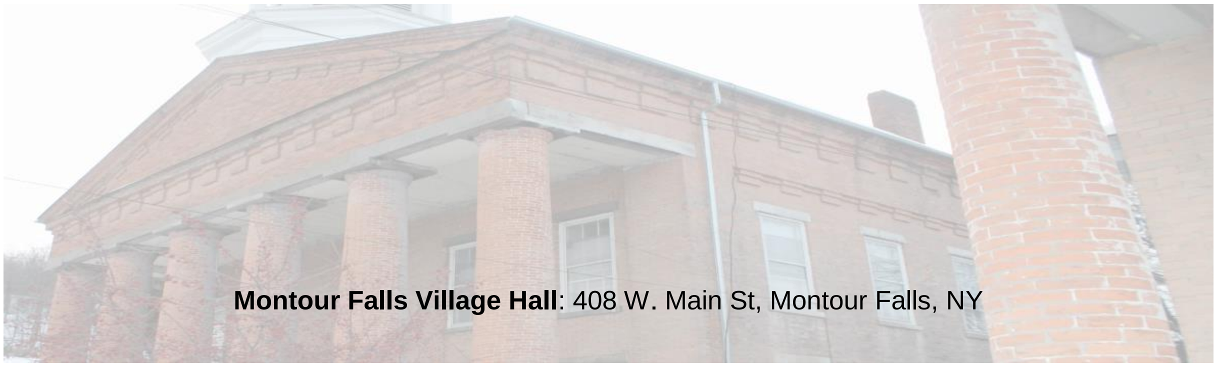
Montour Falls Village Hall– Energy Action Plan



Montour Falls Village Hall: 408 W. Main St, Montour Falls, NY

1 Introduction/Overview

1.1 Overview of the Municipality

The village of Montour Falls is a rural community in Schuyler County with a population of approximately 1,500. The Deputy Mayor of Montour Falls is interested in energy efficiency and wants to explore opportunities to lower energy use at their Village Hall building. The Montour Falls Village Hall was the only building inspected for this analysis.

The site audit at the Montour Falls Village Hall was conducted on 1/16/2019 by Katherine Herleman, Clean Energy Communities Coordinator through a partnership with Cornell Cooperative Extension of Tompkins County. The onsite contact for the town was Jim Ryan, Deputy Mayor. Analysis and reporting were completed by a team from Taitem Engineering, with Aditi Parlikar as the primary point of contact.

The site consists of an approximately 7,252 sf brick two-story building with a basement below grade. The building is well zoned and manual/automatic thermostats are installed in each room. All rooms have automatic setbacks set up except for the courtroom, where the occupants change thermostat settings as required. Photos of the spaces, building envelope and major equipment are included in the appendix.

The building is broken into four main use areas:

- 1st floor offices, board room and kitchenette: The clerk's office, code enforcement office, bathrooms, kitchenette, and boardroom take up approximately 75% of the first floor area. These rooms are occupied between 7 AM and 5 PM every day of the week. They are heated by hot water baseboards that run along the walls. Four split air conditioning units are used in the summer to cool these rooms. The occupants often use electric space heaters, as despite the 70 deg F setpoint during the heating season, it is often cold enough to cause discomfort.
- Courtroom: The courtroom is in the Southwest corner of the building. It is occupied from 8 AM to 5 PM on weekdays, and the thermostat setting is 70 deg F for this time. This space has a manual thermostat that is seldom adjusted to lower the temperature at night and on weekends. This space has five windows, and two of them have multiple cracks, gaps between the frames and the wall and badly worn timber frames. The occupants have complained of drafts and discomfort during the heating season.
- Mudroom: The Mudroom or corridor runs along the length of the building, from the street-facing South wall up to the North wall and occupies approximately 10% of the first floor area. The mudroom thermostat is set at 70 deg F from 8.45 AM to 5.00 PM on weekdays

and 60 deg F on the weekends. The space is heated by hot water baseboards and has no cooling equipment.

- Unconditioned basement: The basement floor area is equal to that of the first and second floors (3,626 sqft) and the height is approximately 10-12 ft. The boilers, domestic hot water system, and emergency gas shutoff valve are in the basement. Piping for both the boilers and domestic hot water in the basement are uninsulated.
- 2nd floor community theater: The 2nd floor of the building is currently a community theater space that is no longer utilized, because of the high heating and cooling costs associated with using this space. The area of this room is 3,112 sqft and the height of the ceiling is 20 ft. Two Reznor gas-fired heaters suspended from the ceiling and two indoor split AC units served the space when it was being used. This area has 17 of the total 32 windows in the building. A non-functioning manual thermostat is installed in the space, set up to control the split units and the Reznor heaters.

The Montour Falls Village Hall building is part of the Montour Falls Historic District that was listed on the National Register of Historic Places in 1978. The building rests on a foundation of large stones hewn to fit closely and then mortared together. The original door and sidelights contribute to the facade. An octagonal wood frame cupola and two brick chimneys rise from the roof to about 10 ft. All the bricks, rounded for the columns and straight for the walls, were handmade and fired from clay at the time of construction in 1855. Very few structural changes have been made within the building. Some of the interior has been renovated with paint and the plank floors have been covered with tiles. The back of the building has wooden walls that were likely installed as an addition shortly after construction and are assumed to be wood lath with a coat of plaster. These walls have exterior wood siding installed at the same time that the walls were added. It could not be determined if these walls have any cavity insulation.

The site contact mentioned that the roof had polyisocyanurate insulation of an undetermined R-value under the shingles. It could not be verified if the roof has a membrane to prevent moisture from seeping into the building structure. The auditor captured photos of significant water damage along the West wall and in the Northwest corner of the building. This seems to be from a previous water leak from either the roof or a gutter pipe. Taitem observed from photos of the building exterior that approximately 760 sqft of wall area showed signs of water damage.

The first floor of the village hall is divided into two sections by the mudroom. The spaces on the first floor are zoned well. Each space has its own programmable thermostat and adheres to a setback of 60 deg F, apart from the courtroom, which has a manual thermostat that is rarely set back. The first floor is the part of the building with the highest occupancy and utilization.

A single room occupies the entire second floor, which is currently unconditioned and has a nonfunctioning thermostat. Previously used as a community theater space, the Village stopped using this room because the utility costs associated with heating and cooling it were too high. There are two ceiling mount Reznor gas fired heaters (rated at 132,000 Btu/h and 104,000 Btu/h) in the space and two split AC units (each rated 30,000 Btu/h) that provide cooling. Both the heating and cooling systems have not been used or maintained since this room has been out of use. The Village is seeking to renovate and utilize this space as either an event space capable of handling 80-100 occupants or an office for the Village court, with an occupancy of 15.

The basement walls are composed of stone and the basement ceiling is 3-4 ft above grade. The basement is unconditioned, and the windows are boarded up and insulated with 1” thick rigid board insulation with an R-value of 6.5. The auditor observed many areas in the basement where the old blown-in cellulose insulation of undetermined thickness had settled. The two gas-fired boilers, the gas-fired domestic hot water system and electric and gas meters are all located in the basement, which is divided into smaller rooms and utility closets. There is a significant amount of hot water piping in the basement, both from the boiler and the DHW system.

The building has 32 windows, and the auditor observed multiple windows with cracks and gaps between the frame and the wall. In addition, old weather stripping on the windows and doors had fallen apart, leaving gaps between windows and the walls, and between the doors and their frame. Thus, there were numerous sources of infiltration. Even though the building is segmented and zoned well, the courtroom is one of the largest spaces in the building, has two exterior walls, and 2 out of its 5 windows have broken panes. The courtroom thermostat is rarely setback when the room is unoccupied. This causes the spaces to be heated to the respective setpoint even when they are unoccupied. The board room has single pane inoperable windows that are painted shut. Though there are no cracks in the window panes, the occupants experienced very low temperatures in this room, owing to the gaps between the window jambs and the wall. Three windows on the second floor were also reported to have broken panes.

The interior and exterior lighting is a mix of incandescent bulbs and 4' T12 lamps. The village hall recently had an energy audit for their lighting systems and they are considering options to replace the existing lighting.

The natural gas boilers are 13 years old, function well and are regularly maintained. The site wants to conduct a cost-benefit analysis of replacing these boilers with Air Source Heat Pumps, as they are considering options for a Power Purchase Agreement with a solar developer. The domestic hot water demand at the site is low, as there are no showers. The existing DHW system is a natural-gas fired storage tank system.

1.2 Goals

The site recently received a grant for $50,000 to pursue energy efficiency improvements, and wants to spend these funds on five main objectives, listed below:

The first objective is to identify and perform a Cost benefit analysis for common insulation related building comfort issues. The occupants complained of drafts and insufficient heating throughout the building and the auditor noted many issues with the envelope. Taitem used the auditor's notes and photographs to determine sources of air leaks and infiltration and calculated associated energy costs and savings.

The second objective is to identify appropriate HVAC updates to accommodate ASHP proposals for both the first and second floors. For the first floor, Taitem investigated replacing the existing natural gas boilers and portable electric heaters with mini or multi split Air Source heat pumps. The size and style of the heat pumps recommended will come with a packaged controller and are generally not compatible with commercially available third-party programmable thermostats. For the second floor, the heating and cooling use demand and expected use depends on how the space will be used, as an events space or an office. Taitem analyzed the heating and cooling requirements for both scenarios and recommended an approximate system size, with associated energy costs and savings.

The third objective is to identify ways to reduce the site's dependence on natural gas completely. The village would like to explore options to stop buying electricity from utilities and source 100% of their electric usage from a PPA with a solar developer. Taitem analyzed measures to replace the heating systems for both floors with ASHP's and provided information on the energy and cost savings based on whether the site purchases electricity from the utility company or through a PPA with a solar developer. After review of the Village Hall's utility data, Taitem found that the site was paying 17 cents/kWh of electricity, which is extremely high, compared to what neighboring towns pay. This is partly because the Village Hall's electricity supply rate is 10.5 cents/kWh.

The fourth objective is to improve and automate interior lighting. The site recently had a lighting audit performed by Lime Energy. As the lighting use and associated energy costs were already addressed in Lime Energy's report, Taitem did not consider this measure to be in our scope.

The fifth objective was identifying potential renovation issues and costs as related to the building's historical status. Taitem determined that this task falls out of our scope and would be better answered by an architect or the regulatory board that the site consults for permissions related to renovations.

Taitem analyzed other possible low-cost energy reduction opportunities for the Village Hall building that were of interest to the site contact. Several of these were envelope and insulation measures, along with one thermostat and one boiler replacement measure.

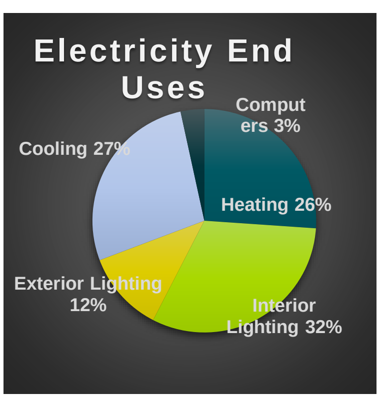
The town spends an average of $2,058 every year on natural gas at a rate of $0.92/therm and $1,942 a year on electricity at a blended rate of $0.17/kWh. Of the 11,409 kWh of electricity that the site consumes annually, approximately 2,976 kWh or 26% is used for heating.

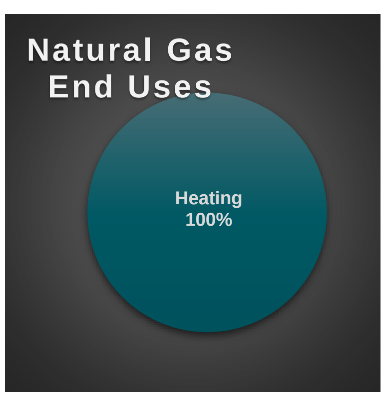
Taitem recommends that the site implement the ECM's listed in this report in two phases; Phase 1 consists of building envelope and insulation measures and Phase 2 consists of improvements to heating and cooling systems. The current boilers are 13 years old and are not in need of immediate replacement, but the auditor listed several issues (as described above) with broken windows, gaps between exterior doors and walls, insufficient heating, drafts and water damage that should be addressed more urgently.

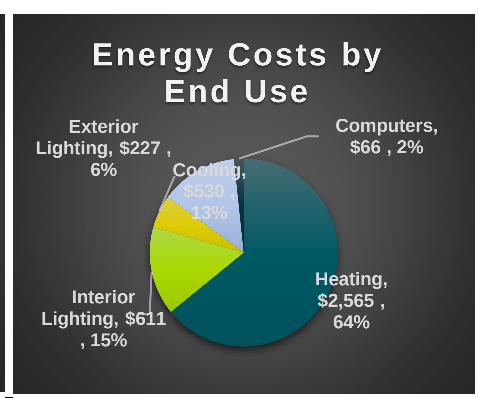
1.3 Summary Tables

Current Energy Consumption:

Fuel	Annual Cost	$/sq. ft./year	Annual Energy Use	Blended Unit Cost	Incremental Unit Cost
Electricity	$ 1,942	$ 0.27	11,409 kwh	$0.17 per kWh	$0.15 per kWh
Natural gas	$ 2,058	$ 0.28	2,240 therms	$0.92 per therm	$0.82 per therm
Total Energy Cost	**$ 4,000**	**$ 0.55**			







2 List of Recommended Actions

Phase 1, building envelope and insulation, damage repair: Cost and Energy Impacts

	Energy Reduction (Fuel units/ per year)	Energy cost reduction/ year ($/year)	Estimated Cost to Implement	Simple Payback Period	Greenhouse gas emission reduction
2.1 Water damage repair: Tuckpointing bricks in sections of North, West and East walls (approx. 760 sqft) damaged by water leaks	NA	NA	$30,000	NA	NA
2.2 Air sealing and weatherization: Install weather stripping for windows, caulk roof/ceiling-wall joints, add weather strips to exterior doors.	52 therms of Natural gas	$41	$1,177	28.4 years	278 (**kg CO_2** per year)
2.3 Insulation: Install 2” spray foam insulation on interior of basement walls.	972 therms of Natural gas	$770	$5,830	7.6 years	5,156 (**kg CO_2** per year)
2.4 Window replacements and Window skins: Replace 5 windows in courtroom and install “Window skins” on all 32 windows of the building.	809 therms of Natural gas	$641	$4,839	7.6 years	4,290 (**kg CO_2** per year)
2.5 Piping insulation: Install fiberglass piping on boiler and DHW piping throughout building	129 therms of Natural gas	$102	$644	6.3 years	684 (**kg CO_2** per year)
2.6 Thermostat schedules & setback: Install one programmable thermostat in Courtroom to set temperature at night and weekends (after 5 PM) to 60 F during heating season.	97 therms of Natural gas	$77	$59	0.8 years	516 (**kg CO_2** per year)

NA: Not applicable, NV: Not verified
Emissions factors from: https://www.eia.gov/environment/emissions/co2_vol_mass.php and https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf

Taitem recommends that the site install the measures in Phase 1 (measure 2.1 to 2.6) before trying to replace the heating and cooling systems for the site (measures 2.7 to 2.9). Phase 1 consists of envelope and insulation measures, which will reduce heat loss from the building and reduce the load on heating and cooling systems. After the measures in Phase 1 are implemented, a design contractor can estimate the new heating and cooling load for the building and size the proposed ASHP's accurately to meet the building load. If an ASHP system is added to the site without addressing its many envelope and insulation issues, the energy costs are likely to increase and the actual returns from the ASHP system will be lower than expected or will be negative.

2.1 Repairing water damage to the building

Tuckpointing is an improvement/rehabilitation of existing mortar joints in masonry walls. Fresh mortar is tucked into the joints to replace old and crumbling mortar. When done properly, tuckpointing can provide a strong a waterproof mortar joint matching the original appearance of mortar joints.

From the auditor's photos of the site, Taitem observed that the North, West and East walls showed signs of water damage from either a roof leak or a break in the gutter pipe that runs along the perimeter of the building. This damage needs to be repaired by tuckpointing the bricks in the masonry wall, removing any parts of the wall frame that are rotting due to moisture and adding a fresh coat of paint where necessary. It is difficult to estimate from just photos how much damage has been caused to the walls, so Taitem used an estimate to calculate only the cost of tuckpointing bricks for the portions of the wall with visible signs of damage.

At a price of $30,000 for repairing (only for tuckpointing bricks and excluding other steps) approximately 760 sqft of masonry walls, this measure won't result in direct energy savings, but it is a must before any air sealing measures are installed. It is imperative that the site hire a contractor to assess and repair water damage caused to the building and to locate the cause of moisture infiltration, as this directly affects the structural integrity of the building. The other recommended measures in Phase 1 should be installed only after this measure has been implemented.

2.2 Air sealing and weatherization

Figure 1: Sources of air leakage

The purpose of air sealing is to create an effective air tight seal on the building envelope. This will reduce the amount of air flow and heat loss from conditioned space to un-conditioned space or to the outdoors. Reducing air infiltration is vital to creating a more energy efficient building. Factors that cause high air flow rates include the size and number of openings that connect the conditioned and unconditioned spaces and pressure differences between the interior and exterior of the building. The differences in pressures are typically caused by stack effect, wind, and temperature differences between the inside and outside of the building.

This measure includes installing new weather stripping at exterior doors between the doors and door frames (approximately 72 linear ft), and new weather stripping for 27 operable windows (200 linear ft total for all windows except the ones in the courtroom and board room). It also includes caulking 100 ft of roof-wall joints on the second floor and parts of the first floor and caulking approximately 200 linear ft of the joints between window jambs and walls. An air sealing contractor will use special diagnostic tools to pinpoint and seal hidden air leaks

There are numerous sources of air infiltration and heat loss in the building, and together, these measures will reduce heat loss from the building and increase occupant comfort. These measures are only useful if they are installed in conjunction with repairing water damage to large sections of the wall.

At a total price of $1,177, this measure will return in annual energy cost savings of $41, equivalent to 52 therms of natural gas. Despite the high payback of 28.4 years, this measure is crucial because it improves indoor air quality, reduces the load on the heating/cooling system and improves occupant comfort and well-being.

2.3 Adding spray foam insulation to basement walls

Heat moves from areas of high temperature to areas of low temperature. As the temperature between a heated and an unheated area becomes greater, so does the rate of heat transfer. Insulation reduces the rate of heat transfer by filling the space with material that is less conductive than what is currently there. The effectiveness of insulation is measured by R-value, which is the resistance to heat transfer. As the R-value gets higher, the rate in which heat is transferred gets lower.

The basement walls of the building are composed of stone and are uninsulated. The ceiling of the basement is 3-4 ft above grade, which results in heat being lost from the building to the basement and then to the ambient air through this part of the walls. We recommend that the site add 2” thick closed cell polyurethane insulation to the interior of the basement walls. This is a relatively easy measure to install and it will take up minimal space in the basement. Since the basement is divided into smaller rooms and utility closets, these walls that are perpendicular to the exterior walls should also be sprayed at the joints between exterior-interior walls.

At a price of $5,830 for insulating approximately 2,460 sqft of the basement foundation walls at the interior surface, the energy savings for this measure are 972 therms of natural gas, equivalent to $770 in gas costs. This measure has a payback of 7.6 years. When insulation is combined with air sealing, convective air currents that circulate air within cavities and through insulation are reduced, which increases the effective R-value of the insulation.

2.4 Replacing 5 windows and installing Window Skins for all 32 windows in the building

Figure 2: Single pane inoperable window in board room, painted shut

As mentioned in the building description, the auditor noted that two of the courtroom windows and all three board room windows are older single pane windows. The former also have cracked panes and gaps between the window jambs and walls. The board room windows are also single pane inoperable windows that are painted shut, but occupants have complained of very low temperatures in the room adjacent to the windows.

In addition, heat loss due to conduction through single pane windows can be very high. The five new replacement windows will utilize two panes of glass instead of one. The best option is to replace these windows with double pane single hung windows with an interior storm window and WindowSkins. WindowSkin is a transparent custom-fit window insulation system that mounts onto existing windows, upgrading energy efficiency and indoor comfort. It is an affordable window upgrade for the remaining 27 windows in the building too, as these already have storm windows.

Thus, this measure will consist of:

a. Replacing courtroom (2) and board room windows (3) with new double pane single hung windows with interior storm windows and WindowSkins.
b. Window skins added to the remaining 27 single pane single hung windows in the building, which already have storm windows.

At a total cost of $4,839, this measure will result in 395 therms of natural gas saved annually, equivalent to annual cost savings of $743, at a payback of 7.6 years. The savings for this measure were adjusted to reflect the current non-use of the second floor (the indoor temperature for the existing case was lowered to 66 deg F).

2.5 Installing piping insulation for boiler and DHW piping

Figure 3: Fiberglass insulation with jacket for boiler and DHW piping

Heat is distributed from the boiler to baseboards in each zone by pipes containing hot water. These heating distribution system pipes lose heat to the surrounding space. If the heat is lost to an area that does not require heating, the drop in system efficiency can be significant. Un-insulated pipes in conditioned space may also overheat the space, wasting energy and causing comfort problems. All heating distribution system and DHW pipes located in unconditioned space should be insulated.

The boiler and the DHW system at the Village Hall are in the basement, which is unconditioned. The DHW copper piping, the boiler mains piping, zone pumps and PEX zone piping runs (to 8 zones) are in the basement and all the piping is uninsulated. We propose adding 1” of fiberglass insulation with jacket for the following:

a. Steel boiler piping, 0.75” diameter: 25 ft
b. Steel boiler piping mains, 3” diameter: 20 ft
c. DHW copper piping, 0.5” diameter: 50 ft

With a total estimated price of $644, this measure saves 129 therms of gas annually, resulting in cost savings of $102. Thus, this measure has a relatively low payback of 6.3 years. This measure is a must if the site decides to retain its existing hot water boiler and DHW system.

2.6 Thermostat controls and schedules:

Figure 4: Programmable thermostat

The Courtroom is occupied from 8 AM to 5 PM every weekday, and the auditor observed the following settings on the room’s thermostat:

M-F: 8.00 AM to 5.00 PM – 70 deg F, 5.00 PM to 7.59 AM – 67 deg F

Weekends: 65 deg F

However, the site contact stated that the occupants override the temperature manually and often forget to set it back. As a result, the room is heated to the occupied time setpoint even when it is not being used. The occupants change the thermostat settings frequently because 2 out of the 5 windows in this room are broken and loose, which causes cold air infiltration and a drop in the space temperature. Thus, even if the thermostat is set at 70 deg F, the actual temperature in the space is often closer to 65-67 deg F.

We propose installing a programmable thermostat which controls the hot water baseboards and sets back the temperature of this space to 65 deg F every day when the space is unoccupied.

Thus, the space temperature will be maintained at 68 deg F for 9 hours per day, from 8 AM to 5 PM and then set back to 65 deg F. At a price of $59 for one thermostat, this measure will save 97 therms of natural gas annually, equivalent to $77 in natural gas costs. The payback period for this measure is 9.6 months.

Savings can be achieved with any 7-day programmable thermostat. A suitable example is shown in the link: https://www.homedepot.com/p/Honeywell-Wi-Fi-7-Day-Programmable-Thermostat-Free-App-RTH6580WF/203556922). Current DOE guidance is to expect savings of approximately 1% of your heating bill for each degree reduced during an 8-hour setback period, which would result in significant savings.

Phase 2, Heating and cooling system improvements: Cost and Energy Impacts

	Energy Reduction (Fuel units/ per year)	Energy cost reduction/ year ($/year)	Estimated Cost to Implement	Simple Payback Period	Greenhouse gas emission reduction
2.7 Boiler replacement: Install new condensing gas-fired HW boiler (206,000 Btu/hr capacity) to replace existing non-condensing boiler.	441 therms of Natural gas	$801	$18,188	22.7 years	2,338 (**kg CO_2** per year)
2.8 Multi split ASHP's for 1st floor: Install ASHP split system with a combined capacity of 206,000 Btu/hr. to heat all rooms on 1st floor	(14,531) kWh, (112.4) kW and 2,240 therms of Natural gas	($1,710)	$32,634	(19.1) years	4,240 (**kg CO_2** per year)
2.9 Multi split ASHP's for 1st floor, powered by solar energy: Power ASHP's in above measure through electricity sourced from a solar developer through a PPA.	(14,531) kWh, (112.4) kW and 2,240 therms of Natural gas	$13	$32,634	2,486 years	4,240 (**kg CO_2** per year)
2.10 Multi split ASHP's for 2nd floor: Install ASHP split system with a combined capacity of 236,000 Btu/hr to heat and cool the second floor.	(23,013) kWh, (128.8) kW and 3,278 therms of Natural gas	($2,478)	$27,900	(11.3) years	5,286 (**kg CO_2** per year)
2.11 Multi split ASHP's for 2nd floor, powered by solar energy: Install ASHP split system with a combined capacity of 236,000 Btu/hr to heat and cool the second floor.	(23,013) kWh, (128.8) kW and 3,278 therms of Natural gas	($375)	$27,900	(74.4) years	5,286 (**kg CO_2** per year)
2.12 Electric resistance water heater: Install point-of-use water heater to replace storage tank gas water heater	(1,248) kWh, (1.8) kW and 129 therms of Natural gas	($291)	$555	(1.9) years	117 (**kg CO_2** per year)

NA: Not applicable, NV: Not verified
Emissions factors from: https://www.eia.gov/environment/emissions/co2_vol_mass.php and https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf

The measures listed in the table above are related to heating and cooling systems at the Village Hall. The site stated that they are interested in installing Air Source Heat Pumps, identifying pathways to use 100% renewable electricity and when feasible, completely removing natural gas use. We believe that once the site has sealed the building envelope by implementing the measures in Phase 1, the Village Hall will be a better candidate for high-efficiency heating and cooling systems like heat pumps. Plus, the site will have comfort issues if measures in Phase 1 aren't implemented before Phase 2. Please note that the measures in Phase 2 are thus sized according to the building's current heating and cooling load and not the predicted load after measures in Phase 1 are implemented.

2.7 Replacing the existing gas-fired non-condensing boiler with a gas-fired condensing boiler

Figure 5: Proposed 100 MBH condensing boilers

The two existing forced air gas-fired boilers are 13 years old, are maintained regularly and work well. The site could install two condensing boilers to replace these, which would increase the combustion efficiency from the current 82.4% to approximately 92-95%.

From the occupancy and schedules obtained from the auditor and details about the building envelope for the existing condition, Taitem calculated the heating capacity of the boiler needed to provide enough heating to the building to be approximately equal to the existing capacity of 206 MBH.

Installing the new boiler will save the site 441 therms of natural gas per year. The boiler would also replace 2,976 kWh of electric resistance heating, equivalent to $451 in electricity costs. The total equipment and installation costs of $18,188 are based on prices for a two 100 MBH sized boilers with stainless steel vent piping. With annual savings of $801, this measure has a payback of 22.7 years. The capacity of the proposed boilers is likely to reduce if the building implements measures in Phase 1. This could in turn increase the energy and cost savings for this measure and lower the payback. However, this measure would still use natural gas and is not in line with the site's goal of relying completely on clean energy.

2.8 Installing multi split Air Source Heat Pumps to replace existing natural gas boiler, 1st floor

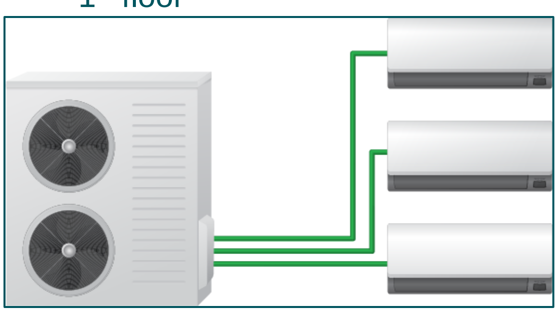


Figure 6: Proposed multi split heat pumps

Instead of installing new gas-fired boilers, the site can install ductless mini or multi-split Air Source Heat Pumps (ASHP) to heat and cool all the rooms on the first floor. Taitem assumed that the ASHP's would be used in the cooling season as well, as the site uses 4 split AC units (each rated at 11,000 Btu/hr) during the cooling season on the first floor.

The approximate material and installation price is $32,634 for ASHP's with a total heating capacity of 206,000 Btu/hr. This measure does not pay back, despite saving 2,240 therms of natural gas (100% of the site's current gas consumption), the measure would consume 14,531 kWh and 112.4 kW annually that it does not consume right now. With the site currently paying a relatively high price of 17 cents/kWh, this measure can take the site towards its goal of reducing dependence on natural gas, but it is not cost-effective until the Village Hall's cost of electricity reflects what Montour Falls' neighbors pay (roughly 10 cents/kWh).

Furthermore, because the site currently has a low demand during peak hours, it does not pay a demand charge to NYSEG. If the site were to install ASHP's in accordance with this measure, Taitem assumed that the Village Hall would pay $9/kW, or $1,012 in demand charges for the 112.4 kW the ASHP's would consume. Even with the heat pump system's annual COP of 2.9, this measure would thus have a negative payback. Due to the factors listed above, this measure has a negative payback value and a negative NPV.

The ASHP would substantially lower the site's dependence on fossil fuel, as it could replace the natural gas boiler and all portable electric heaters, plus the older split systems that cool the first floor spaces. Along with ECM 2.10, this measure can completely remove the necessity to purchase natural gas.

In addition, the ASHP would also provide better zone control and increase occupant comfort. It would reduce dependence on manual thermostats, as the recommended ASHP's are equipped with a packaged controller that will provide the occupants in the three divisions with a simplified control strategy for temperature control.

2.9 Installing multi split air source heat pumps to replace gas-fired boiler and buying power used for ASHP's through a PPA

If the site decides to buy electricity through a Power Purchase Agreement to power the ASHP's described in Measure 2.8, the heating for the entire first floor can be powered by electricity obtained from renewable energy. Buying electricity through a PPA will likely lower the site's electricity rate compared to what it currently pays. Taitem recommends that the site consult solar developers and other agencies that can provide the Village hall with a detailed description, contract and quote for a PPA.

After conducting research on typical electricity costs for power purchased from solar developers in the area, we assumed that the site would pay 9 cents/kWh and $7/kW if it bought its power through a PPA. These rates are likely to change and affect the cost-effectiveness of this measure. With the assumptions we made, it has a very high payback. This measure would save 2,240 therms of natural gas but consume 14,531 kWh and 112.4 kW more, similar to Measure 2.8. It would save the site $13 per year.

2.10 Installing multi split air source heat pumps to replace gas-fired heating and split AC units serving second floor

This measure consists of installing multi split system to replace the Reznor gas-fired units and the split air conditioning systems that served the second floor community theater. There are two ceiling mount Reznor gas fired heaters (rated at 132,000 Btu/h and 104,000 Btu/h) in the space and two split AC units (each rated 30,000 Btu/h) that provide cooling. Both the heating and cooling systems have not been used or maintained since this room has been out of use.

If the second floor room were to be used right away, the Village Hall would repair and utilize the existing Reznor units. Thus, a suitable replacement would be a multi split system of the same capacity as the Reznor units and a cooling capacity of approximately 15 TR. This cooling capacity is sufficient if the space were to be used as an office with up to 15 occupants. If the space were to be used as an events hall, the cooling capacity would drop to 5-6 TR, and the multi split systems are well equipped to run at part load and satisfy this cooling demand. Thus, these heat pumps would be well equipped to handle the existing heating and cooling loads for both scenarios.

If implemented, this measure would reduce natural gas use to heat the space by 3,278 therms and increase the annual electricity/demand consumption by 23,013 kWh and 129 kW. Due to the same factors that affect Measures 2.8 and 2.9, this measure has a very high cost for electricity and does not pay back.

2.11 Installing multi split air source heat pumps to replace gas-fired heating and split AC units serving second floor

If the site decides to buy electricity through a Power Purchase Agreement to power the ASHP's described in Measure 2.10, the heating for the entire second floor can also be powered by electricity obtained from renewable energy. As noted in Measure 2.9, Taitem recommends that the site consult solar developers and other agencies that can provide the Village hall with a detailed description, contract and quote for a PPA.

We assumed that the site would pay 9 cents/kWh and $7/kW if it bought its power through a PPA. These rates are likely to change and affect the cost-effectiveness of this measure. With the assumptions we made, it has a negative payback. If implemented, this measure would have the same gas and electric savings as for Measure 2.10.

2.12 Installing a point-of-use electric water heater to replace natural gas fired storage tank water heater

The existing domestic water heater is a natural gas fired storage type system that serves the sinks in restrooms. The site has no showers. If the Village Hall replaces the existing storage type natural gas water heater with a point-of-use electric water heater, the proposed electric water heater is rated at 1.8 kW. Because of the high costs of electricity and relatively low cost of gas, this measure does not pay back. At a total material and installation price of $555, this measure would save 146 therms a year, and consume 1,248 kWh and 21.6 kW annually.

If the site were to replace the heating system with an ASHP system and implement this measure, it will save $24 a month (equivalent to $283 a year) in basic service charges on their natural gas bill. This would reduce the site's dependence on fossil fuels completely. With the current price of electricity ($0.17/kWh and an estimated $9/kW demand charge), this measure still does not pay back. The annual energy cost savings for this measure with and without the basic service charge are ($291) and ($8) respectively. However, if the Village Hall were to purchase power from a solar developer at a comparatively lower rate, this measure can pay back and be cost effective.

Measures 2.8, 2.9, 2.10, 2.11 and 2.12 would certainly be cost-effective if the site negotiated the price of its electricity. All the measures in Phase 1 if implemented together would reduce the heating and cooling load at the building, improve indoor air quality and occupant comfort. The site can then consult a contractor to size their heating, cooling and domestic hot water systems as described in Phase 2 to the new improved building loads. Moreover, even if the site decides not to implement the measures in Phase 2, implementing the Phase 1 measures will reduce the quantity of natural gas the existing boiler uses considerably and thus save money.

If the proposed systems in all Phase 2 measures were sized to the new heating/cooling load, the energy consumption to heat and cool the building would decrease. We strongly encourage that before adding heat pumps to the current leaky building, the site should use the funds from its grant to address the poor condition of the building envelope, as these impact the long-term structural integrity of the Village Hall and would help maintain its historical status while lowering its energy bills.

3 Appendix

3.1 Project Contacts:

Project Name	Montour Falls Village Hall
Project Owner	Village of Montour Falls
Site visit date	Wednesday, January 16, 2019
Site Auditor	Katherine Herleman CEC Coordinator 607 535 7161 x 3225 kch227@cornell.edu
Taitem contact (Analysis)	Aditi Parlikar Project Engineer 607 277 1118 x137 aparlikar@taitem.com

Building Address	408 West Main St Montour Falls, NY Schuyler County
Building Contact	Jim Ryan Deputy Mayor 607 351 2000 jryan@villageofmontourfalls.com
Taitem contact (Reviewer)	Umit Sirt Partner, Senior Engineer 607 277 1118 x128 usirt@taitem.com

3.2 Project Photos

Figure 7: South Elevation

Figure 8: West Elevation

Figure 9: Board room

Figure 10: Mudroom / corridor

Figure 11: Court room

Figure 12: Fujitsu outdoor condensing unit for 2nd floor split system

Figure 13: Clerk's office

Figure 14: Second floor community theater room

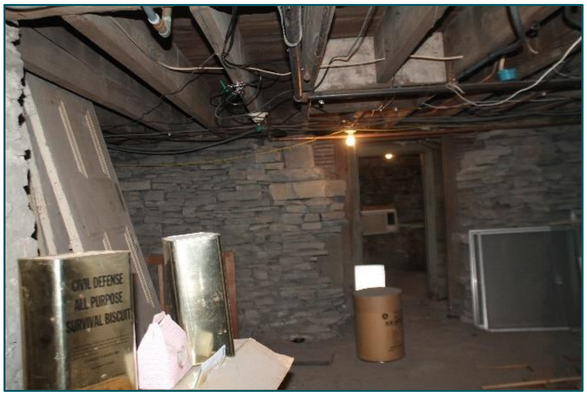


Figure 15: Basement

Figure 16: Basement window – boarded up, rigid board insulation

Figure 17: Old courtroom window – single window, cracks in pane

Figure 18: Hot Water Baseboard (Offices, courtroom, bathrooms)

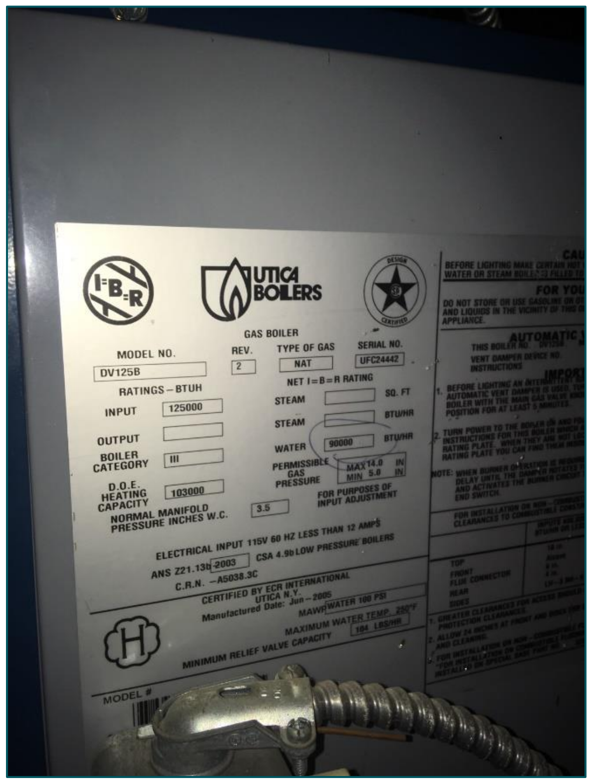


Figure 19: Existing hot water boilers

Figure 20: Domestic Hot Water Tank


Figure 23: Existing boilers


Figure 21: Example of water damage on East wall


Figure 24: Gaps between window jamb and wall


Figure 22: Improper drainage leading to moisture infiltration

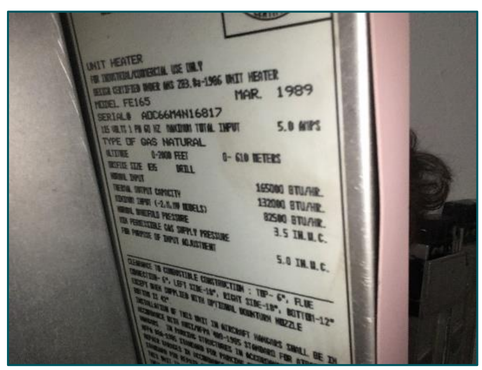


Figure 25: Reznor unit on second floor

Figure 26: Second Reznor unit on 2nd floor

Figure 27: Gap between board room window and window frame

Figure 28: More water damage along West wall of building

Figure 29: One split AC unit in second floor room

3.3 Disclaimer

This energy use assessment must be considered a preliminary evaluation only. The advisability of any suggested improvements would, in many cases, depend upon a more precise estimate of the savings available, as well as consideration of specific factors unique to your situation but which were not taken into account here. In addition, any actions which you will take, of course, must comply with all applicable codes and other legal requirements. The final responsibility for any actions taken lies with you and your firm.

The scope of this survey is to provide recommendations for energy conservation improvements for the building envelope and the building systems. The building envelope consists of the walls, roof, windows, and doors. The building systems consist of the heating, air conditioning, ventilation, lighting, and domestic hot water equipment. The report is not intended to be a highly detailed analysis of each improvement. The Energy Conservation Improvements recommended in this study are presented as stand-alone recommendations. The interaction between them may affect the savings if they are implemented together and savings will be different depending on the order of implementation. Assuming any order of implementation would be speculative in this report. It is left up to the owner's judgment to decide based on their priorities.

About Taitem

Taitem Engineering, PC, is a consulting engineering firm based in Ithaca, NY, specializing in -

- mechanical, electrical and structural design for green buildings
- commissioning
- LEED consulting
- energy studies & energy research
- solar PV design, service and commissioning

Our mission is to apply technology thoughtfully for the benefit of the earth and for the living beings that depend on it.