring


Remote Access




Event (alarm) notification


Archives and Trends


52.3 °F
FTR_15
69.2 °F
HC_04_00
66.6 °F
HC_03_00
69.8 °F
HC_02_01
70.3 °F
68°
RP_01
68.6 °F
RP_02
66.8 °F
HC_03_02
71.2 °F
HC_02_02
69.4 °F
HC_02_00
70.3 °F
HC_05_00
68.1 °F

chool District-Elementary Biomass

# BIOMASS

**HWS Setpoints**
HotWaterSysEnabled
**YES**
OutsideAirHWSystemEnable:
60 °F
HWSupplyTempSp
110 °F
OAForMaxSp
20 °F
HWSupplyTempSpMax
180 °F
OAForMinSp
60 °F
HWSupplyTempSpMin
120 °F

**Biomass Inf**
WoodChipBoilerEnable
**Disabled**
WoodChipBoilerEnableSp
120 °F

**Alarms**
LowHWSSupplyTemperature

LpBoilerEnabled3Times
**Normal**

**Combustion Damper**

CombustionDamper
**Open**
CombustionDamperAlarm
**Normal**
Reset

**EF07B**

RoomTemperature
**83 °F**
RoomTempSpCooling
**85 °F**
EF07BStartStop
**Stop**
EF07BStatus
**Stopped**
ExhaustFan07BAlarmStatu
Reset

DP01StartStop
**Start**
DP01Status
**Running**
DP01AlarmStatus
Reset

HWSupplyTemperature
**147 °F**

Boiler02SupplyTemp
**150 °F**

InjectionPumpStartSto
**Stop**
InjectionPumpStatus
**Stopped**
InjectionPumpSpeed
**0 %**
InjectionPumpAlarmStatu
**Normal**
Reset

**B-1**

**B-2**

LPGasBoilerEnable
**Disabled**
Boiler02SetpointSigna
**44 %**
Boiler02Alarm

Boiler01Alarm
**Normal**
Y T D EnergyTotal S
**974572 kBTU**
SchmidBoiler:

DP02StartStop
**Start**
DP02Status
**Running**
DP02AlarmStatus
Reset

HX_TempLeaving
**138 °F**

**HX-1**

ElemHWSupply
**132 °F**
**Elem. Loop**

GymHWSupplyTemp
**145 °F**
**Gym Loop**
GymHWReturnTemp
**148 °F**

**Override Lp Boiler "ON" if Biomass is turned off and a boiler is needed**

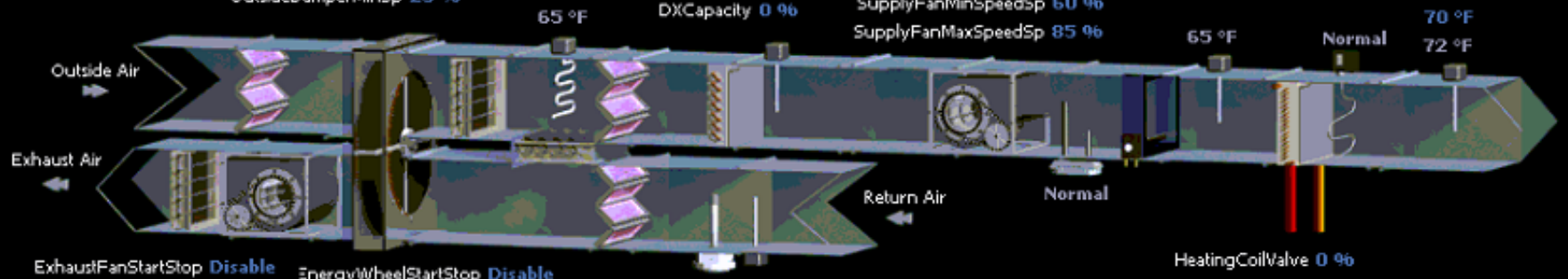
Unit Operating Mode Stopped
SupplyDuctSmoke Normal
Unit Alarm Status Normal

ReturnHumidity 44 %RH
ReturnHumiditySp 60 %RH
HotGasReheatValve 0 %

EconOaEnthalpyEnableSp 26 btu/lb
EconOaRaEnthalpyDiffSp 1 btu/lb
OutsideDamper 0 %
OutsideDamperMinSp 25 %

DXCapacityFeedback 0
DXCapacity 0 %

SupplyFanStartStop Disable
SupplyFanStatus Stopped
SupplyFanAlarmStatus Normal
SupplyFanSpeed 0 %
SupplyFanMinSpeedSp 60 %
SupplyFanMaxSpeedSp 85 %




ExhaustFanStartStop Disable
ExhaustFanStatus Running
ExhaustFanAlarmStatus Normal
ExhaustFanSpeed 0 %
ExhaustFanSpeedOffset 10 %

EnergyWheelStartStop Disable
EnergyWheelSpeed 0 %

ReturnTemperature 68 °F
ReturnHumidity 44 %RH
RaEnthalpy 23.5 BTU/lb
ReturnCarbonDioxide 357 ppm
ReturnCarbonDioxideSp 1000 ppm

HeatingCoilValve 0 %

**Supply Temperature Reset Control**

| | Min Demand | Max Demand | Current Room Demand |
|---|---|---|---|
| Heating | 72 °F | 90 °F | 0 |
| Cooling | 68 °F | 55 °F | 0 |

| | |
|---|---|
| Current Supply Temp | 72 °F |
| Calc. Supply Temp Setpoint | 70 °F |

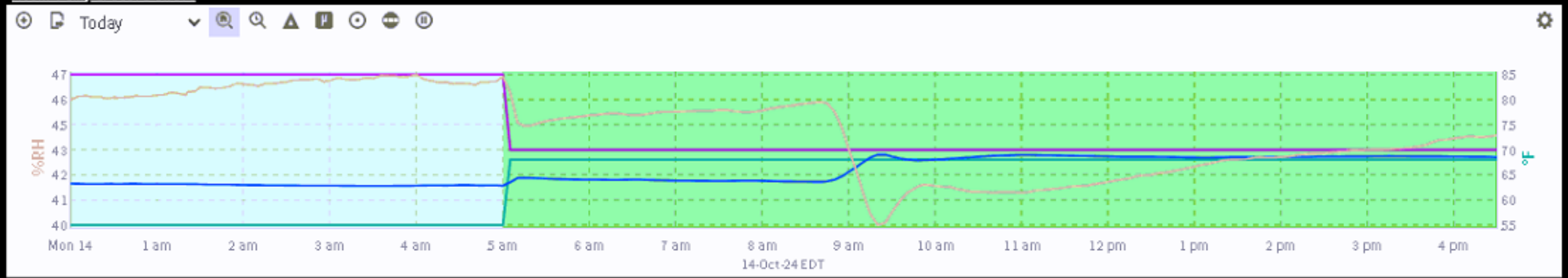
*NOTE: "Room Demand" is generated by how far Room Temperature is above or below setpoint*

**Space Temperature Controls**

RoomTemperature 68.5 °F
RoomTempSp 68 °F

| Heating | Cooling |
|---|---|
| Active SP 55 °F | Active SP 85 °F |
| Offset 0 °F | Offset 2 °F |
| Unocc SP 55 °F | Unocc SP 85 °F |

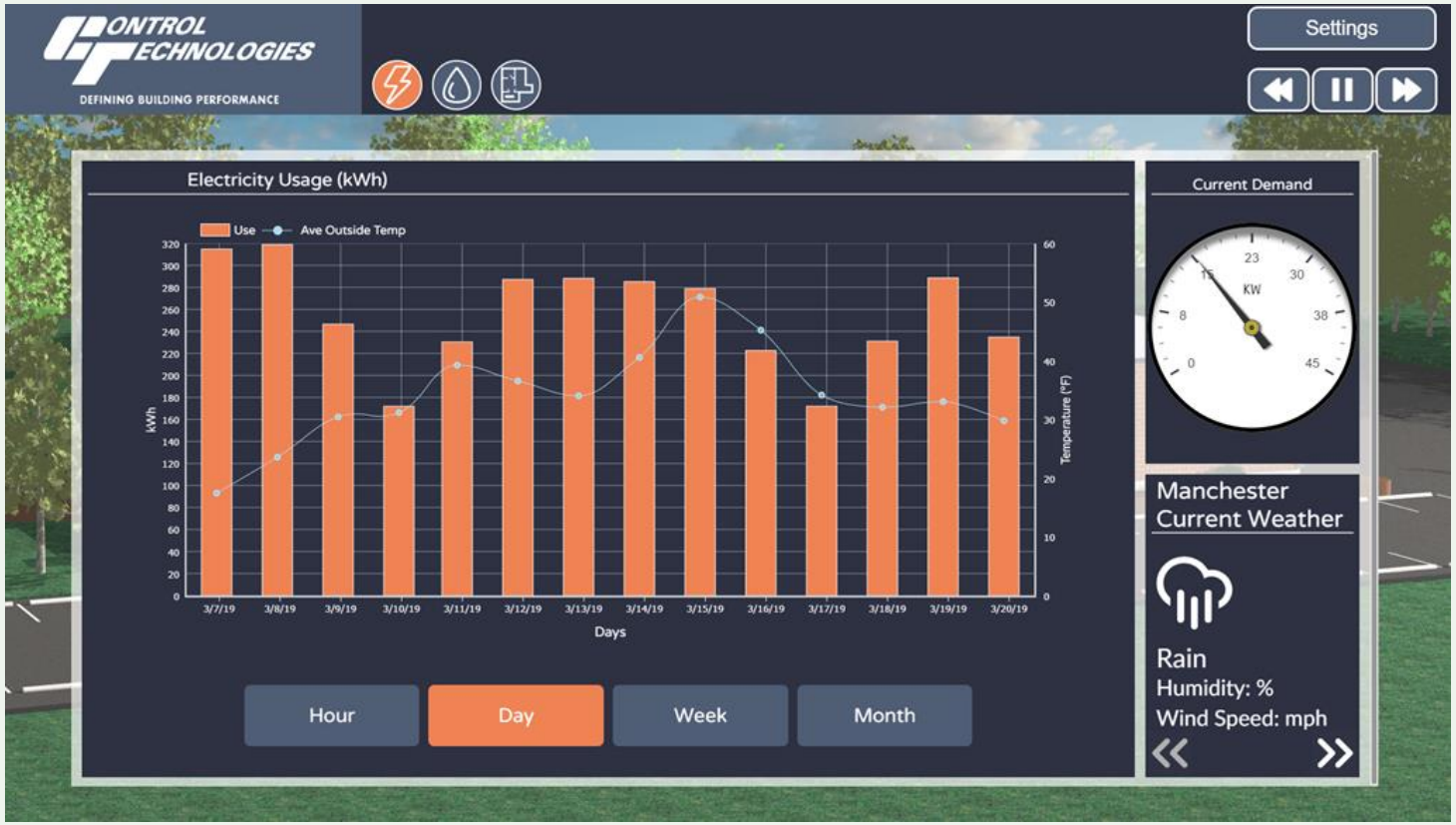
***Room Temperature Chart***



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stage_Vest | 131 Social Studies | 65.5 °F | 55 °F | 70 °F | 55 °F | 0 % | Unoccupied | Unoccupied | NO |
| Stage_Storage | 134 Social Studies | 63.0 °F | 55 °F | 70 °F | 55 °F | 0 % | Unoccupied | Unoccupied | NO |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rm_A108 | 132 Social Studies | 67.6 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A109 | 134 Social Studies | 69.2 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A110 | 129 Social Studies | 69.0 °F | 65 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A111 | conference room | 68.9 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A112 | 134 Social Studies | 69.3 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A113 | Councillors office | 70.1 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A114 | 132 Social Studies | 71.6 °F | 65 °F | 72 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A115 | 134 Social Studies | 68.7 °F | 65 °F | 72 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A116 | 129 Social Studies | 69.4 °F | 65 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_A117 | 131 Social Studies | 68.7 °F | 72 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| AdminNHall | 131 Social Studies | 66.7 °F | 65 °F | 75 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| AdminSHall | 131 Social Studies | 66.8 °F | 65 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rm_C110 | Greenhouse | 64.5 °F | 55 °F | 70 °F | 55 °F | 0 % | Unoccupied | Unoccupied | NO |
| Rm_C201 | 132 Social Studies | 66.8 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C202 | 132 Social Studies | 68.4 °F | 68 °F | 72 °F | 68 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C203 | 134 Social Studies | 70.2 °F | 65 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C204 | 134 Social Studies | 67.7 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C205 | 134 Social Studies | 67.2 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C206 | 132 Social Studies | 67.6 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C207 | 132 Social Studies | 67.2 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C208 | 134 Social Studies | 67.3 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C210 | 132 Social Studies | 68.0 °F | 68 °F | 68 °F | 68 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C213 | 134 Social Studies | 67.7 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C214 | 132 Social Studies | 67.9 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C215 | 134 Social Studies | 69.1 °F | 68 °F | 70 °F | 68 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C218 | 132 Social Studies | 69.7 °F | 69 °F | 72 °F | 69 °F | 100 % | Unoccupied | Unoccupied | YES |
| Rm_C219 | 134 Social Studies | 67.8 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| Rm_C220 | 132 Social Studies | 67.6 °F | 65 °F | 68 °F | 65 °F | 0 % | Unoccupied | Unoccupied | YES |
| C_Wing_Stairs | 129 Social Studies | 67.2 °F | 65 °F | 70 °F | 65 °F | 0 % | Unoccupied | Unoccupied | NO |




# Control Optimization

Demand Control Ventilation

Resets (OA and Building)

Schedule Zones

Load Shedding

ASHRAE Guideline 36 Trim and Respond

# PERFORMANCE CONTRACTING & WOOD HEAT CASE STUDIES

Eric Lafayette
EEI

# ERIC LAFAYETTE
## PROJECT DEVELOPER

- Project Developer
- Burlington, VT – BHS Grad of 06’
- Roger Williams University in Rhode Island majoring in Construction Management
- Live in So. Burlington w/ wife & two girls
- VT School Construction Aid Task Force

# Who is EEI?

- ESCO (Energy Service Company) that provides “turn-key” energy services typically through performance contracting
- Based in Merrimack, NH; office in Williston, VT
- We help schools, universities, hospitals, and municipalities meet their energy goals – Analysis to Completion
- We focus on efficiency & sustainability trying to utilize renewable energies

# Why am I Here – Performance Contracting?

- Performance Contracting and its ability to address key infrastructure problems in the state affordably
- Delivery Methods for Schools & Municipalities
- Currently Plan & Spec. & Construction Manager where an Architect leads the project planning
- Owner hires Architect & Engineering firm and they start a long review of capital needs and potential options

# Why Energy Performance Contracting?

- Delivery Method Focused on Results
- We Help Finance - Reduced energy costs help to finance the project
  - *Help customers attain grants & rebates – State & Federal*
  - *Provide Investment Grade Audits to finance lower cost lease payments for energy efficiency*
  - *Provide lending opportunities to our clients through various means*
- Numerous Options w/ Upfront Costs
  - *We do not want to think "What if we had tried this"*
- Maximize Rebates & Grants
  - *Significant rebates from Efficiency Vermont*
  - *Utilize the Inflation Reduction Act (IRA) or other rebate*
- No Risk or Cost to Schools Upfront – if we can't come up w/ energy savings projects that the school accepts to, there is no charge for our services
- Continuous Commissioning
  - *On going analytics have allowed for increases in savings over a period of time – continuously monitoring the system*

# Our Process

**LONG TERM RELATIONSHIPS**
PARTNERS IN ENERGY

EEI
ENERGY EFFICIENT INVESTMENTS INC.

**Identify Options**
Identify building inefficiencies and provide "a-la-cart" energy cost measures that reduce building operating expenses (utility & operational)

**Review**
Review all options with the owner and align measures with the goals and objective of the owner – Steam Heating, Geothermal, Solar, CO2 Reduction, Renewable Energies

*Review "magnitude of cost" for each measure and present potential energy savings & grant opportunities for each measure.*

**Design**
Owner selects measures for development – EEI than engages the design team to put measures to paper. We then develop the final energy savings & guaranteed savings

**Procurement**
EEI reviews design, schedule, and updated pricing with the owner based on engineers design

*EEI procures work by creating bid packages and putting the project out to bid*

**Site Management**
EEI provides on site management constructs project with a team of subcontractors

**Commissioning & Guaranteed Savings**
EEI commissions the building and provides ongoing data analytics & measurement & verification

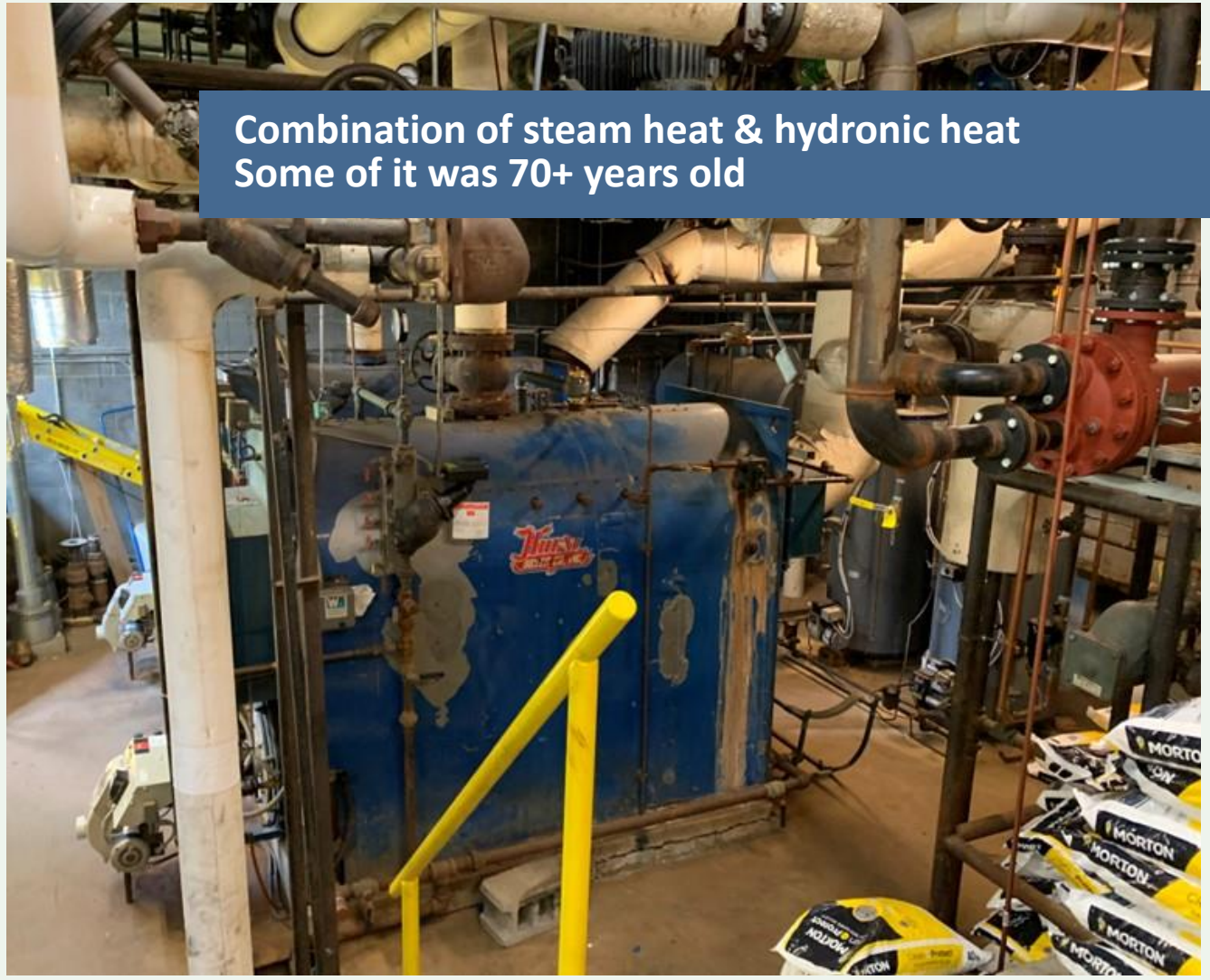
# Options & analysis we provide

- What is the fuel source of the future?
- Oil, LP, Biomass, Geothermal, electric heat pump
- 2. Does the campus keep Steam or Convert to hot water?
- Maintaining a Steam system means standard efficient boilers and a commitment to fossil fuel or biomass
- Key infrastructure still needs upgrade but could reuse some boilers and building mechanical rooms
- Do they stay on oil or propane – or move away from fossil fuels
- How far do we take the energy upgrades, and where does it go?
- Should we change the lights to LED?
- What additional code or capital needs do we need.
- Phased Approach

**Franklin Elementary School, VT – 2022**
- Oil to LP w/ Condensing Boilers

# Case Study - Bethel Middle School
# Existing Situation

- Pneumatic Controls that were past end of life
- The steam traps had failed around the building and the owner group had a retiring maintenance staff
- Fluorescent Lighting
- Oil as primary heat source burning around 45,000 /gallons year





EEI
ENERGY EFFICIENT INVESTMENTS INC.

# Biomass Wood Chip Boiler

- ✓ Cheaper Fuel Source
- ✓ Reduction of CO2
- ✓ 80% of cost stays within a 60-mile radius
- ✓ 40-year infrastructure investment
- ✓ Renewable energy source

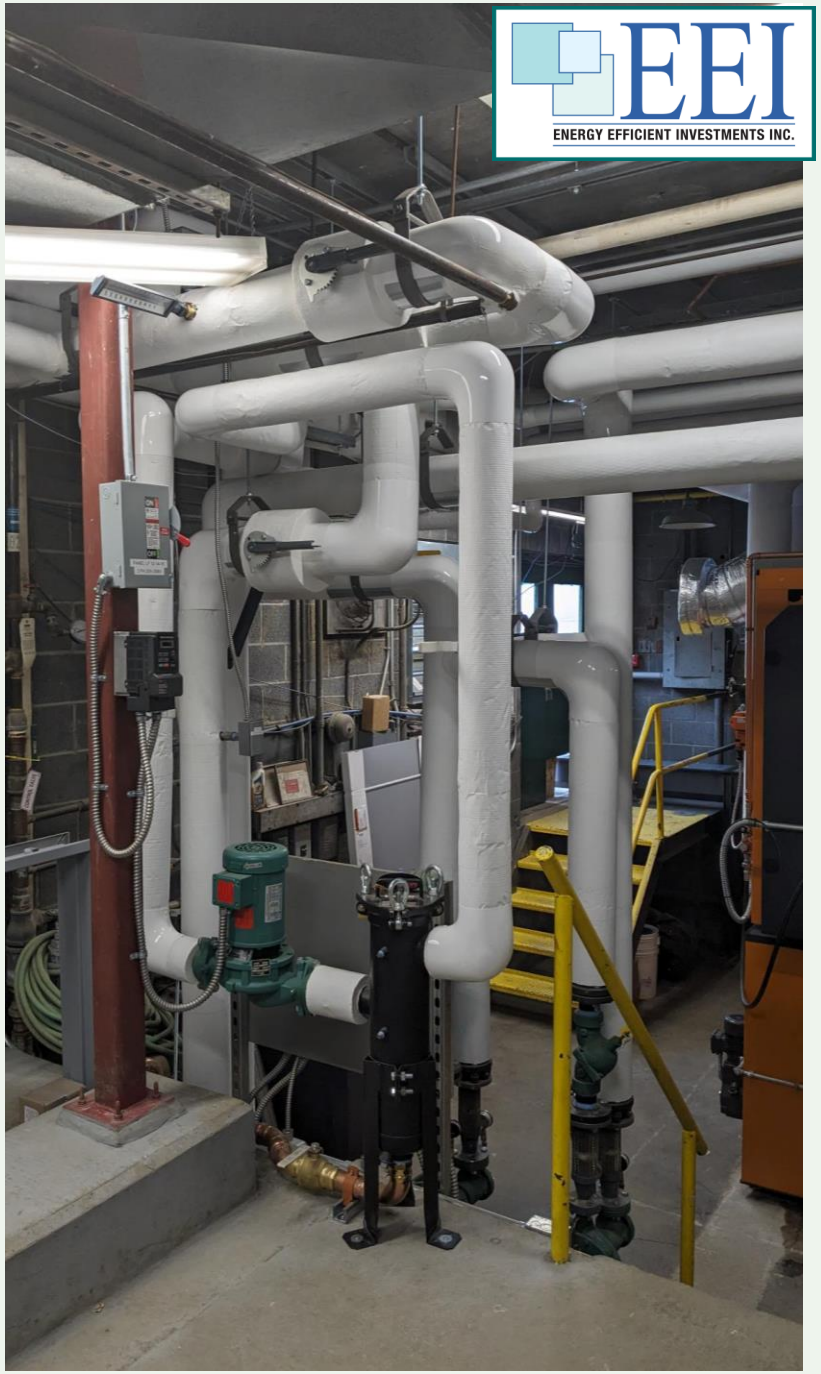

# Challenges

- Decisions - Dry Chip vs. Pellet
- Space issues & access
- ACT 250 Permitting
- Because the site had an active ACT 250 permit, this triggered a decision
- Multiple funding sources with strict guidelines for use & timelines
- Oil as primary heat source burning around 45,000 /gallons year

# ECM Matrix - Bethel Campus

| Measure | Description | Cost | Savings | Grants | Rebate |
|---|---|---|---|---|---|
| ECM 1 | Remove Existing Underground Fuel Oil Tank | $35,000 | | | |
| ECM 2 | Install Underground LP Tanks & Pipe to the Building (4 Underground - 1,000 Gallon Tanks) | $50,000 | | | |
| ECM 3 | Add Wood Pellet Boiler w/ LP Backup | $675,000 | $48,000 | | |
| ECM 4 | Convert Steam to Hydronic | $425,000 | | $250,000 | $24,000 |
| ECM 5 | DDC Control System | $245,000 | $4,200 | | |
| ECM 6 | LED Lighting upgrade thoughout (fixture replacement) | $240,000 | $12,000 | | $65,000 |
| ECM 7 | Abestos Abatement (allowance) | $50,000 | | | |
| | **Total** | **$1,720,000** | **$64,200** | **$250,000** | **$89,000** |
| | **Less Grants & Rebates** | $1,381,000 | | | |
| | **WRVSU ESSER Contribution** | $310,000 | | | |
| | **Bethel/Royalton Responsibility** | $1,071,000 | | | |
| | **15 Year Lease on LED Lighting & Pellet Boiler** | $920,000 | | | |
| | **WRVSD - Contribution** | $151,000 | | | |





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ENERGY EFFICIENT INVESTMENTS INC.

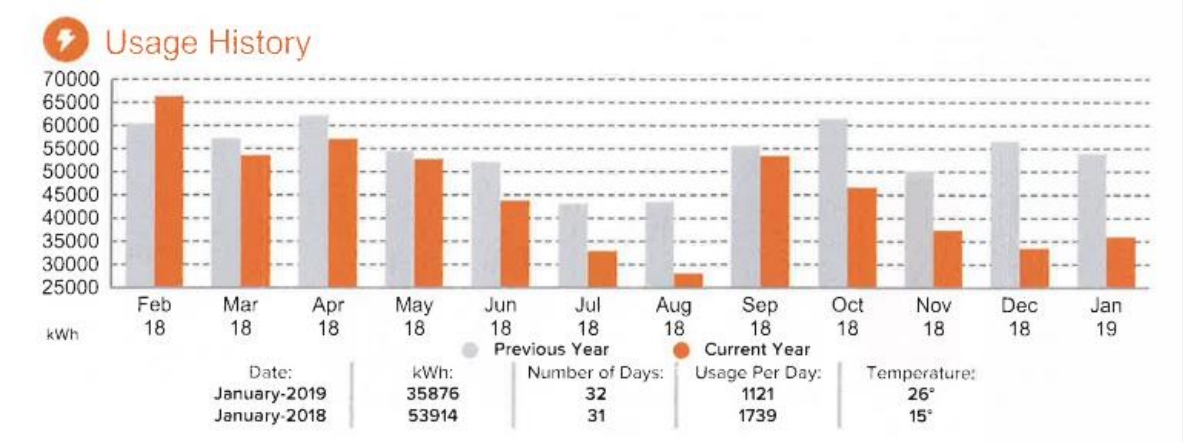

# Results

- In 2024  we used 9,000 gallons of Propane & 145 tons of wood chip
- Total Fuel Savings $58,000 / Year
- Completed Wood Chip January 2024
- Utilized Propane for first part of heating season
- Electrical lighting savings slightly below projected due to new split system, heat pump hot water, heater
- All new Heating System – no more service calls, DDC web based controls, & continuous commissioning looking for added savings this year

# Case Study - Addison Northwest SU

**In 2017, after a competitive selection process, EEI was selected to complete an energy audit**

- Driver of the project was the failed steam and boiler system at VUHS.
- The project was completed in late 2018 and include
- Condensing gas boilers at VUHS and VES
- Solar Panels VUHS
- Several new ventilation units at all 4 Schools
- Fire Safety improvements ant VES
- LED Lighting at all Schools



EEI
ENERGY EFFICIENT INVESTMENTS INC.

# THANK YOU

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# THANK YOU REV2024 SPONSORS!