# FLEXTECH ENERGY STUDY

**For**

**Newfield Town Hall**
166 Main St
Newfield, NY 14867
***and***
**Newfield Town Barn**
79 Main St
Newfield, NY 14867

**New York State Energy Research and Development Authority**
17 Columbia Circle
Albany, New York 12203-6399

REV 2
May 2nd, 2022

For questions regarding this report, please contact FlexTech@nyserda.ny.gov.

We hope the findings of this report will assist you in making decisions about energy efficiency improvements in your facility. Thank you for your participation in this program.

**NOTICE**

This report was prepared pursuant to the Flexible Technical Assistance Program (Hereinafter "FlexTech") administered by the New York State Energy Research and Development Authority (hereinafter "NYSERDA"). The opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it by NYSERDA or the State of New York. Further, NYSERDA and the State of New York make no warranties or representations, expressed or implied, as to the fitness for a particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, energy savings, or other information contained, described, disclosed, or referred to in this report. NYSERDA and the State of New York make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately-owned rights and will assume no responsibility for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed or referred to in this report.

State of New York
Kathy Hochul, Governor

New York State Energy Research and Development Authority

## DISCLAIMER

This FlexTech energy audit study report must be considered a preliminary evaluation only. The savings presented in this report do not incorporate any interactive effect between the measures. The projected implementation costs of the measures, and the resulting energy and monetary savings, are all estimated values based on limited site observations, calculations and assumptions.

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. However, because energy savings ultimately depend on behavioral factors, the weather, and many other factors outside its control, Taitem Engineering does not guarantee the cost savings estimated in this report. Taitem Engineering shall in no event be liable should the actual energy savings vary from the estimated savings herein.

Estimated installation costs are based on a variety of sources, including our own experience at similar facilities, our own pricing research using local contractors and vendors, and cost handbooks such as those by RS Means. The cost estimates represent our best judgment for the proposed action. The building owner is encouraged to independently confirm these cost estimates. Since actual installed costs can vary widely for a particular installation, and for conditions, which cannot be known prior to in-depth investigation and design, Taitem Engineering does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein.

In addition, any actions which building management will take must comply with all applicable codes and other legal requirements. Building management will also need to obtain professional guidance for developing work scopes or design for the improvements recommended in this report.

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# 1. EXECUTIVE SUMMARY

## Introduction

This report presents the results of an energy use and savings opportunities assessment for the Newfield Town Hall, located at 166 Main Street in Newfield, NY and the Newfield Town Barn, located at 79 Main Street, also in Newfield. Taitem Engineering conducted a site visit to the facilities on January 13th, 2022 to observe the existing conditions of the facilities and to identify opportunities to reduce energy consumption. Heather McCarty (Town Councilperson) and Blixy Taetzsch (Town Bookkeeper) represented the Town of Newfield for the Town Hall, and Kevin Berggren (Highway Superintendent) represented the Town for the Town Barn. George Aiken represented Taitem Engineering for both facilities.

The purpose of the study is to provide insights into the building energy use and to identify opportunities to reduce energy consumption and greenhouse gas emissions. This study is also intended to identify feasible pathways towards eliminating direct fossil fuel consumption at each building by replacing existing fossil fuel burning equipment with electrically driven equipment.

This report was written and prepared by George Aiken, Project Engineer, Taitem Engineering, and was reviewed by Umit Sirt, PE, Senior Engineer and Partner, Taitem Engineering. All questions and comments should be directed to George Aiken at (607) 277-1118 ext. 137, or gaiken@taitem.com.

## Project Background

The Town of Newfield commissioned this study for multiple, related reasons. The first is that they are nearing (or have exceeded) the end of their expected useful life for much of the HVAC equipment in the Town Hall. As such, they are, or will soon be, facing large capital cost expenditures for equipment replacement. The second reason is that reducing energy consumption typically means reducing operating costs. It also has the possibility of reducing HVAC equipment replacement costs if savings are substantial enough to impact equipment sizing. The third reason is the opportunity for substantial reduction of greenhouse gas (GHG) emissions. As responsible stewards of their environment, the Town of Newfield is focused on reducing the GHG emissions associated with their operations to the extent of economic and practical feasibility.

It is worth noting that the Town of Newfield has already made significant improvements to their operations in the interest of reducing energy consumption and greenhouse gas emissions. Most notably, the two buildings at focus in this study have had all interior

and exterior retrofitted with LED lighting, substantially reducing electrical demand. Staff at both buildings are also very conscientious about energy use, and are diligent about keeping lights off when spaces are not in use, and setting back thermostats during unoccupied periods.

### Summary of Findings

Multiple energy conservation measures were identified and analyzed for their cost effectiveness as well as their energy and greenhouse gas savings impacts. Of these measures, air sealing and insulation stood out as the highest impact on energy and greenhouse gas emissions as well as being among the most cost effective options. Moderate thermostat setbacks also had a significant impact on energy usage and GHG emissions with very short payback periods. Replacing the gas fired heating systems in both buildings with air source heat pumps provided the single largest reduction in GHG emissions with very short payback periods when considering depreciation of existing equipment. Some of the measures which did *not* have as large impacts or cost effectiveness include heat pump water heaters and air curtains over garage doors. Details on all of the measures analyzed in this report can be found in Section 4. Areas of Opportunity.

# 2. PROJECT DESCRIPTION

## Building Systems Narrative

### Town Hall

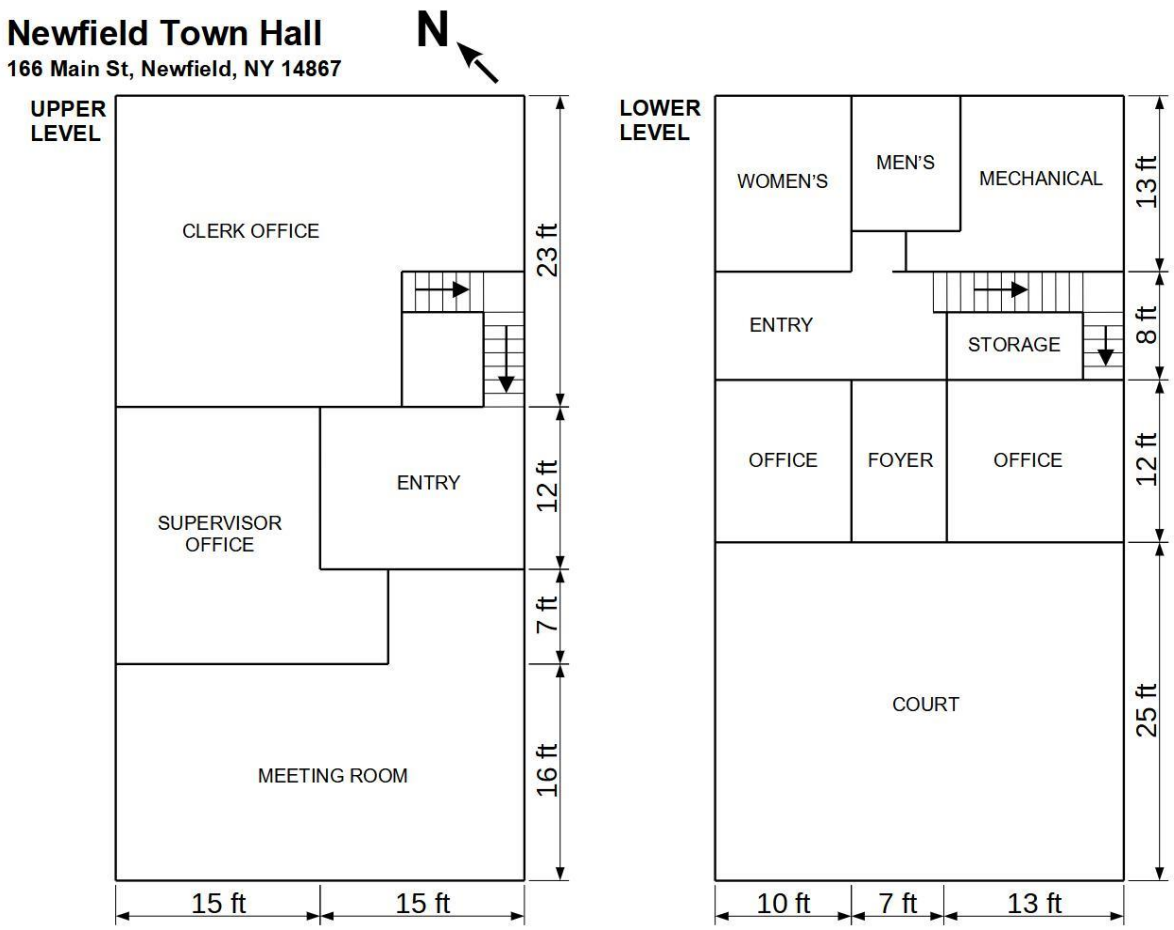
The Newfield Town Hall is a municipal building used for government offices, public meetings, and town court. The building was originally constructed in the 1970s. The building has about 3,500 $ft^2$ of gross floor area, containing office spaces, a meeting room, a courtroom, bathrooms, and storage/utility spaces. It has two floors, one of which is partially below grade. Two primary entrances serve the building, one on each floor. The building operating schedule varies based on community meetings in the evenings, but generally is in occupied mode approximately 8:00 am – 4:00 pm, Monday – Friday.

#### Building Envelope

The building walls are masonry construction with interior wood framing and minimal insulation (presumably fiberglass) between stud spaces. The ceiling of the top floor is

insulated with 5" – 6" of cellulose insulation housed under a vented attic space. The windows (about 6% of gross wall area) are more recent double pane vinyl type and are reasonably tight. The main entrance doors are insulated aluminum frame units with glazing with minimal gaps, though they are reported to not shut tightly with the spring door closers alone.


Photo: Newfield Town Hall – top floor shown, bottom floor is open to the back (building is on a steep slope).




Drawing: Newfield Town Hall – Rough dimensions and layout of the building shown.

## Heating, Ventilation, and Cooling (HVAC)

Heating is provided by a forced draft, non-condensing natural gas fired boiler. Heat is distributed by a hydronic baseboard radiant system with three zones serving both floors of the building. The total area of the baseboard system is small relative to the size and insulation level of the building, so water temperatures are expected to be high with this system. The boiler was originally manufactured in 2000. NYSERDA's expected useful life for this type of boiler is 25 years.

Cooling is provided by four ductless minisplit systems serving the Town Clerk's office, meeting room, court room, and court office. The remaining areas are cooled passively by this system. The minisplits are also used for supplementary heating in the winter, allowing the thermostats controlling the hydronic system to be left turned down when spaces (primarily the court room and meeting space) are occupied for just a short time. Three of

the minisplit systems were manufactured in 2008, with the fourth being manufactured in 2000. NYSERDA's expected useful life of a minisplit system is 15 years.

### Domestic Hot Water

Domestic hot water (DHW) is supplied by an electric storage water heater, with non-recirculating distribution.

### Lighting

Interior lighting consists of T8 fluorescent fixtures with replacement LED bulbs. Exterior lighting consists of LED spot lights and wallpacks.

See the appendix for a list of equipment and lighting currently installed in the Town Hall.

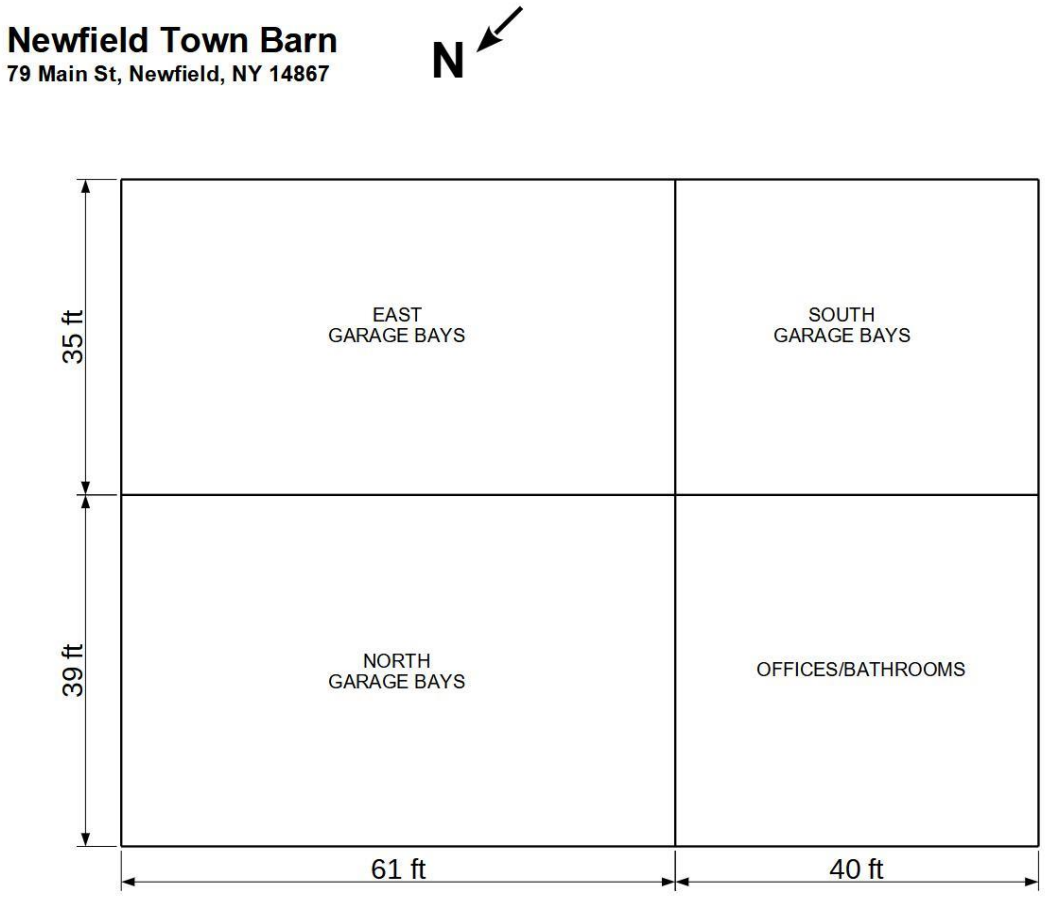
## Town Barn

The Newfield Town Barn is used as offices for the Department of Public Works and as garages for equipment storage and repair. The building was originally built in 1942, and two additions were made, one in 1976 and the second in 1993. The building has 7,500 $ft^2$ of gross floor area, of which about 1,600 $ft^2$ is devoted to offices, bathrooms, mechanical room, and small equipment storage areas. The remainder is open garage space divided into three areas, each with separate overhead door entrances. The building operating schedule varies with the seasons – during the winter the building is typically occupied from 7:00 am – 3:30 pm, Monday – Friday. In the summer, that shifts to 6:30 am – 4:00 pm, Monday – Thursday.

### Building Envelope

The original barn was constructed with concrete block and has uninsulated walls. The newer additions are built with poured concrete stem walls with wood framed walls above those. The wood frame walls are insulated with fiberglass batt, though the insulation appears to have deteriorated in some places. The ceiling above all areas of the barn is insulated with about 8" of loose fiberglass. All five overhead garage doors (approx. 30% of gross wall area) have been replaced with high quality, insulated and weather sealed units. Of the windows (approx. 1% of gross wall area) half have been replaced with double pane vinyl windows, and there is a plan to replace the remaining windows in the near future.

Photo: Newfield Town Barn - the roof profile of the original barn can be seen directly above the double doors. The 1976 addition is obscured by the later 1993 addition to the left of the original barn.




Drawing: Newfield Town Barn – Rough dimensions and layout of the building shown.

## Heating, Ventilation, and Cooling (HVAC)

The office area and one of the garage bays are heated by a natural gas fired condensing boiler. Heat is distributed in the office areas with baseboard heaters and in the garage bay with fan coil units. Heat is provided to the remaining two garage areas by two natural gas fired, non-condensing unit heaters. Mechanical cooling of the office spaces is provided by one or two window AC units. Ventilation is provided by a hood over the welding area, with a larger fan located in the same garage bay for whole area ventilation. These fans are typically left off, and a sliding door is provided over the larger fan to reduce air exfiltration. With frequent garage door openings, ventilation is usually adequate without the need for fans.

### Domestic Hot Water

Domestic hot water (DHW) is supplied by an indirect storage water heater heated by the space heating condensing boiler with non-recirculating distribution.

### Lighting

Interior lighting consists of T8 fluorescent fixtures with replacement LED bulbs and LED fixtures. Exterior lighting consists of LED spot lights and wallpacks.

See the appendix for a list of equipment and lighting currently installed in the Town Barn.

## 3. ENERGY USAGE ANALYSIS

Electricity is delivered by NYSEG and supplied by Constellation Energy and NexAmp for both buildings. Natural gas is supplied and delivered by NYSEG for both buildings.

Dates used to calculate annual energy costs were November 2020 – October 2021 for both buildings.

Greenhouse gas emissions from electricity and natural gas consumption were calculated based on the NY Upstate GHG emissions rate of 234.5 lb $CO_2$/MWh and 11.86 lb $CO_2$/therm, respectively[1].

[1] From the US EPA Emissions & Generation Resource Integrated Database (eGRID) https://www.epa.gov/egrid Data from 2020.

# Town Hall

## Utility Bill Data

**ELECTRICITY CONSUMPTION AND COST ANALYSIS**

Town of Newfield

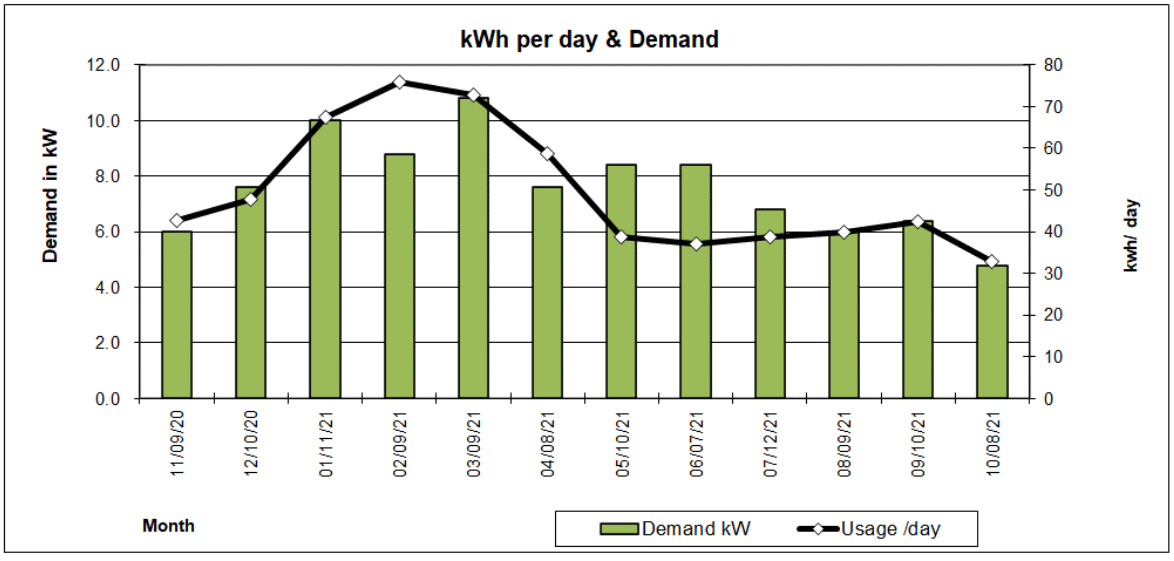
Utility: NYSEG
Account # ends w/ -062
Rate: SC
Meter Charge: $ 20.70 / month
Demand Charge: $ 9.43 / kW
Supplier: Constellation/NexAmp

Gross Area: 3,480 s.f.
17,609 Btu/s.f./Yr
$ 0.64 /s.f.
3.1 watts/s.f.

| Month Ending | Days | Usage Energy kWh | Usage Demand kW | Electricity Charges Utility Cost | Electricity Charges Supply Costs | Total Electricity Cost | Demand Cost | Energy $/kWh | Load Factor | Usage /day |
|---|---|---|---|---|---|---|---|---|---|---|
| 11/09/20 | 30 | 1,280 | 6.0 | $ 83 | $ 53 | $ 136 | $ 57 | $ 0.046 | 0.30 | 43 |
| 12/10/20 | 31 | 1,480 | 7.6 | $ 100 | $ 52 | $ 152 | $ 72 | $ 0.040 | 0.26 | 48 |
| 01/11/21 | 32 | 2,160 | 10.0 | $ 130 | $ 88 | $ 218 | $ 94 | $ 0.048 | 0.28 | 68 |
| 02/09/21 | 29 | 2,200 | 8.8 | $ 117 | $ 74 | $ 191 | $ 83 | $ 0.040 | 0.36 | 76 |
| 03/09/21 | 28 | 2,040 | 10.8 | $ 138 | $ 94 | $ 232 | $ 102 | $ 0.054 | 0.28 | 73 |
| 04/08/21 | 30 | 1,760 | 7.6 | $ 105 | $ 53 | $ 158 | $ 72 | $ 0.037 | 0.32 | 59 |
| 05/10/21 | 32 | 1,240 | 8.4 | $ 157 | $ 48 | $ 205 | $ 79 | $ 0.085 | 0.19 | 39 |
| 06/07/21 | 28 | 1,040 | 8.4 | $ 121 | $ 57 | $ 178 | $ 79 | $ 0.075 | 0.18 | 37 |
| 07/12/21 | 35 | 1,360 | 6.8 | $ 104 | $ 94 | $ 198 | $ 64 | $ 0.083 | 0.24 | 39 |
| 08/09/21 | 28 | 1,120 | 6.0 | $ 100 | $ 77 | $ 177 | $ 57 | $ 0.089 | 0.28 | 40 |
| 09/10/21 | 32 | 1,360 | 6.4 | $ 99 | $ 109 | $ 208 | $ 60 | $ 0.093 | 0.28 | 43 |
| 10/08/21 | 28 | 920 | 4.8 | $ 82 | $ 75 | $ 157 | $ 45 | $ 0.099 | 0.29 | 33 |
| | **363** | **17,960** | **91.6** | **$ 1,336** | **$ 874** | **$ 2,210** | **$ 864** | **$ 0.061** | **0.27** | **49** |

**Annual Energy:** 17,960 kWh / year $ 2,210 /year
**Peak Demand:** 11 kW Peak
**Average Demand:** 8 kW
**NY Upstate GHG Emissions Rate:** 235 lb CO2 / MWh
**Total GHG Emissions:** 4,212 lb CO2 / year

**Unit Costs**
**Demand** $ 9.43 $/kW
**Energy** $ 0.061 $/kWh Incremental
**Blended** $ 0.123 $/kWh Blended



## NATURAL GAS CONSUMPTION AND COST ANALYSIS

Town of Newfield

3,480 s.f.
21,580 Btu/s.f./Yr
$ 0.37 /s.f.

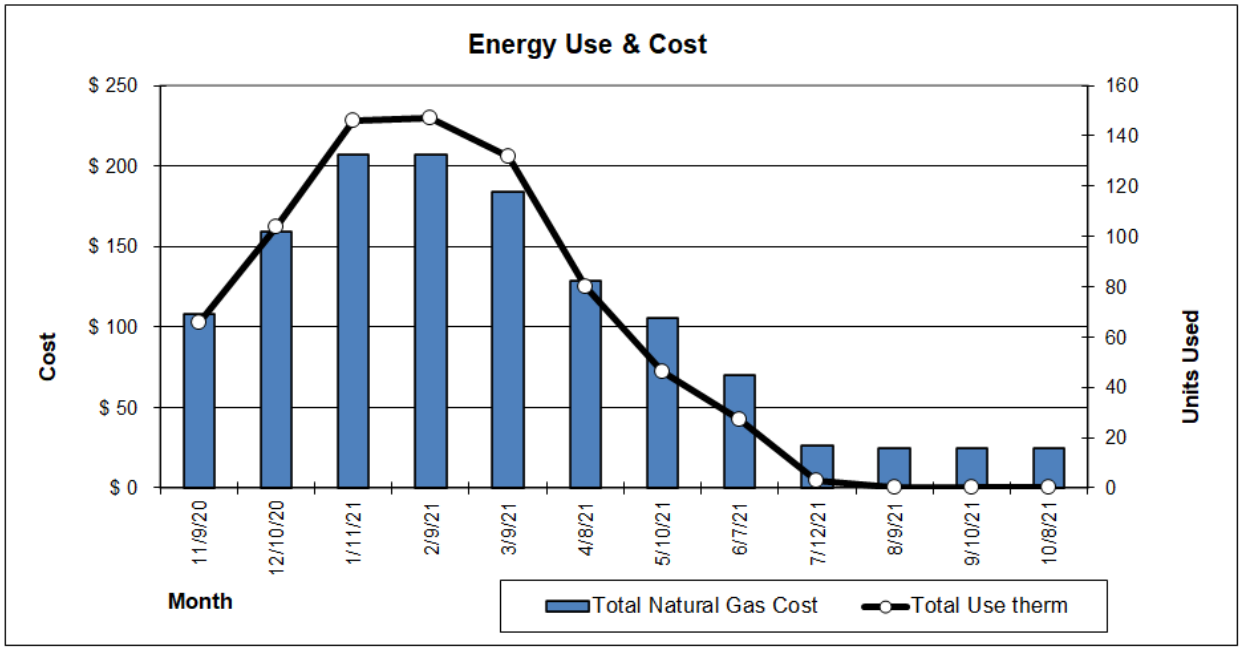
Utility: **NYSEG**
Account # : ends w/ -062
Rate: SC
Billing unit: therm
BTU/Unit: **100,000**
Meter Charge: **$ 24.60** / month
Supplier: **NYSEG**

**Natural Gas**

**Use & Cost Summary:**

| Month Ending | # Days | Utility Charges therm | Utility Charges Cost | Supplier Charges therm | Supplier Charges Cost | **Total Use therm** | **Total Natural Gas Cost** | Average $/therm |
|---|---|---|---|---|---|---|---|---|
| 11/9/20 | 30 | 66 | $ 108 | 66 | $ 0 | 66 | $ 108 | $ 1.26 |
| 12/10/20 | 31 | 104 | $ 159 | 104 | $ 0 | 104 | $ 159 | $ 1.29 |
| 1/11/21 | 32 | 146 | $ 207 | 146 | $ 0 | 146 | $ 207 | $ 1.25 |
| 2/9/21 | 29 | 147 | $ 207 | 147 | $ 0 | 147 | $ 207 | $ 1.24 |
| 3/9/21 | 28 | 132 | $ 184 | 132 | $ 0 | 132 | $ 184 | $ 1.21 |
| 4/8/21 | 30 | 80 | $ 129 | 80 | $ 0 | 80 | $ 129 | $ 1.31 |
| 5/10/21 | 32 | 46 | $ 106 | 46 | $ 0 | 46 | $ 106 | $ 1.76 |
| 6/7/21 | 28 | 27 | $ 70 | 27 | $ 0 | 27 | $ 70 | $ 1.68 |
| 7/12/21 | 35 | 3 | $ 26 | 3 | $ 0 | 3 | $ 26 | $ 0.47 |
| 8/9/21 | 28 | 0 | $ 25 | 0 | $ 0 | 0 | $ 25 | |
| 9/10/21 | 32 | 0 | $ 25 | 0 | $ 0 | 0 | $ 25 | |
| 10/8/21 | 28 | 0 | $ 25 | 0 | $ 0 | 0 | $ 25 | |
| | 363 | **751** | **$ 1,271** | **751** | **$ 0** | **751** | **$ 1,271** | $ 1.30 |

**Annual Natural Gas Cost** **$ 1,271** **/year**
**Annual Natural Gas Consumption** **751** **therm**
**Incremental Cost per therm:** **$ 1.299** **$ 12.99** **/ mmBtu**
**NY Upstate GHG Emissions Rate:** **11.86** **lb CO2 / therm**
**Total GHG Emissions:** **8,907** **lb CO2 / year**



## Analysis

The Town Hall's utility history show the greatest electrical demand in the winter, reflecting use of the minisplit heat pumps for supplemental heating, as well as multiple small, in-wall electric space heaters and potentially higher DHW usage during the colder months. Electric demand shows a second, smaller peak in the summer months, reflecting the use of the minisplits for space cooling. Electric demand is lowest in the more temperate fall months.

The natural gas demand, not surprisingly, is highest in the coldest winter months, tapering to zero demand in the summer.

## Benchmarking

The EPA's Energy Star Portfolio Manager website compares the energy use of Newfield Town Hall to similar buildings nationwide, normalized for weather and operating characteristics. Portfolio Manager generates a benchmark score that indicates your performance. A score of 50 represents median performance. A higher score is better than average; lower is worse. A score of 75 or higher would earn the Energy Star designation. The website can be used to track building energy use over time and document the success of energy conservation efforts.

Portfolio Manager is located at:

https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

For the analysis period of October 2020 through September 2021, Newfield Town Hall has an Energy Star Score of 86. This relatively high score reflects well on the energy savings practices the town has implemented already, as well as some of the building's characteristics such as a compact footprint, partially earth-bermed lower level, and moderate levels of insulation in the walls and attic.

# Town Barn

## Utility Bill Data

**ELECTRICITY CONSUMPTION AND COST ANALYSIS**

Town of Newfield

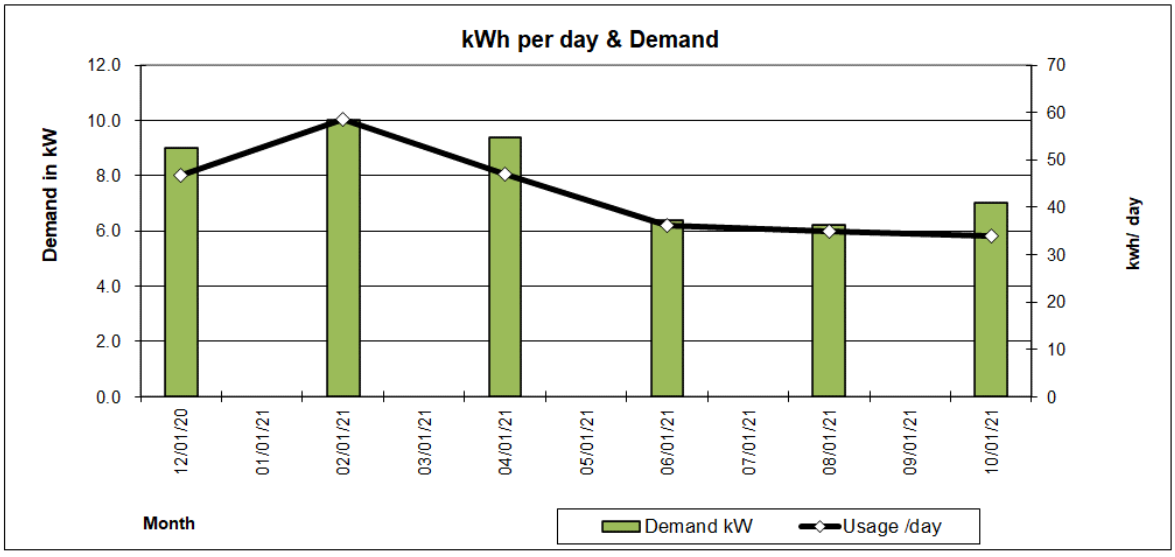
Utility: NYSEG
Account # ends w/ -159
Rate: SC
Meter Charge: $ 20.70 / month
Demand Charge: $ 9.43 / kW
Supplier: Constellation/NexAmp

Gross Area: 7,474 s.f.
7,039 Btu/s.f./Yr
$ 0.27 /s.f.
1.3 watts/s.f.

| Month Ending | Days | Usage Energy kWh | Usage Demand kW | Electricity Charges Utility Cost | Electricity Charges Supply Costs | Total Electricity Cost | Demand Cost | Energy $/kWh | Load Factor | Usage /day |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/10/20 | 62 | 2,900 | 9.0 | $ 217 | $ 111 | $ 328 | $ 85 | $ 0.070 | 0.22 | 47 |
| 02/02/21 | 54 | 3,160 | 10.0 | $ 249 | $ 107 | $ 356 | $ 94 | $ 0.070 | 0.24 | 59 |
| 04/05/21 | 62 | 2,920 | 9.4 | $ 237 | $ 97 | $ 334 | $ 89 | $ 0.070 | 0.21 | 47 |
| 06/03/21 | 59 | 2,140 | 6.4 | $ 185 | $ 77 | $ 262 | $ 60 | $ 0.075 | 0.24 | 36 |
| 08/05/21 | 63 | 2,200 | 6.2 | $ 187 | $ 137 | $ 324 | $ 58 | $ 0.102 | 0.23 | 35 |
| 10/06/21 | 62 | 2,100 | 7.0 | $ 247 | $ 154 | $ 401 | $ 66 | $ 0.140 | 0.20 | 34 |
| | **362** | **15,420** | **48.0** | **$ 1,322** | **$ 683** | **$ 2,005** | **$ 453** | **$ 0.085** | **0.22** | **43** |

**Annual Energy:** 15,420 kWh / year $ 2,005 /year
**Peak Demand:** 10 kW Peak
**Average Demand:** 8 kW
**NY Upstate GHG Emissions Rate:** 235 lb CO2 / MWh
**Total GHG Emissions:** 3,616 lb CO2 / year

**Unit Costs**
**Demand** $ 9.43 $/kW
**Energy** $ 0.085 $/kWh Incremental
**Blended** $ 0.130 $/kWh Blended



## NATURAL GAS CONSUMPTION AND COST ANALYSIS

Town of Newfield

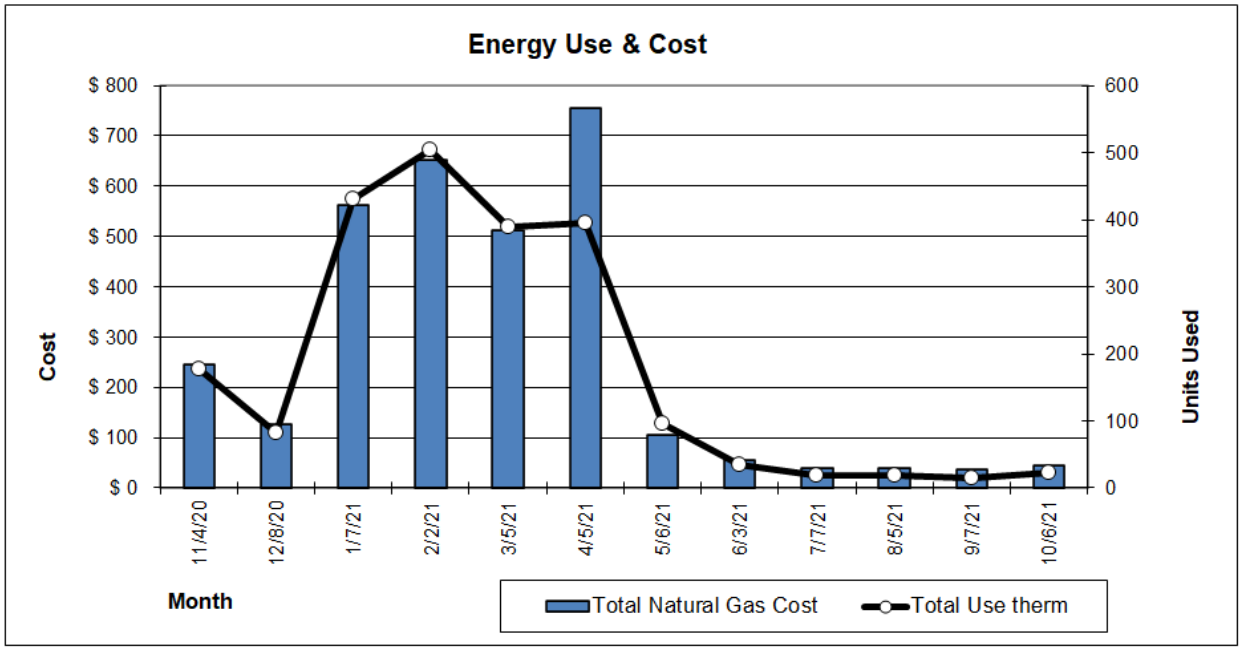
7,474 s.f.
29,181 Btu/s.f./Yr
$ 0.43 /s.f.

Utility: **NYSEG**
Account # : ends w/ -159
Rate: SC
Billing unit: therm
BTU/Unit: **100,000**
Meter Charge: **$ 24.60** / month
Supplier: **NYSEG**

**Natural Gas**
**Use & Cost Summary:**

| Month Ending | # Days | Utility Charges therm | Utility Charges Cost | Supplier Charges therm | Supplier Charges Cost | **Total Use therm** | **Total Natural Gas Cost** | Average $/therm |
|---|---|---|---|---|---|---|---|---|
| 11/4/20 | 30 | 177 | $ 246 | 177 | $ 0 | 177 | $ 246 | $ 1.25 |
| 12/8/20 | 34 | 82 | $ 126 | 82 | $ 0 | 82 | $ 126 | $ 1.24 |
| 1/7/21 | 30 | 430 | $ 563 | 430 | $ 0 | 430 | $ 563 | $ 1.25 |
| 2/2/21 | 26 | 504 | $ 653 | 504 | $ 0 | 504 | $ 653 | $ 1.25 |
| 3/5/21 | 31 | 390 | $ 513 | 390 | $ 0 | 390 | $ 513 | $ 1.25 |
| 4/5/21 | 31 | 395 | $ 755 | 395 | $ 0 | 395 | $ 755 | $ 1.85 |
| 5/6/21 | 31 | 96 | $ 106 | 96 | $ 0 | 96 | $ 106 | $ 0.85 |
| 6/3/21 | 28 | 34 | $ 55 | 34 | $ 0 | 34 | $ 55 | $ 0.89 |
| 7/7/21 | 34 | 18 | $ 40 | 18 | $ 0 | 18 | $ 40 | $ 0.86 |
| 8/5/21 | 29 | 18 | $ 39 | 18 | $ 0 | 18 | $ 39 | $ 0.80 |
| 9/7/21 | 33 | 15 | $ 37 | 15 | $ 0 | 15 | $ 37 | $ 0.83 |
| 10/6/21 | 29 | 22 | $ 44 | 22 | $ 0 | 22 | $ 44 | $ 0.88 |
| | 366 | **2,181** | **$ 3,177** | **2,181** | **$ 0** | **2,181** | **$ 3,177** | $ 1.32 |

**Annual Natural Gas Cost** **$ 3,177** **/year**
**Annual Natural Gas Consumption** **2,181** **therm**
**Incremental Cost per therm:** **$ 1.321** **$ 13.21** **/ mmBtu**
**NY Upstate GHG Emissions Rate:** **11.86** **lb CO2 / therm**
**Total GHG Emissions:** **25,867** **lb CO2 / year**



## Analysis

The Town Barn's utility history shows the greatest electrical demand in the winter, likely due to more frequent garage use during winter for things like lighting, welding, etc. Electrical demand is lower in the summer and fall months where outside work predominates.

The natural gas demand, not surprisingly, is highest in the coldest winter months, tapering to minimal demand in the summer for domestic hot water production.

## Benchmarking

The EPA's Energy Star Portfolio Manager website compares the energy use of Newfield Town Barn to similar buildings nationwide, normalized for weather and operating characteristics. Portfolio Manager generates a benchmark score that indicates your performance. A score of 50 represents median performance. A higher score is better than average; lower is worse. A score of 75 or higher would earn the Energy Star designation. The website can be used to track building energy use over time and document the success of energy conservation efforts.

Portfolio Manager is located at:

https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

Many building types are represented in the EPA's Energy Star Portfolio Manager; however, vehicle maintenance garages are not represented. However, if the barn were to be considered a distribution warehouse, then for the analysis period of October 2020 through September 2021, it would receive an Energy Star Score of 82. This relatively high score reflects well on the energy savings practices the town has implemented already (e.g. LED lighting upgrades, thermostat setbacks, highly insulated and weather-stripped garage doors, etc.), as well as the moderate levels of insulation in the walls and attic.

# 4. AREAS OF OPPORTUNITY

In the following section, operation and maintenance improvements and capital-intensive modifications are discussed individually and identified as energy conservation measures (ECMs, also referred to informally as "measures"). For each measure, this discussion may include:

1) The rationale for implementing the measure;
2) Cost/savings values;
3) Important assumptions that were made in evaluating the potential costs and savings; and
4) Notes on other issues related to the measure.

The list of ECMs is organized by building, with the Town Hall measures first, followed by Town Barn measures. Within each building, the list is organized into two categories. The first category is measures that save energy by reducing the energy load on the building, such as installing additional insulation or installing more efficient lighting. The second category is measures that switch from natural gas heating equipment to heat pumps.

The ECM calculations in this section are stand-alone measures that do not account for possible interactions with the other calculations. Each measure shows the energy savings that may be expected if it is the only measure to be implemented. If multiple measures will be implemented, energy savings will be lower than the individual values represented.

For example, ECM-1 Insulate Attic serves to reduce energy loss through the building shell while ECM-3 Setback Thermostats serves to reduce energy consumption by better use of heating equipment. If ECM-1 is implemented, the expected energy savings would be 6.5% of baseline, meaning that the new energy use would be around 93.5% of baseline. If ECM-3 is *also* implemented, the expected energy savings would be approximately 5.1% of the *new* energy use (93.5% of baseline) or about 4.8% of baseline energy use. The *combined* effect of these two measures would be about 11.2% of baseline. The cumulative savings figures in the following tables take these interactive effects into account.

See the appendix for detailed calculations for each of the measures in this report.

# Table 4.1: Recommended Energy Conservation Measures – Town Hall

**BASELINE ENERGY SUMMARY**

| | Electric (kWh) | Natural Gas (therms) | #2 Oil (gallons) | #4 Oil (gallons) | #6 Oil (gallons) | Steam (lbs.) | Propane (gallons) | Coal (tons) | Other (MMBtu) | **Total Baseline Use (MMBtu)** |
|---|---|---|---|---|---|---|---|---|---|---|
| Baseline Energy Use | 17,960.0 | 751.0 | | | | | | | | **136.4** |
| Average Utility Rate | $0.12 | $1.69 | | | | | | | | **Total Annual Cost ($)** |
| Baseline Annual Cost | $2,210 | $1,271 | | | | | | | | **$3,481** |

**ENERGY SAVINGS SUMMARY**

| Measure Description | Measure Status [1] | Fuel Savings Type [2] | Electric | | Fuel Savings (MMBtu) | Energy Savings to Total Baseline Use (%) [3] | Annual Cost Savings | Cost Savings to Total Annual Cost (%) [4] | Project Cost | Simple Payback (Years) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Supply Savings (kWh) | Demand Savings (kW) | | | | | | |
| ECM 1 - Insulate Attic | RNE | NGas | 19 | 0.0 | 8.8 | 6.5% | $115 | 3.3% | $3,567 | 31 |
| ECM 2 - Air Seal Penetrations | R | NGas | 0 | 0.0 | 11.8 | 8.7% | $153 | 4.4% | $350 | 2.3 |
| ECM 3 - Setback Thermostats | R | NGas | 0 | 0.0 | 7.0 | 5.1% | $91 | 2.6% | $600 | 6.6 |
| ECM 4 - Install Tankless Water Heater | RNE | Elec | 507 | 0.0 | 0.0 | 1.3% | $37 | 1.1% | $1,800 | 49 |
| ECM 5 - Install Air Source Heat Pump | R | NGas | -3,801 | -4.1 | 75.1 | 45.6% | $705 | 20.3% | $34,200 | 48.5 |
| | | TOTAL (All): | -3,275 | -4 | 103 | 67.1% | $1,101 | 31.6% | $40,517 | 37 |
| | | **TOTAL (Recommended Only with Interactions):** | **-1,975** | **-2** | **75** | **50.1%** | **$835** | **24.0%** | **$40,517** | **49** |

| Measure Status[1] | |
|---|---|
| I | Implemented |
| R | Recommended |
| RS | Further Study Recommended |
| NR | Not Recommended |
| RME | Recommeded Mutually Exclusive |
| ME | Mutually Exclusive to Recommended Option |
| RNE | Recommended Non-Energy |

| Fuel Saved | |
|---|---|
| Elec | Electric |
| NGas | Natural Gas |
| Oil2 | #2 Oil |
| Oil4 | #4 Oil |
| Oil6 | #6 Oil |
| Steam | District Steam |
| LPG | Propane |
| Coal | Coal |
| Other | Other |

| MMBtu Conversion Factor | |
|---|---|
| Btu | 1,000,000 |
| kWh | 0.003412 |
| therms | 0.1 |
| #2 gallon | 0.139 |
| #4 gallon | 0.1467 |
| #6 gallon | 0.15 |
| Steam lbs. | 0.0012 |
| LPG gallon | 0.0915 |
| Coal tons | 24 |

Notes:

[2] Fuel Savings Type: Indicate the reported MMBtu savings fuel type. Select the predominant fuel type if there are MMBtu savings from multiple fuel sources

[3] Energy Savings to Total Fuel Baseline Use is a comparison of the total electric & fuel savings to the total baseline energy use

[4] Cost Savings to Total Annual Cost is a comparison of the total annual cost savings to the total baseline annual energy cost

Instructions:

* Fill in the light blue cells, as appropriate. White cells will auto-calculate.
* Energy savings must be presented as savings at the customer's utility meter(s), not at the individual building or tenant space
* Update the baseline energy use conversion factors in the 'References' tab, as necessary
* Unhide rows to enter more measures, as necessary

# Table 4.2: Recommended Energy Conservation Measures – Town Barn

**BASELINE ENERGY SUMMARY**

| | Electric (kWh) | Natural Gas (therms) | #2 Oil (gallons) | #4 Oil (gallons) | #6 Oil (gallons) | Steam (lbs.) | Propane (gallons) | Coal (tons) | Other (MMBtu) | **Total Baseline Use (MMBtu)** |
|---|---|---|---|---|---|---|---|---|---|---|
| Baseline Energy Use | 15,420.0 | 2,181.0 | | | | | | | | **270.7** |
| Average Utility Rate | $0.13 | $1.46 | | | | | | | | **Total Annual Cost ($)** |
| Baseline Annual Cost | $2,005 | $3,177 | | | | | | | | **$5,182** |

**ENERGY SAVINGS SUMMARY**

| Measure Description | Measure Status [1] | Fuel Savings Type [2] | Electric | | Fuel Savings (MMBtu) | Energy Savings to Total Baseline Use (%) [3] | Annual Cost Savings | Cost Savings to Total Annual Cost (%) [4] | Project Cost | Simple Payback (Years) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Supply Savings (kWh) | Demand Savings (kW) | | | | | | |
| ECM 6 - Insulate Attic | RNE | NGas | 0 | 0.0 | 21.9 | 8.1% | $289 | 5.6% | $12,781 | 44 |
| ECM 7 - Insulate Walls | R | NGas | 0 | 0.0 | 66.0 | 24.4% | $873 | 16.8% | $15,406 | 18 |
| ECM 8 - Install Air Curtains | NR | NGas | 0 | 0.0 | 5.3 | 2.0% | $70 | 1.4% | $38,600 | 551 |
| ECM 9 - Setback Thermostats | R | NGas | 0 | 0.0 | 20.2 | 7.5% | $262 | 5.1% | $800 | 3.1 |
| ECM 10 - Install Tankless Water Heater | RNE | NGas | -217 | 0.0 | 20.2 | 7.2% | $248 | 4.8% | $1,800 | 7 |
| ECM 11 - Install Air Source Heat Pump | R | NGas | -15,255 | -37.8 | 197.9 | 53.9% | $961 | 18.5% | $50,400 | 52 |
| | | TOTAL (All): | -15,472 | -38 | 332 | 103.0% | $2,703 | 52.2% | $119,787 | 44 |
| | | **TOTAL (Recommended Only with Interactions):** | **-6,914** | **-17** | **218** | **71.9%** | **$2,135** | **41.2%** | **$81,187** | **38** |

| Measure Status[1] | |
|---|---|
| I | Implemented |
| R | Recommended |
| RS | Further Study Recommended |
| NR | Not Recommended |
| RME | Recommended Mutually Exclusive |
| ME | Mutually Exclusive to Recommended Option |
| RNE | Recommended Non-Energy |

| Fuel Saved | |
|---|---|
| Elec | Electric |
| NGas | Natural Gas |
| Oil2 | #2 Oil |
| Oil4 | #4 Oil |
| Oil6 | #6 Oil |
| Steam | District Steam |
| LPG | Propane |
| Coal | Coal |
| Other | Other |

| MMBtu Conversion Factc | |
|---|---|
| Btu | 1,000,000 |
| kWh | 0.003412 |
| therms | 0.1 |
| #2 gallon | 0.139 |
| #4 gallon | 0.1457 |
| #6 gallon | 0.15 |
| Steam lbs. | 0.0012 |
| LPG gallon | 0.0915 |
| Coal tons | 24 |

Notes:

[2] Fuel Savings Type: Indicate the reported MMBtu savings fuel type. Select the predominant fuel type if there are MMBtu savings from multiple fuel sources

[3] Energy Savings to Total Fuel Baseline Use is a comparison of the total electric & fuel savings to the total baseline energy use

[4] Cost Savings to Total Annual Cost is a comparison of the total annual cost savings to the total baseline annual energy cost

Instructions:

* Fill in the light blue cells, as appropriate. White cells will auto-calculate.
* Energy savings must be presented as savings at the customer's utility meter(s), not at the individual building or tenant space
* Update the baseline energy use conversion factors in the 'References' tab, as necessary
* Unhide rows to enter more measures, as necessary

## Table 4.3: Greenhouse Gas Reduction Summary

| Greenhouse Gas Reductions for Town of Newfield | | | | | |
|---|---|---|---|---|---|
| **Newfield Town Hall** | | | | | |
| Existing Greenhouse Gas (GHG) Emissions | | 13,119 lb CO2/year | | | |
| **Energy Conservation Measures** | **Recommendation** | lb CO2/year Reduction | % GHG Reduction | Installed Cost | Payback Years |
| ECM 1 - Insulate Attic | RNE | 1,047 | 8% | $ 3,567 | 31 |
| ECM 2 - Air Seal Penetrations | R | 1,398 | 11% | $ 350 | 2 |
| ECM 3 - Setback Thermostats | R | 827 | 6% | $ 600 | 7 |
| ECM 4 - Install Tankless Water Heater | RNE | 119 | 1% | $ 1,800 | 49 |
| ECM 5 - Install Air Source Heat Pump | RNE | 7,671 | 58% | $ 34,200 | 49 |
| **Subtotal (Recommended Measures with Interaction Effects)** | | **9,080** | **69%** | **$ 40,517** | **49** |
| **Newfield Town Barn** | | | | | |
| Existing Greenhouse Gas (GHG) Emissions | | 29,483 lb CO2/year | | | |
| **Energy Conservation Measures** | **Recommendation** | lb CO2/year Reduction | % GHG Reduction | Installed Cost | Payback Years |
| ECM 6 - Insulate Attic | RNE | 2,593 | 9% | $ 12,781 | 44 |
| ECM 7 - Insulate Walls | R | 7,834 | 27% | $ 15,406 | 18 |
| ECM 8 - Install Air Curtains | NR | 629 | 2% | $ 38,600 | 551 |
| ECM 9 - Setback Thermostats | R | 2,396 | 8% | $ 800 | 3 |
| ECM 10 - Install Tankless Water Heater | R | 2,395 | 8% | $ 1,800 | 7 |
| ECM 11 - Install Air Source Heat Pump | RNE | 19,893 | 67% | $ 50,400 | 52 |
| **Subtotal (Recommended Measures with Interaction Effects)** | | **25,785** | **87%** | **$ 81,187** | **38** |

# Evaluated Energy Conservation Measures

## ECM 1: Town Hall – Insulate Attic

### *Existing Conditions*

The attic is insulated with approximately 5.5 inches of loose cellulose. The cellulose is evenly distributed and no voids were found. While the insulation appears to be in good condition, there is not much of it – for comparison, current energy conservation code requires the equivalent of 14 inches of cellulose in attics.


Photo: The attic is insulated with approximately 5.5 inches of loose cellulose.

Photo: The insulation is evenly distributed and appears to be in good condition.

### *Analysis*

Adding another 8 to 10 inches of cellulose would help further reduce winter heat loss through the ceiling as well as reducing summer heat gain. While cellulose is relatively inexpensive, the labor to install it is a significant portion of the cost. If labor costs could be reduced by using town employees, the cost could be reduced by roughly half.

### *Results*

- Annual Energy Savings: 88 therms/year; 19 kWh/year
- Annual $ Savings: $115/year
- Cost: $3,567 ($1,705 in materials + $1,862 in labor)
- Payback: 31 years
- GHG Emissions Reduction at NY Upstate Rate: 1,047 lb CO2/year (8.0% of total)

*Recommended Action*

Although the payback period is near the expected useful life of this measure (30 years), if labor costs can be reduced by using town employees, this could turn into a project with a more reasonable payback period. In addition, this measure will help reduce the thermal load on the building, which will make electrification less costly. For these reasons, this measure is recommended for consideration.

Add 8 to 10 inches of cellulose to the existing insulation. It is important to allow for adequate ventilation in the attic space, especially when increasing insulation depth. The Town Hall appears to rely on vents in the soffits to allow air into the attic and out through gable end vents. Install vent baffles and air seal around them at the soffits to ensure a clear pathway for outside air to enter the attic. Vent baffles also help to prevent the phenomenon of "wind washing" whereby loose insulation is blown back from the eaves of the attic by ventilation air entering through soffit vents. While installing vent baffles and air sealing around them, also take the opportunity to air seal the top plate of the exterior wall directly inside of the eaves. This can help reduce significant amounts of air infiltration into the attic at the joint where the wall meets the ceiling. Spray foam makes a very effective air barrier for this application.

# ECM 2: Town Hall – Air Seal Penetrations

## *Existing Conditions*

Three locations were found with potentially significant air leakage. One location was two 3 in. PVC conduit pipes that run from the basement straight into the attic. The conduits carry ethernet cable from the server room in the basement into the attic where they are then distributed to various locations. The two conduits are wide open and provide a very good path for air exfiltration from the conditioned space into the attic.

Another location was a large exhaust fan on the side of the building that is open to the courthouse on the lower level. It is not clear what this fan was originally intended to do, but it serves no purpose now and is a source of significant air infiltration.

The third major location was the attic hatch. This hatch, while properly fitted to its opening, is not weather-stripped or sealed in any way. The small gap around the entire opening can add up to a moderate amount of air leakage. In addition, the attic hatch is not insulated. While this does not in itself contribute to air leakage, it does increase conductive heat loss.

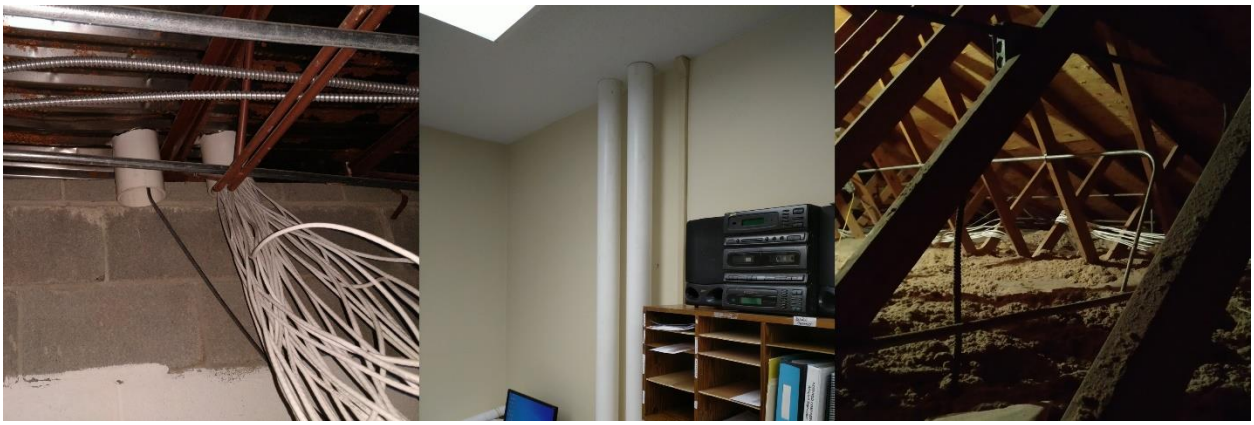


Photo: These two conduit pipes provide a significant air leakage path from the basement, through the conditioned space, into the attic.


Photo: This exhaust fan serves no purpose currently and allows for significant air leakage.

Photo: This attic hatch has no weather-stripping or insulation.

### *Analysis*

The primary driver for air leakage is the wintertime "stack effect" where warmer, less dense interior air is pushed up and out of the building by cooler, more dense outside air. Because the density difference is dependent on height, openings near the bottom and top of the building have the greatest leakage potential. The three locations identified in this study are all at or near the bottom or top of the building's air boundary, and thus represent significant leakage.

### *Results*

- Annual Energy Savings: 118 therms/year
- Annual $ Savings: $153/year
- Cost: $350 ($50 in materials + $300 in labor)
- Payback: 2.3 years
- GHG Emissions Reduction at NY Upstate Rate: 1,398 lb CO2/year (11% of total)

### *Recommended Action*

Seal both ethernet conduits at the top and bottom (i.e. in the basement and the attic) with either duct seal or foam plugs. Foam plugs have the benefit of being easily removable should additional cable need to be pulled in the future.

Seal the exhaust fan opening with a foam board plug and seal with silicone or urethane caulk. This also has the benefit of being reversible if a use for the exhaust fan is found in the future.

Seal the perimeter of the attic hatch opening with vinyl or foam weatherstripping. Add latches to the hatch to allow for a positive seal against the weatherstripping. Glue a 4 in. thick foam plug to the top of the attic hatch to provide some insulating value as well.

## ECM 3: Town Hall – Setback Thermostats

### *Existing Conditions*

While the minisplit system used for cooling and supplemental heat is essentially turned off or down at night to reduce energy consumption, the hydronic heating system is typically only turned down when someone remembers to do so. Because there is little visual or audial indication that the system is still at occupied temperature settings, this turndown tends to happen relatively infrequently.

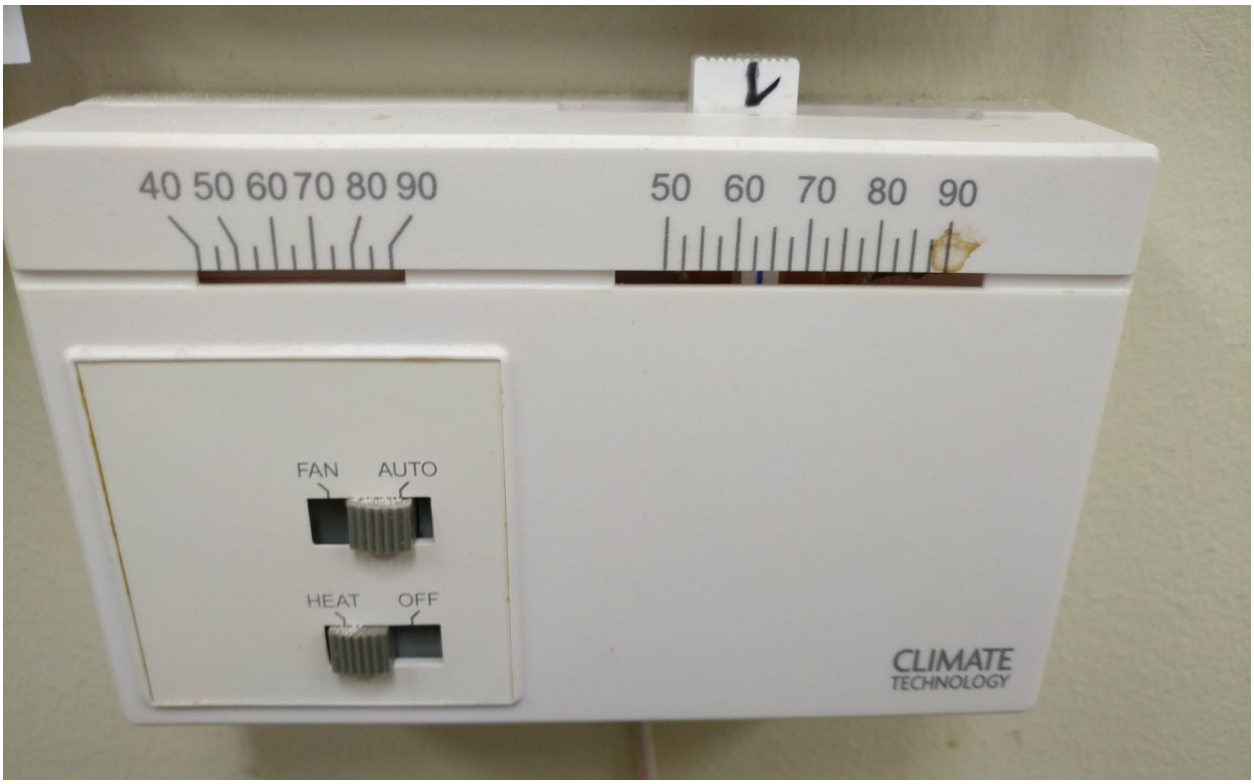



Photo: This manual thermostat is indicative of the control for the other two zones in the hydronic system.

### *Analysis*

Replacing the manual thermostats with simple, 7-day programmable thermostats will remove the need to remember to turndown thermostats, and still allow for manual overrides for off-schedule events (e.g. late court sessions, town meetings, etc.). This is a very simple and straight-forward task, so costs are minimal. Although the recommended night setback temperature is 55 $^{0}$F, due to the high thermal mass of the building, the actual interior temperature will take some time to drop to that setback temperature.

Calculations based on thermal mass estimates and hourly weather data indicate that the building will spend most of the heating season setback hours at higher temperatures than the recommended 55 $^0$F setpoint. In fact, it appears that the average night setback temperature would be around 62 $^0$F. Nonetheless, these same calculations estimate measurable savings which, combined with the relatively low capital cost, lead to a moderate payback period.

### *Results*

- Annual Energy Savings: 70 therms/year
- Annual $ Savings: $91/year
- Cost: $600 ($450 in materials + $150 in labor)
- Payback: 6.6 years
- GHG Emissions Reduction at Upstate NY Rate: 827 lb CO2/year (2.8% of total)

### *Recommended Action*

Replace all three hydronic thermostats with 7-day programmable thermostats. Set "home" and "away" or "occupied" and "unoccupied" schedules based on normal daily schedules. Set "away" or "unoccupied" down to at least 55 $^0$F to realize estimated savings. Lower setbacks are anticipated to have negligible additional savings. If the heat pump electrification measure is implemented, this measure will no longer be relevant. However, due to the low capital cost and short payback period, this measure would be a good one to implement while plans for the more expensive heat pump measure are made. After the heat pump system is installed, the programmable thermostats can still be used to provide emergency freeze protection using the gas fired equipment.

## ECM 4: Town Hall – Install Tankless Electric Water Heater

### *Existing Conditions*

The existing water heater is a very old (from 1977) tank style electric resistance water heater. Domestic hot water demands are relatively low for the facility having only two bathrooms with lavatory faucets only (i.e. no showers or kitchen sinks). The water heater is not reported to be having problems, but due to its age, the town is well advised to be prepared to replace it in the near future.


Photo: The Town Hall water heater is a very old electric resistance tank-style heater.

### *Analysis*

Replacing the water heater with a tankless electric water heater would reduce electrical consumption by reducing the heat loss associated with a tank full of hot water. Due to the low hot water usage in the building, most of the energy consumed by the existing water heater is used to replace the heat lost to the surrounding basement from the tank itself. A tankless water heater heats water as it is being used and thus does not have the associated losses to the surroundings. The one drawback of tankless electric heaters is the large amount of electrical current they require when operating. To provide enough capacity for instantaneous use, an electrical service upgrade may be required. Although the energy cost savings are low and the associated payback period is long, this option is expected to be *less* expensive than a tank style water heater. Due to the age of the existing heater, this measure is still recommended in lieu of a tank style water heater.

### *Results*

- Annual Energy Savings: 507 kWh/year
- Annual $ Savings: $37/year
- Cost: $1,800 ($600 in materials + $1,200 in labor)
- Payback: 49 years
- GHG Emissions Reduction at NY Upstate Rate: 119 lb CO2/year (0.9% of total)

### *Recommended Action*

Replace the existing water heater with a tankless on-demand electric heater. Evaluate instantaneous water heating needs and size the tankless unit appropriately. Evaluate the electrical capacity of the existing main service and consider whether an upgrade will be necessary. If an upgrade is necessary for other reasons (i.e. cold climate heat pump installation), then factor in the additional capacity needed for a tankless water heater as well.

# ECM 5: Town Hall – Install Air Source Heat Pump

## *Existing Conditions*

The Town Hall is currently heated primarily by a natural gas fired boiler with supplemental heat coming from four ductless heat pump systems. The boiler is nearing the end of it's expected useful life (25 years) and is beginning to exhibit performance and reliability problems. The ductless heat pump systems, while mostly newer, are still near the end of their expected useful lives (15 years) as well. In addition, these heat pumps are not "cold-climate" rated – their capacity diminishes rapidly at the typical low temperatures Newfield experiences in the winter. In addition to the performance and reliability issues, the boiler is the primary contributor to the Town Hall's stationary GHG emissions.


Photo: The natural gas fired boiler is nearing the end of its useful life and is exhibiting performance and reliability problems.

Photo: The ductless heat pumps are also nearing the end of their useful lives and are not rated for low temperature operation.

### *Analysis*

Replacing the existing boiler and ductless heat pumps with a new, "cold-climate" rated ductless air source heat pump system would provide all of the functions of the existing system at a much higher efficiency and effectiveness as well as removing the sole source of site fossil fuel combustion (the existing boiler). While the initial capital outlay is estimated as $34,200, when accounting for depreciation of the boiler ($12,760) and heat pumps ($16,000), the *net* cost ($5,440) is recouped relatively quickly (7.7 years) with annual utility savings. This measure may also qualify for utility and/or NYSERDA rebates, which would further reduce the payback period.

### *Results*

- Annual Energy Savings: 751 therms/year; -3,801 kWh/year
- Annual $ Savings: $705/year
- Cost: $34,200 ($20,500 in materials + $13,700 in labor)
- Payback: 49 years
- GHG Emissions Reduction at NY Upstate Rate: 7,671 lb CO2/year (58% of total)

*Recommended Action*

Install a ductless air source heat pump system in place of the existing system. Ensure that the system being installed is "cold-climate" rated. A list of suitable models can be found at the following website:

https://ashp.neep.org/

The new system should be sized to provide at least 90% of the total heat load of the building at the ASHRAE design conditions for Newfield (6.1 $^{0}$F).

# ECM 6: Town Barn – Insulate Attic

## *Existing Conditions*

The attic is insulated with approximately 8 inches of loose fiberglass. The fiberglass is not evenly distributed and appears dirty (fiberglass is bright white when clean), indicating air leakage through the ceiling into/out of the attic. The ceiling in all areas consists of corrugated sheet metal panels that are screwed to the roof trusses. This assembly is expected to have very high air leakage. While 8 inches is a significant amount of insulation, especially considering the size of the building, it is still well below the 14 in. required by current energy conservation code.

Photo: The attic is insulated with approximately 8 inches of loose fiberglass.

Photo: The insulation is not evenly distributed and appears dirty – indicating air leakage through the ceiling.

### *Analysis*

Adding 8 inches of cellulose to the top of the fiberglass and evening out the variations in depth would add insulating value and also help reduce air leakage – loose cellulose being much more resistant to airflow than fiberglass. Reducing air leakage through the ceiling is important because air flowing through porous insulation dramatically reduces its insulating value as well as contributing to higher moisture loading in the attic and heat loss from the infiltration itself. Although the ideal situation would be to air seal the ceiling with sprayfoam, taped drywall, or some other similar method, cellulose is a much more cost effective option.

### *Results*

- Annual Energy Savings: 219 therms/year
- Annual $ Savings: $289/year
- Cost: $12,781 ($6,110 in materials + $6,671 in labor)
- Payback: 44 years
- GHG Emissions Reduction at NY Upstate Rate: 2,593 lb CO2/year (8.8% of total)

*Recommended Action*

Although the payback period is longer than the expected useful life of this measure (30 years), if labor costs can be reduced by using town employees, this could turn into a project with a reasonable payback period. In addition, this measure will help reduce the thermal load on the building, which will make electrification less costly. For these reasons, this measure is recommended for consideration.

Add 8 inches of cellulose to the existing insulation. While installing insulation, also take the opportunity to air seal the top plate of the exterior wall directly inside of the eaves. This can help reduce significant amounts of air infiltration into the attic at the joint where the wall meets the ceiling. Spray foam makes a very effective air barrier for this application.

# ECM 7: Town Barn – Insulate Walls

## *Existing Conditions*

The Town Barn walls are a combination of poured concrete, concrete block, and wood framed. The concrete walls are uninsulated, while the wood framed sections are skinned with corrugated sheet metal on both sides and appear to be insulated with fiberglass batt. These wood framed, metal skinned walls are leaky assemblies, and the insulation is not expected to be very effective. Although these walls exhibited higher interior temperatures than the concrete walls, the IR measurements on the high reflectivity, low emissivity aluminum panels likely inflate the actual difference in heat loss between the two walls.

Photo: The Town Barn walls are a combination of poured concrete, concrete block, and wood framed.

Photo: The wood framed, metal skinned wall section above appears 11 F warmer than the poured concrete wall below. However, the high reflectivity and low emissivity of aluminum and its close proximity to radiant heat sources make these readings less indicative than they would seem.

### *Analysis*

Even though the wall area is less than half that of the ceiling, because of the much lower insulating value of the walls, heat loss is estimated to be about 2.5 times more than that through the ceiling. Insulating and air sealing these walls represent a significant energy savings. Because the walls are a combination of different materials, a foil faced polyisocyanurate foam board (Dow Thermax) was determined to be the most appropriate material.

### *Results*

- Annual Energy Savings: 660 therms/year
- Annual $ Savings: $873/year
- Cost: $15,406 ($9,432 in materials + $5,975 in labor)
- Payback: 18 years
- GHG Emissions Reduction at NY Upstate Rate: 7,834 lb CO2/year (27% of total)

### *Recommended Action*

Install 2 in. of foil faced polyisocyanurate foam board on all exterior walls. Glue and/or screw the foam board to the interior face of the walls. Tape seams with approved foil mastic tape to maintain an adequate air and moisture barrier.

# ECM 8: Town Barn – Install Air Curtains

## *Existing Conditions*

The garage areas have five large rollup doors for vehicle and equipment access. These doors have been recently replaced and are very well insulated and weather sealed. However, when the doors are opened, large amounts of air exchange occur, rapidly filling the space with outside air during the cold winter months.

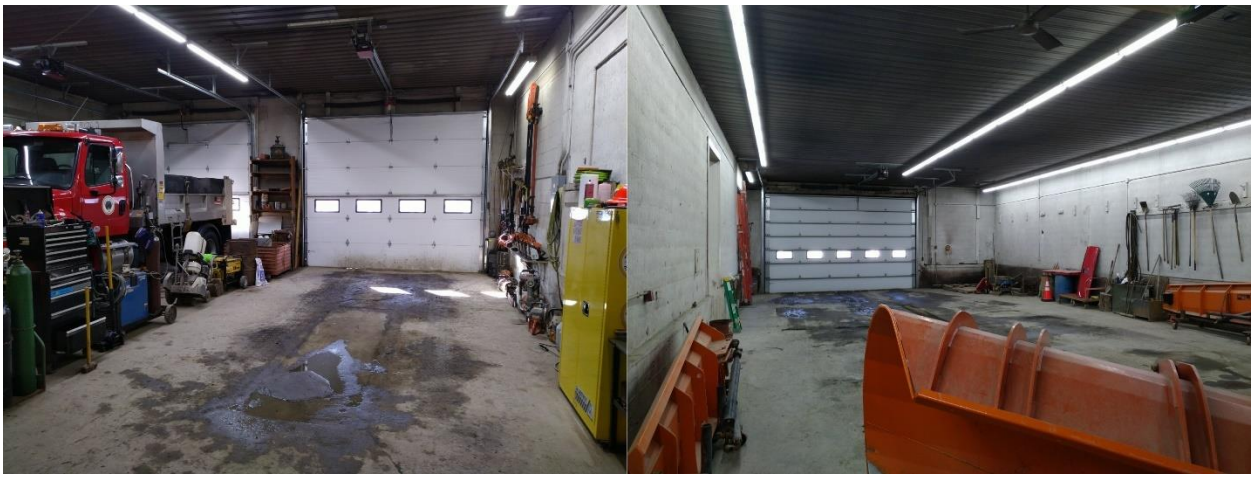


Photo: The Town Barn has five large rollup doors to allow vehicle and equipment access. These doors are well insulated and weather sealed, but allow large amounts of air exchange when open.

## *Analysis*

Based on an average heating season outdoor temperature of 36 $^{0}$F, the garage bays take an average of only 1.5 minutes to completely replace the entire volume of air in the space with outdoor air with the garage doors open. It is anticipated that the garage doors are open for longer than this, so that every period that doors are open completely replaces the entire volume of air in the garage bay. It is further assumed that the doors are only open twice per day, once in the morning and again in the evening. While this assumption likely does not hold every day, it appears to be a good average based on reported use and utility bill analysis.

Installing unheated air curtains above each door which would turn on when the door is open and turn off when it closes would help reduce air infiltration by an estimated 60%. Even though the infiltration rate is very high when the doors are open, the limited frequency of openings means that this measure has a relatively small effect on overall fuel usage.

### *Results*

- Annual Energy Savings: 53 therms/year
- Annual $ Savings: $70/year
- Cost: $38,600 ($30,100 in materials + $8,500 in labor)
- Payback: 551 years
- GHG Emissions Reduction at Upstate NY Rate: 629 lb CO2/year (2.1% of total)

### *Recommended Action*

Because of the high cost and low savings of this measure, this is not a recommended action to take. Although the assumption on how many door openings occur each day will affect the cost effectiveness of this measure, it is estimated it would take over 70 door openings per day to give this a 15 year payback period, which seems to be beyond the realm of reason.

# ECM 9: Town Barn – Setback Thermostats

## *Existing Conditions*

The Town Barn is split into four heating zones – two heated by the hydronic boiler, and two heated by separate gas-fired unit heaters. Each zone is controlled by a separate thermostat. The garage spaces are kept at 60 $^0$F, and the office spaces are kept at 65 $^0$F during occupied and unoccupied periods (i.e. no setbacks).

Photo: The Town Barn is split into four heating zones – two heated by the hydronic boiler, and two heated by separate gas-fired unit heaters.

## *Analysis*

Replacing the manual thermostats with simple, 7-day programmable thermostats will allow setbacks to be made automatically, and still allow for manual overrides for off-schedule events (e.g. plowing season work, emergency repairs, etc.). This is a very simple and straight-forward task, so costs are minimal. Although the recommended night setback temperature is 50 $^0$F, due to the high thermal mass of the building, the actual interior temperature will take some time to drop to that setback temperature. Calculations based on thermal mass estimates and hourly weather data indicate that the building will spend most of the heating season setback hours at higher temperatures than the recommended 50 $^0$F setpoint. In fact, it appears that the average night setback temperature would be around 58 $^0$F. Nonetheless, these same calculations estimate

substantial savings which, combined with the relatively low capital cost, lead to a short payback period.

### *Results*

- Annual Energy Savings: 202 therms/year
- Annual $ Savings: $262/year
- Cost: $800 ($600 in materials + $200 in labor)
- Payback: 3.1 years
- GHG Emissions Reduction at Upstate NY Rate: 2,396 lb CO2/year (8.1% of total)

### *Recommended Action*

Replace all four hydronic thermostats with 7-day programmable thermostats. Set "home" and "away" or "occupied" and "unoccupied" schedules based on normal daily schedules. Set "away" or "unoccupied" down to at least 50 $^{0}$F to realize estimated savings. Lower setbacks are anticipated to have negligible additional savings. If the heat pump electrification measure is implemented, this measure will no longer be relevant. However, due to the low capital cost and short payback period, this measure would be a good one to implement while plans for the more expensive heat pump measure are made. After the heat pump system is installed, the programmable thermostats can still be used to provide emergency freeze protection using the gas fired equipment.

# ECM 10: Town Barn – Install Electric Tankless Water Heater

## *Existing Conditions*

The existing water heater is a tank style indirect heater using the gas fired boiler to heat the domestic hot water. Domestic hot water demands are relatively low for the facility having only one breakroom sink and two bathrooms with lavatory faucets only (i.e. no showers).

Photo: The Town Barn water heater uses this boiler to heat the water.

### *Analysis*

Replacing the water heater with a tankless water heater would displace gas consumption by using electricity instead. The tankless water heater would also eliminate the heat loss associated with a tank full of hot water. Due to the low hot water usage in the building, most of the energy consumed by the existing water heater is used to replace the heat lost to the surrounding basement from the tank itself. A tankless water heater heats water as it is being used and thus does not have the associated losses to the surroundings. The one drawback of tankless electric heaters is the large amount of electrical current they require when operating. To provide enough capacity for instantaneous use, an electrical service upgrade may be required. Although the energy cost savings are low and the associated payback period is long, this option is expected to be *less* expensive than a tank style water heater. Because the town is focused on electrifying their buildings, this measure is still recommended for implementation.

Results

- Annual Energy Savings: 202 therms/year; -217 kWh/year
- Annual $ Savings: $248/year
- Cost: $1,800 ($600 in materials + $1,200 in labor)
- Payback: 7.2 years
- GHG Emissions Reduction at NY Upstate Rate: 2,344 lb CO2/year (8.0% of total)

### *Recommended Action*

Replace the existing water heater with a tankless on-demand electric heater. Evaluate instantaneous water heating needs and size the tankless unit appropriately. Evaluate the electrical capacity of the existing main service and consider whether an upgrade will be necessary. If an upgrade is necessary for other reasons (i.e. cold climate heat pump installation), then factor in the additional capacity needed for a tankless water heater as well.

# ECM 11: Town Barn – Install Air Source Heat Pump

## *Existing Conditions*

The Town Barn is heated by a gas fired boiler with hydronic fan coils and two gas fired unit heaters. While the boiler is relatively new (built in 2015), the unit heaters are both over 10 years old and have an expected useful life of 15 years. This equipment is the primary contributor to site GHG emissions at the barn, accounting for about 80% of site emissions.

Photo: The Town Barn is heated by a gas fired boiler and two gas fired unit heaters.

## *Analysis*

Replacing the existing boiler and unit heaters with a new, "cold-climate" rated ductless air source heat pump system would provide heating for the space at a much higher efficiency as well as removing the sources of site fossil fuel combustion. An additional benefit of this system is its ability to provide summertime cooling. For this analysis, only the costs of heating were considered (using the system for cooling was estimated to reduce cost savings by about 20%). While the initial capital outlay is estimated as $50,400, when accounting for depreciation of the boiler ($6,440) and unit heaters ($10,120), the *net* cost ($33,840) is significantly less. This measure may also qualify for utility and/or NYSERDA rebates, which may further reduce the payback period to a reasonable level.

*Results*

- Annual Energy Savings: 1,979 therms/year; -15,255 kWh/year
- Annual $ Savings: $961 /year
- Cost: $33,840 ($30,200 in materials + $20,200 in labor)
- Payback: 52 years
- GHG Emissions Reduction at Upstate NY Rate: 19,893 lb CO2/year (67% of total)

*Recommended Action*

Install a ductless air source heat pump system in place of the existing system. Ensure that the system being installed is "cold-climate" rated. A list of suitable models can be found at the following website:

https://ashp.neep.org/

The new system should be sized to provide at least 90% of the total heat load of the building at the ASHRAE design conditions for Newfield (6.1 $^{0}$F).

# 5. APPENDIX DATA

## Town Hall Equipment & Lighting

**Heating and Air Conditioning Equipment**

| Unit Type | Qty | Make/Model | Heating kBtuh | Rated Heating Eff. | Cooling Capacity | Units | EER | Serves/Location | Year |
|---|---|---|---|---|---|---|---|---|---|
| Boiler | 1 | Laars/JVH125 | 125 | 82% | | | | Whole Building | 2000 |
| Minisplit | 1 | Fujitsu/AOU9RLFW | 12 | 322% | 9 | kbtuh | 13.8 | Downstairs Office | 2008 |
| Minisplit | 1 | Fujitsu/AOU30RLX | 32 | 278% | 30 | kbtuh | 10.0 | Courtroom | 2008 |
| Minisplit | 1 | Fujitsu/AOU36RML1 | 42 | 264% | 36 | kbtuh | 8.8 | Meeting Room | 2008 |
| Minisplit | 1 | Mitsubishi/PUGH24 | 24 | 261% | 25 | kbtuh | 9.0 | Clerk's Office | 2000 |

**Domestic Hot Water**

| Unit Type | Qty | Make/Model | Capacity | Units | Fuel Type | Storage Capacity (gal.) | Eff. | Serves/Location | Year |
|---|---|---|---|---|---|---|---|---|---|
| Storage | 1 | State/CV 42 | 9 | kW | Electricity | 42 | 100% | Whole Building | 1977 |

**Interior Lighting Fixtures**

| Existing Fixtures | | | | | | Recommended | Recommended Interior Lighting Efficiency Improvements | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Line # | Area | Qty | Present Lighting Type | Lamps /fixt | Watts /Fixt | Control Type | Measure Type | Qty | Proposed Lighting Type | Lamps /fixt | Watts /Fixt |
| 1 | 1st Flr Entry | 3 | 2' LED tube 1150 lu. 7W | 2 | 14 | No Change | No change | 3 | 2' LED tube 1150 lu. 7W | 2 | 14 |
| 2 | 1st Flr Super | 5 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 5 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 3 | 1st Flr Meeting Rm | 9 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 9 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 4 | 1st Flr Clerk | 10 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 10 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 5 | Basement Entry | 3 | 2' LED tube 1150 lu. 7W | 2 | 14 | No Change | No change | 3 | 2' LED tube 1150 lu. 7W | 2 | 14 |
| 6 | Basement Office | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 7 | Basement Foyer | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 8 | Basement Storage | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 9 | Basement Court | 12 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 12 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 10 | Basement Womens | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 11 | Basement Mens | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 1 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 12 | Basement Mech | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 2 | 4' LED T8 2200 lu. 17W | 4 | 68 |

**Exterior Lighting Fixtures**

| Existing Fixtures | | | | | | Recommended | Lighting Efficiency Improvements | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Line # | Area | Qty | Present Lighting Type | Lamps /fixt | Watts /Fixt | Control Type | Measure Type | Qty | Proposed Lighting Type | Lamps /fixt | Watts /Fixt |
| 1 | Front Entrance | 2 | LED area light, 28W | 2 | 56 | No Change | No change | 2 | LED area light, 28W | 2 | 56 |
| 2 | Rear Entrance | 2 | LED area light, 28W | 2 | 56 | No Change | No change | 2 | LED area light, 28W | 2 | 56 |
| 3 | Sidewalls | 2 | LED wallpack, 20W | 1 | 20 | No Change | No change | 2 | LED wallpack, 20W | 1 | 20 |

# Town Barn Equipment & Lighting

**Heating and Air Conditioning Equipment**

| Unit Type | Qty | Make/Model | Heating kBtuh | Rated Heating Eff. | Cooling Capacity | Units | EER | Serves/Location | Year |
|---|---|---|---|---|---|---|---|---|---|
| Boiler | 1 | Weil McLain | 155 | 95% | | | | Offices/N Garage Bays | 2015 |
| Gas Fired Unit Heater | 1 | Modine/HD 125A | 125 | 80% | | | | E Garage Bays | 2010 |
| Gas Fired Unit Heater | 1 | Modine/HD 100A | 100 | 80% | | | | S Garage Bays | 2011 |

**Domestic Hot Water**

| Unit Type | Qty | Make/Model | Capacity | Units | Fuel Type | Storage Capacity (gal.) | Eff. | Serves/Location | Year |
|---|---|---|---|---|---|---|---|---|---|
| Unfired Tank | 1 | Bradford White/SW240RL | 157 | kBtuh | NA | 38 | NA | Offices | 2014 |

**Interior Lighting Fixtures**

| Existing Fixtures | | | | | | Recommended | Recommended Interior Lighting Efficiency Improvements | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Line # | Area | Qty | Present Lighting Type | Lamps /fixt | Watts /Fixt | Control Type | Measure Type | Qty | Proposed Lighting Type | Lamps /fixt | Watts /Fixt |
| 1 | Offices | 5 | 4' LED T8 2200 lu. 17W | 4 | 68 | No Change | No change | 5 | 4' LED T8 2200 lu. 17W | 4 | 68 |
| 2 | Offices | 38 | 4' LED T8 2200 lu. 17W | 2 | 34 | No Change | No change | 38 | 4' LED T8 2200 lu. 17W | 2 | 34 |
| 3 | N Garage Bays | 36 | 4' LED T8 2200 lu. 17W | 2 | 34 | No Change | No change | 36 | 4' LED T8 2200 lu. 17W | 2 | 34 |
| 4 | E Garage Bays | 48 | 4' LED T8 2200 lu. 17W | 2 | 34 | No Change | No change | 48 | 4' LED T8 2200 lu. 17W | 2 | 34 |
| 5 | S Garage Bays | 13 | 4' LED fixture 4500 lu. 42w | 1 | 42 | No Change | No change | 13 | 4' LED fixture 4500 lu. 42w | 1 | 42 |
| 6 | S Garage Bays | 4 | 4' LED T8 2200 lu. 17W | 2 | 34 | No Change | No change | 4 | 4' LED T8 2200 lu. 17W | 2 | 34 |

**Exterior Lighting Fixtures**

| Existing Fixtures | | | | | | Recommended | Lighting Efficiency Improvements | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Line # | Area | Qty | Present Lighting Type | Lamps /fixt | Watts /Fixt | Control Type | Measure Type | Qty | Proposed Lighting Type | Lamps /fixt | Watts /Fixt |
| 1 | Wall Packs | 2 | LED area light, 75W | 1 | 75 | No Change | No change | 2 | LED area light, 75W | 1 | 75 |
| 2 | Pole Lights | 2 | LED area light, 100W | 1 | 100 | No Change | No change | 2 | LED area light, 100W | 1 | 100 |
| 3 | Flood Lights | 2 | LED Medium Flood, 2,461 l | 1 | 40 | No Change | No change | 2 | LED Medium Flood, 2,461 lu. | 1 | 40 |

# ECM-1 Calculations

## CALCULATIONS TO INSULATE ATTIC
**ECM-1 Town of Newfield**

**INPUT DATA:**

| Surface to be insulated: | Roof | Walls | | |
|---|---|---|---|---|
| Area: | 1,740 | 2,058 | sq ft | |
| Present R value: | 20.3 | 10.6 | | |
| Revised R value | 50.1 | 10.6 | | |
| Present U factor:: | 0.049 | 0.095 | Btuh/sq ft-deg F | |
| Revised U factor: | 0.020 | 0.095 | Btuh/sq ft-deg F | |
| Present U x Area | 86 | 195 | 280 | UA Total present |
| Proposed U x Area | 35 | 195 | 229 | UA Total proposed |

| **CALCULATIONS:** | Occupied | Unoccupied | **Fuel Data** | Heating | Cooling |
|---|---|---|---|---|---|
| Heating Setpoint: | 68 | 62 | Type: | Natural Gas | Electricity |
| Cooling Setpoint: | 72 | 72 | Units: | therm | kwh |
| Q internal gains (Btuh): | 13,002 | 1,885 | Unit cost: | $ 1.299 | $ 0.06 |
| BLC (Btuh/degree F): | 576 | 678 | BTU/unit | 100,000 | 3,412 |
| T Balance (°F.): | 45.4 | 59.2 | Efficiency/ COP: | 81.6% | 2.93 |
| T Balance = T Setpoint - (Q internal gains / BLC) | | | EER: | | 10.0 |

| Bin Mid-Pt. | Occupied Hours | Unoccupied Hours | Change in Occupied Heat Loss | Change in Unoccupied Heat Loss | Heating Savings therm | Cooling Savings kwh |
|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 3,844 | 3,539 | 0 | 0 |
| (2.5) | 0 | 7 | 3,589 | 3,284 | 0 | 0 |
| 2.5 | 1 | 19 | 3,335 | 3,029 | 1 | 0 |
| 7.5 | 2 | 31 | 3,080 | 2,775 | 1 | 0 |
| 12.5 | 9 | 94 | 2,826 | 2,520 | 3 | 0 |
| 17.5 | 37 | 270 | 2,571 | 2,266 | 9 | 0 |
| 22.5 | 73 | 390 | 2,317 | 2,011 | 12 | 0 |
| 27.5 | 84 | 487 | 2,062 | 1,757 | 13 | 0 |
| 32.5 | 136 | 586 | 1,807 | 1,502 | 14 | 0 |
| 37.5 | 217 | 770 | 1,553 | 1,247 | 16 | 0 |
| 42.5 | 141 | 628 | 1,298 | 993 | 10 | 0 |
| 47.5 | 194 | 642 | 0 | 738 | 6 | 0 |
| 52.5 | 185 | 436 | 0 | 484 | 3 | 0 |
| 57.5 | 147 | 567 | 0 | 229 | 2 | 0 |
| 62.5 | 264 | 757 | 0 | 0 | 0 | 0 |
| 67.5 | 239 | 456 | 0 | 0 | 0 | 0 |
| 72.5 | 177 | 240 | (25) | (25) | 0 | 1 |
| 77.5 | 144 | 159 | (280) | (280) | 0 | 8 |
| 82.5 | 88 | 71 | (535) | (535) | 0 | 9 |
| 87.5 | 2 | 9 | (789) | (789) | 0 | 1 |
| 92.5 | 0 | 0 | (1,044) | (1,044) | 0 | 0 |
| 97.5 | 0 | 0 | (1,298) | (1,298) | 0 | 0 |
| 102.5 | 0 | 0 | (1,553) | (1,553) | 0 | 0 |
| 107.5 | 0 | 0 | (1,807) | (1,807) | 0 | 0 |
| | 8,760 hours | | | Energy Savings: | 88 | 19 |
| | | | | | $ 114 | $ 1.2 |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 1,043 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 4 | lb $CO_2$/yr |
| Total Emissions Savings | 1,047 | lb $CO_2$/yr |
| | 8.0% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material ($ / sq ft) | Labor | Quantity | Total |
|---|---|---|---|---|
| Roof | $ 0.98 | $ 1.07 | 1,740 | $ 3,567 |
| | 1,705 | 1,862 | | |
| Implementation Cost: | | | $ 3,567 | = 30.9 year payback |
| Annual Energy Savings: | | | $ 115 | |

# ECM-2 Calculations

## CALCULATIONS FOR AIR SEAL PENETRATIONS

**ECM-2** **Town of Newfield**

**INPUT DATA:**

| Opening | | Conduit | Exhaust Fan | Attic Hatch | Total |
|---|---|---|---|---|---|
| Equivalent Diameter | (in) | 3.0 | 12.0 | 2.5 | |
| Free Area | (%) | 90% | 25% | 100% | |
| Relative Height | (ft) | 18 | 8 | 8 | |
| Qty | | 2 | 1 | 1 | |
| Average Infiltration Occupied | (cfm) | 30 | 45 | 8 | 83 |
| Average Infiltration Unoccupied | (cfm) | 25 | 37 | 7 | 69 |
| Infiltration Reduction | (%) | 90% | 90% | 80% | 89% |

**CALCULATIONS:**

Infiltration = 5.21 x Opening Area x [ Height Difference x ( Inside Temp - Outside Temp ) / Inside Temp (absolute) ] ^ 1/2
Energy Savings = (Present Leakage - New Leakage) x Accum Hours x Temp Difference x CF2
Energy Cost Savings = (Energy Savings / CF1) x (Unit cost / Efficiency)

| | Occupied | Unoccupied | |
|---|---|---|---|
| T Setpoint: | 68 | 62 | °F |
| Q internal gains: | 13,002 | 1,885 | Btuh |
| BLC: | 576 | 678 | Btuh/°F |
| T Balance: | 45.4 | 59.2 | °F. T Balance = T Setpoint - (Q internal gains / BLC) |
| Bin Data for Elmira, 41 hrs./week | | | |
| Accumulated Hours | 700 | 4,928 | below balance temp. |
| Avg. OAT | 33.3 | 38.3 | °F below balance temp. |
| (T Set- Avg OAT) | 34.7 | 23.7 | °F difference |

| | | |
|---|---|---|
| Type: | Natural Gas | |
| Units: | therm | |
| Unit cost: | $ 1.299 | /therm |
| CF1 | 100,000 | Btu/therm |
| Efficiency: | 82% | |
| CF2 | 0.018 | Btu/hr-°F-cfh |

| | Energy Savings - Btu/year | | | Total Savings | |
|---|---|---|---|---|---|
| | Occupied | Unoccupied | Total | therm / yr | $ |
| Infiltration Reduction | 1,931,600 | 7,688,000 | 9,619,600 | 118 | $ 153 |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 1,398 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 1,398 | lb $CO_2$/yr |
| | 11% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Materials ($) | Labor ($) | Total ($) | Savings ($) | |
|---|---|---|---|---|---|
| Sealing Conduit | $ 10.00 | $ 120.00 | $ 130 | $ 56 | = 2.3 year payback |
| Covering Exhaust Fan | $ 30.00 | $ 120.00 | $ 150 | $ 83 | = 1.8 year payback |
| Attic Hatch | $ 10.00 | $ 60.00 | $ 70 | $ 15 | = 4.8 year payback |
| | | **Totals:** | $ 350 | $ 153 | = 2.3 year payback |

## ECM-3 Calculations

### CALCULATIONS TO IMPLEMENT DEEPER SETBACK

**EEM-3 Town of Newfield**

**INPUT DATA:** 100% of Building to be Setback

| | | Current | Proposed | |
|---|---|---|---|---|
| Heating T Setpoint: | Occupied | 68 | 68 | deg. F. |
| | Unoccupied | 62 | 55 | deg. F. |
| Cooling T Setpoint: | Occupied | 72 | 72 | deg. F. |
| | Unoccupied | 72 | 72 | deg. F. |
| HVAC Schedule | Occupied | 41.0 | 41.0 | Hours per week |
| | Unoccupied | 127.0 | 127.0 | Hours per week |
| Q internal gains: | Occupied | 13,002 | 13,002 | Btuh |
| | Unoccupied | 1,885 | 1,885 | Btuh |
| Q internal gains: | Schedule | 41 | 41 | Hours per week |
| BLC: | Occupied | 576 | 576 | Btuh/deg. F. |
| (excludes DOAS) | Unoccupied | 678 | 678 | Btuh/deg. F. |
| Heating T Actual | Occupied | 68 | 68 | |
| (w/ thermal mass effects): | Unoccupied | 64 | 62 | |

| **Fuel Data** | Heating | Cooling | | |
|---|---|---|---|---|
| Type: | Natural Gas | Electricity | Economizer? | |
| Units: | therm | kwh | No | |
| Unit cost: | $ 1.299 | $ 0.06 | | |
| BTU/unit | 100,000 | 3,412 | | |
| Efficiency/ COP: | 79.8% | 4.25 | Avg. COP. EER: | 14.5 |
| | | 100.0% | of bldg. is cooled | |

**CALCULATIONS:**

Current Elmira, 41 hrs./week

| Bin Mid Pt. | Occupied Hours | Unoccupied Hours | Occ Net Heat Loss BTUH | Unocc Net Heat Loss BTUH | Heating Fuel Use therm | Cooling Energy kwh |
|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 0 | 45,964 | 1 | 0 |
| (2.5) | 0 | 7 | 0 | 42,903 | 4 | 0 |
| 2.5 | 1 | 19 | 34,920 | 19,200 | 5 | 0 |
| 7.5 | 2 | 31 | 31,871 | 37,205 | 15 | 0 |
| 12.5 | 9 | 94 | 29,851 | 34,124 | 44 | 0 |
| 17.5 | 37 | 270 | 27,222 | 30,493 | 116 | 0 |
| 22.5 | 73 | 390 | 24,862 | 27,134 | 155 | 0 |
| 27.5 | 84 | 487 | 22,778 | 24,323 | 172 | 0 |
| 32.5 | 136 | 586 | 20,000 | 21,530 | 192 | 0 |
| 37.5 | 217 | 770 | 17,259 | 18,297 | 224 | 0 |
| 42.5 | 141 | 628 | 13,492 | 14,561 | 138 | 0 |
| 47.5 | 194 | 642 | 8,062 | 9,786 | 98 | 0 |
| 52.5 | 185 | 436 | 8,516 | 8,100 | 64 | 0 |
| 57.5 | 147 | 567 | 5,856 | 4,853 | 45 | 0 |
| 62.5 | 264 | 757 | 2,612 | 1,144 | 19 | 0 |
| 67.5 | 239 | 456 | 179 | 62 | 1 | 0 |
| 72.5 | 177 | 240 | (1,162) | (1,137) | 0 | 33 |
| 77.5 | 144 | 159 | (3,114) | (3,674) | 0 | 71 |
| 82.5 | 88 | 71 | (6,024) | (7,186) | 0 | 72 |
| 87.5 | 2 | 9 | (8,513) | (10,727) | 0 | 8 |
| 92.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 1,294 | 184 |

## CALCULATIONS TO IMPLEMENT DEEPER SETBACKCONTINUED

### EEM-3 Town of Newfield

| Proposed | | Elmira, 41 hrs./week | | | | |
|---|---|---|---|---|---|---|
| Bin Mid Pt. | Occupied | Unoccupied | Occ Net Heat | Unocc Net Heat | Heating Fuel | Cooling Energy kwh |
| (7.5) | 0 | 1 | 0 | 43,795 | 1 | 0 |
| (2.5) | 0 | 7 | 0 | 41,134 | 4 | 0 |
| 2.5 | 1 | 19 | 31,718 | 17,610 | 5 | 0 |
| 7.5 | 2 | 31 | 28,271 | 35,318 | 14 | 0 |
| 12.5 | 9 | 94 | 26,991 | 31,740 | 40 | 0 |
| 17.5 | 37 | 270 | 25,896 | 28,296 | 108 | 0 |
| 22.5 | 73 | 390 | 24,028 | 25,053 | 144 | 0 |
| 27.5 | 84 | 487 | 22,308 | 22,455 | 161 | 0 |
| 32.5 | 136 | 586 | 19,557 | 20,142 | 181 | 0 |
| 37.5 | 217 | 770 | 16,906 | 17,359 | 214 | 0 |
| 42.5 | 141 | 628 | 13,313 | 13,907 | 133 | 0 |
| 47.5 | 194 | 642 | 7,947 | 9,354 | 95 | 0 |
| 52.5 | 185 | 436 | 8,393 | 7,766 | 62 | 0 |
| 57.5 | 147 | 567 | 5,694 | 4,692 | 44 | 0 |
| 62.5 | 264 | 757 | 2,549 | 1,112 | 19 | 0 |
| 67.5 | 239 | 456 | 173 | 60 | 1 | 0 |
| 72.5 | 177 | 240 | (1,164) | (1,137) | 0 | 33 |
| 77.5 | 144 | 159 | (3,114) | (3,674) | 0 | 71 |
| 82.5 | 88 | 71 | (6,024) | (7,186) | 0 | 72 |
| 87.5 | 2 | 9 | (8,513) | (10,727) | 0 | 8 |
| 92.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 1,224 | 184 |

| | Present | Proposed | Savings | |
|---|---|---|---|---|
| Heating | 1,294 | 1,224 | 70 | therm |
| Cooling | 184 | 184 | (0) | kwh |
| Annual Energy $ | | | $ 91 | |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 827 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 827 | lb $CO_2$/yr |
| | 2.8% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material $/unit | Labor $/unit | Quantity | Total |
|---|---|---|---|---|
| 7-day thermostat | $ 150 | $ 50 | 3 | $ 600 |
| | | | | $ 0 |
| | | | | $ 600 |

| | | |
|---|---|---|
| Implementation Cost: | $ 600 | = 6.6 year payback |
| Annual Energy Savings: | $91 | |

# ECM-4 Calculations

## CALCULATIONS TO INSTALL A TANKLESS WATER HEATER

**ECM-4 Town of Newfield**

**INPUT DATA:**

| | Present Fuel | | Proposed Fuel | |
|---|---|---|---|---|
| Fuel: | **Electricity** | | Electricity | |
| Units: | kwh | | kwh | |
| Fuel Cost: | $ 0.06 | per kwh | $ 0.06 | per kwh |
| BTU / unit: | 3,412 | Btu per kwh | 3,412 | Btu per kwh |
| kW Demand cost: | $ 9.43 | per kW | $ 9.43 | per kW |
| Average kW demand: | **0.2** | kW | **0.1** | kW |
| Demand Diversity: | **33%** | | **33%** | |
| Net kW Demand Savings: | 0.1 | kW per month | 0.0 | kW per month |
| Months of demand: | **12** | per year | **0** | per year |

| Annual DHW Consumption: | Present | | Proposed | |
|---|---|---|---|---|
| Hot Water Usage: | **0.5** | Gallons/person/day | 0.5 | Gallons/person/day |
| Number of persons: | **10** | ( estimate) | 10 | ( estimate) |
| Days of Usage: | **250** | per year | 250 | per year |
| Hours of Usage per Day: | 8 | hours | 8 | hours |
| Average inlet water Temp: | 54 | degrees F | 54 | degrees F |
| Average hot water temp: | 125 | degrees F | 125 | degrees F |

| Storage Tank Losses: | Present Tank | | Proposed Tank | |
|---|---|---|---|---|
| Tank U factor: | 0.15 | Btu/SF/Hour | 0.15 | Btu/SF/Hour |
| Height of Tank: | 47.0 | inches | 46.7 | inches |
| Diameter of Tank: | 18.0 | inches | 20.0 | inches |
| | 40 | gallons/tank | 50 | gallons/tank |
| # of Tanks | 1 | Qty. | 0 | Qty. |
| Hours Tank is Hot: | 8,760 | Hours | 8,760 | |
| Water Temperature: | 125 | Deg. F. | 125 | |
| Ambient Temperature: | 65 | Deg. F. | 65 | |

| | | | | | |
|---|---|---|---|---|---|
| Recirculation Losses: | 0.0% | of boiler capacity = | 0 | BTUh | |
| | 8,760 | hours/year | 8,760 | hours/year = | 100% |

| Boiler Jacket & Flue Losses: | | | | | |
|---|---|---|---|---|---|
| Burner Input | 40,000 | BTUH | 44,360 | BTUH | |
| Efficiency: | **100.0%** | | 100.0% | | |
| Boiler Output Capacity | 40,000 | BTU output | 44,360 | BTU output | |
| Jacket & Flue Losses: | 0.0% | of boiler capacity | 0.0% | of boiler capacity | |
| Boiler is Hot: | 8,760 | hours/year | 8,760 | hours/year = | 100% |

**CALCULATIONS:**

| | Present | | Proposed | |
|---|---|---|---|---|
| Consumption Energy: | 741,129 | BTU output rqd/yr | 741,129 | BTU output rqd/yr |
| Tank Energy Losses: | 1,729,995 | BTU/year | 0 | BTU/year |
| Recirculation Losses: | 0 | BTU/year | 0 | BTU/year |
| Boiler Jacket Losses: | 0 | BTU/year | 0 | BTU/year |
| Output BTU/Year | 2,471,124 | | 741,129 | |
| | | | | |
| Annual Fuel Consumption | 724 | kwh | 217 | kwh |
| Demand | 1 | billed kW /yr. | 0 | kW |
| Annual Fuel Cost | $ 50 | | $ 13 | |
| **Annual Savings:** | **507** | **kwh** | **$ 37** | **per year** |
| | **0** | | | |
| | **1** | billed kW /yr. | | |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 0 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 119 | lb $CO_2$/yr |
| Total Emissions Savings | 119 | lb $CO_2$/yr |
| | 0.9% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Quantity | Material Costs | Labor Costs | Total |
|---|---|---|---|---|
| Tankless Electric Water Heater | 1 | $ 600 | $ 1,200 | $ 1,800 |
| | **Implementation Cost:** | | | **$ 1,800** = **48.5 year payback** |
| | **Annual Energy Savings:** | | | **$ 37** |

# ECM-5 Calculations

**CALCULATIONS TO REPLACE HVAC SYSTEM with DUCTLESS HEAT PUMP**
**EEM-5 Town of Newfield**

**INPUT DATA**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Present HVAC system: | Present Fuels | Type: | Units: | Unit cost: | BTU/unit | COP | Rated at | EER |
| Non-Condensing Boiler | Heating 1 | Natural Gas | therm | $ 1.299 | 100,000 | 0.816 | Et | |
| non-heat pump | Heating 2 | Electricity | kwh | $ 0.061 | 3,412 | 3.000 | | |
| 100% of the building | Cooling | Electricity | kwh | $ 0.061 | 3,412 | 2.931 | 95° OAT | 10.0 |
| Proposed HVAC system: | Proposed Fuel | Type: | Units: | Unit cost: | BTU/unit | COP | Rated at | EER |
| Ductless Heat Pump | Heating 1 | Electricity | kwh | $ 0.061 | 3,412 | 4.000 | 47° OAT | |
| heat pump | Heating 2 | ambient air | | $ 0.000 | 0 | | | |
| Below (8) °F. OA Temp | Cooling | Electricity | kwh | $ 0.061 | 3,412 | 3.810 | 95° OAT | 13.0 |
| All heat is provided by | Heating 2 Low | | | $ 0.000 | 0 | | | |

| HVAC Loads (excluding any DOAS system) | | | Present HVAC system: Non-Condensing Boiler | | | | | | Proposed HVAC system: Ductless Heat Pump | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bin Mid Pt. | Occupied Hours | Occ Net Heat Loss BTUH | Heating 1 Et or COP Natural Gas | Heating 2 Et or COP Electricity | Cooling COP Electricity | Heating 1 Natural Gas therm | Heating 2 Electricity kwh | Cooling Electricity kwh | Heating 1 Et or COP Electricity | Heating 2 Et or COP ambient air | Cooling Et or COP Electricity | Heating 1 Electricity kwh | Heating 2 ambient air | Cooling Electricity kwh |
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during occupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Present heating system efficiency) | (NA) | (Present cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in therms) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) | (Proposed heating system efficiency) | (NA) | (Proposed cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in kWh) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) |
| (7.5) | 0 | 30,504 | 0.82 | 1.57 | | 0 | 0 | 0 | 2.10 | 0.00 | | 0 | 0 | 0 |
| (2.5) | 0 | 27,623 | 0.82 | 1.66 | | 0 | 0 | 0 | 2.21 | 0.00 | | 0 | 0 | 0 |
| 2.5 | 1 | 24,742 | 0.81 | 1.75 | | 0 | 1 | 0 | 2.34 | 0.00 | | 3 | 0 | 0 |
| 7.5 | 2 | 21,861 | 0.81 | 1.86 | | 0 | 1 | 0 | 2.48 | 0.00 | | 5 | 0 | 0 |
| 12.5 | 9 | 18,980 | 0.81 | 1.98 | | 2 | 5 | 0 | 2.64 | 0.00 | | 19 | 0 | 0 |
| 17.5 | 37 | 16,098 | 0.81 | 2.11 | | 6 | 16 | 0 | 2.81 | 0.00 | | 62 | 0 | 0 |
| 22.5 | 73 | 13,217 | 0.81 | 2.25 | | 10 | 25 | 0 | 3.00 | 0.00 | | 94 | 0 | 0 |
| 27.5 | 84 | 10,336 | 0.80 | 2.40 | | 9 | 21 | 0 | 3.20 | 0.00 | | 80 | 0 | 0 |
| 32.5 | 136 | 7,455 | 0.80 | 2.56 | | 10 | 23 | 0 | 3.42 | 0.00 | | 87 | 0 | 0 |
| 37.5 | 217 | 4,574 | 0.79 | 2.74 | | 10 | 21 | 0 | 3.65 | 0.00 | | 80 | 0 | 0 |
| 42.5 | 141 | 1,692 | 0.79 | 2.92 | | 2 | 5 | 0 | 3.90 | 0.00 | | 18 | 0 | 0 |
| 47.5 | 194 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 52.5 | 185 | (1,765) | | | 5.6 | 0 | 0 | 17 | | 0.00 | 6.8 | 0 | 0 | 14 |
| 57.5 | 147 | (4,646) | | | 5.2 | 0 | 0 | 38 | | 0.00 | 6.2 | 0 | 0 | 32 |
| 62.5 | 264 | (7,527) | | | 4.9 | 0 | 0 | 120 | | 0.00 | 5.8 | 0 | 0 | 101 |
| 67.5 | 239 | (10,409) | | | 4.5 | 0 | 0 | 161 | | 0.00 | 5.3 | 0 | 0 | 137 |
| 72.5 | 177 | (13,290) | | | 4.2 | 0 | 0 | 164 | | 0.00 | 4.9 | 0 | 0 | 141 |
| 77.5 | 144 | (16,171) | | | 3.9 | 0 | 0 | 175 | | 0.00 | 4.5 | 0 | 0 | 151 |
| 82.5 | 88 | (19,052) | | | 3.6 | 0 | 0 | 137 | | 0.00 | 4.2 | 0 | 0 | 118 |
| 87.5 | 2 | (21,933) | | | 3.3 | 0 | 0 | 4 | | 0.00 | 3.8 | 0 | 0 | 3 |
| 92.5 | 0 | (24,815) | | | 3.0 | 0 | 0 | 0 | | 0.00 | 3.6 | 0 | 0 | 0 |
| 97.5 | 0 | (27,696) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.3 | 0 | 0 | 0 |
| 102.5 | 0 | (30,577) | | | 2.5 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |
| 107.5 | 0 | (33,458) | | | 2.5 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |

| Bin Mid Pt. | Unoccupied Hours | Unocc Net Heat Loss BTUH | Heating Eff./COP Electricity | Heating Eff./COP Electricity | Cooling Eff. EER | Heating 1 Natural Gas therm | Heating 2 Electricity kwh | Cooling Electricity kwh | Heating 1 Et or COP Electricity | Heating 2 Et or COP ambient air | Cooling Et or COP Electricity | Heating 1 Electricity kwh | Heating 2 ambient air | Cooling Electricity kwh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during unoccupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Present heating system efficiency) | (NA) | (Present cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in therms) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) | (Proposed heating system efficiency) | (NA) | (Proposed cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in kWh) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) |
| (7.5) | 1 | 45,231 | 0.82 | 3.00 | | 0 | 1 | 0 | 2.10 | 0.00 | | 6 | 0 | 0 |
| (2.5) | 7 | 41,842 | 0.82 | 3.00 | | 3 | 6 | 0 | 2.21 | 0.00 | | 39 | 0 | 0 |
| 2.5 | 19 | 38,452 | 0.81 | 3.00 | | 7 | 14 | 0 | 2.34 | 0.00 | | 92 | 0 | 0 |
| 7.5 | 31 | 35,062 | 0.81 | 3.00 | | 11 | 21 | 0 | 2.48 | 0.00 | | 128 | 0 | 0 |
| 12.5 | 94 | 31,673 | 0.81 | 3.00 | | 29 | 58 | 0 | 2.64 | 0.00 | | 331 | 0 | 0 |
| 17.5 | 270 | 28,283 | 0.81 | 3.00 | | 76 | 148 | 0 | 2.81 | 0.00 | | 796 | 0 | 0 |
| 22.5 | 390 | 24,894 | 0.81 | 3.00 | | 97 | 188 | 0 | 3.00 | 0.00 | | 949 | 0 | 0 |
| 27.5 | 487 | 21,504 | 0.80 | 3.00 | | 105 | 203 | 0 | 3.20 | 0.00 | | 959 | 0 | 0 |
| 32.5 | 586 | 18,114 | 0.80 | 3.00 | | 107 | 205 | 0 | 3.42 | 0.00 | | 910 | 0 | 0 |
| 37.5 | 770 | 14,725 | 0.79 | 3.00 | | 114 | 219 | 0 | 3.65 | 0.00 | | 910 | 0 | 0 |
| 42.5 | 628 | 11,335 | 0.79 | 3.00 | | 72 | 138 | 0 | 3.90 | 0.00 | | 535 | 0 | 0 |
| 47.5 | 642 | 7,945 | 0.78 | 3.00 | | 53 | 99 | 0 | 4.16 | 0.00 | | 359 | 0 | 0 |
| 52.5 | 436 | 4,556 | 0.76 | 3.00 | | 21 | 38 | 0 | 4.44 | 0.00 | | 131 | 0 | 0 |
| 57.5 | 567 | 1,166 | 0.74 | 3.00 | | 7 | 13 | 0 | 4.73 | 0.00 | | 41 | 0 | 0 |
| 62.5 | 757 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 67.5 | 456 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 72.5 | 240 | (2,224) | | | 4.2 | 0 | 0 | 37 | | 0.00 | 4.9 | 0 | 0 | 32 |
| 77.5 | 159 | (5,613) | | | 3.9 | 0 | 0 | 67 | | 0.00 | 4.5 | 0 | 0 | 58 |
| 82.5 | 71 | (9,003) | | | 3.6 | 0 | 0 | 52 | | 0.00 | 4.2 | 0 | 0 | 45 |
| 87.5 | 9 | (12,393) | | | 3.3 | 0 | 0 | 10 | | 0.00 | 3.8 | 0 | 0 | 9 |
| 92.5 | 0 | (15,782) | | | 3.0 | 0 | 0 | 0 | | 0.00 | 3.6 | 0 | 0 | 0 |
| 97.5 | 0 | (19,172) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.3 | 0 | 0 | 0 |
| 102.5 | 0 | (22,562) | | | 2.5 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |
| 107.5 | 0 | (25,951) | | | 2.5 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Present Energy units: | 751 | 1,468 | 983 | | | | Proposed Energy units: | 6,636 | 0 | 842 |
| | | | | Energy types | Natural Gas | Electricity | Electricity | | | | Energy types | Electricity | ambient air | Electricity |
| | | | | Units | therm | kwh | kwh | | | | Units | kwh | | kwh |
| | | | | BTU/unit | 100,000 | 3,412 | 3,412 | | | | BTU/unit | 3,412 | 0 | 3,412 |
| | | | | mmBtu | 75 | 5 | 3 | | | | mmBtu | 23 | 0 | 3 |
| | | | | mmBtu | | 83 | mmBtu | | | | mmBtu | | 26 | mmBtu |
| | | | | Unit Cost | $ 1.299 | $ 0.061 | $ 0.061 | | | | Unit Cost | $ 0.061 | $ 0.000 | $ 0.061 |
| | | | | Annual Cost | $ 976 | $ 90 | $ 60 | | | | Annual Cost | $ 405 | $ 0 | $ 51 |
| | | | | Pumps & Fans: | | $ 75 | | | | | Pumps & Fans: | | $ 0 | |
| | | | | Total Annual Costs | Present | | $ 1,200 | ann. Cost | | | Total Annual Costs | Proposed | | $ 456 ann. Cost |

**HVAC system replacement - continued**

**Calculation of Loop Pumps & Heat Rejection Fan Loads**

| Present: | Non-Condensing Boiler | | | | Proposed: | Ductless Heat Pump | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Loop 1 | Loop 2 | Heat Rejection | | | Loop 1 | Loop 2 | Heat Rejection | |
| Type | Heating | none | Fan | | Type | none | none | Fan | |
| Assumed Delta T deg. | 20 | 0 | 0 | GPM/HP min. | Assumed Delta T deg. | 0 | 0 | 0 | GPM/HP min. |
| Estimated GPM | 5 | 0 | 0 | | Estimated GPM | 0 | 0 | 0 | |
| Estimated Pump BHP | 0.13 | 0.00 | 0.00 | Fan BHP | Estimated Pump BHP | 0.00 | 0.00 | 0.00 | Fan BHP |
| Estimated Motor Eff. | 45% | | | | Estimated Motor Eff. | | | | |
| Estimated kW | 0.22 | 0.00 | 0.00 | | Estimated kW | 0.00 | 0.00 | 0.00 | |

| | | | | | Present Pump & Fan Loads | | | | # months | Proposed Pump & Fan Loads | | | | Billed kW/yr. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bin Mid | Occupied | Occ Net Heat | Unoccupied | Unocc Net | Loop 1 kWh | Loop 2 kWh | Heat | Present kW | Bin is peak | Loop 1 kWh | Loop 2 | Heat | Proposed kW | savings |
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during occupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Hrs/yr at this outdoor temp during unoccupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | "Estimated kW" x Occ + Unocc Hours | (NA) | (NA) | (Loop kWh + Heat kWh + Cool kWh) / Bin Hours | (# Months the high temp falls within this bin) | "Estimated kW" x Occ + Unocc Hours | (NA) | (NA) | (Loop kWh + Heat kWh + Cool kWh) / Bin Hours | Present kW - Proposed kW |
| (7.5) | 0 | 30,504 | 1 | 45,231 | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| (2.5) | 0 | 27,623 | 7 | 41,842 | 2 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 2.5 | 1 | 24,742 | 19 | 38,452 | 4 | 0 | 0 | 1.0 | 0 | 0 | 0 | 0 | 3.1 | (2.1) |
| 7.5 | 2 | 21,861 | 31 | 35,062 | 7 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 2.6 | 0.0 |
| 12.5 | 9 | 18,980 | 94 | 31,673 | 22 | 0 | 0 | 0.8 | 0 | 0 | 0 | 0 | 2.1 | (2.7) |
| 17.5 | 37 | 16,098 | 270 | 28,283 | 67 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 1.7 | (1.0) |
| 22.5 | 73 | 13,217 | 390 | 24,894 | 101 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 1.3 | (0.7) |
| 27.5 | 84 | 10,336 | 487 | 21,504 | 124 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0.9 | 0.0 |
| 32.5 | 136 | 7,455 | 586 | 18,114 | 157 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0.6 | (0.5) |
| 37.5 | 217 | 4,574 | 770 | 14,725 | 215 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0.4 | (0.1) |
| 42.5 | 141 | 1,692 | 628 | 11,335 | 168 | 0 | 0 | 0.3 | 1 | 0 | 0 | 0 | 0.1 | 0.1 |
| 47.5 | 194 | 0 | 642 | 7,945 | 140 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.0 | 0.2 |
| 52.5 | 185 | (1,765) | 436 | 4,556 | 95 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0.1 | 0.3 |
| 57.5 | 147 | (4,646) | 567 | 1,166 | 124 | 0 | 0 | 0.4 | 1 | 0 | 0 | 0 | 0.2 | 0.4 |
| 62.5 | 264 | (7,527) | 757 | 0 | 0 | 0 | 0 | 0.5 | 1 | 0 | 0 | 0 | 0.4 | 0.1 |
| 67.5 | 239 | (10,409) | 456 | 0 | 0 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 0.6 | 0.0 |
| 72.5 | 177 | (13,290) | 240 | (2,224) | 0 | 0 | 0 | 0.9 | 2 | 0 | 0 | 0 | 0.8 | 0.3 |
| 77.5 | 144 | (16,171) | 159 | (5,613) | 0 | 0 | 0 | 1.2 | 1 | 0 | 0 | 0 | 1.1 | 0.2 |
| 82.5 | 88 | (19,052) | 71 | (9,003) | 0 | 0 | 0 | 1.6 | 4 | 0 | 0 | 0 | 1.3 | 0.8 |
| 87.5 | 2 | (21,933) | 9 | (12,393) | 0 | 0 | 0 | 1.9 | 2 | 0 | 0 | 0 | 1.7 | 0.5 |
| 92.5 | 0 | (24,815) | 0 | (15,782) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 97.5 | 0 | (27,696) | 0 | (19,172) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 102.5 | 0 | (30,577) | 0 | (22,562) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 107.5 | 0 | (33,458) | 0 | (25,951) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| | | | | | 1,226 | 0 | 0 | 1.9 | | 0 | 0 | 0 | 1.7 | (4.1) |
| | | | | Present Pump & Fans | 1,226 | kwh | | | Proposed Pump & Fans | 0 | kwh | | | |

**SUMMARY OF CALCULATED ENERGY USE AND COSTS**

| | Present: | Non-Condensing Boiler | | | Proposed | Ductless Heat Pump | | |
|---|---|---|---|---|---|---|---|---|
| Heating 1 | Natural Gas | 751 | therm | $ 976 | Electricity | 6,636 | kwh | $ 405 |
| Heating 2 | Electricity | 1,468 | kwh | $ 90 | ambient air | 0 | | $ 0 |
| Cooling | Electricity | 983 | kwh | $ 60 | Electricity | 842 | kwh | $ 51 |
| Loop Pump & Heat Rejection Fans | Electricity | 1,226 | kwh | $ 75 | Electricity | 0 | kWh | $ 0 |
| | Demand | 20.3 | billed kW/yr. | $ 192 | Demand | 24.4 | billed kW/y | $ 230 |
| Totals | | | | $ 1,391 | | | | $ 686 |

$ 705

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 8,907 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | -1,236 | lb $CO_2$/yr |
| Total Emissions Savings | 7,671 | lb $CO_2$/yr |
| | 58% | |

**Savings**

| | |
|---|---|
| 751 therm | $ 976 |
| -3,801 kWh | ($ 232) |
| -4.1 kW | ($ 39) |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material ($ / unit) | Labor ($ / unit) | Quantity | Total | |
|---|---|---|---|---|---|
| Ductless Heat Pump | $ 10,260 | $ 6,840 | 2 | $ 34,200 | |
| Boiler Depreciation | ($ 7,656) | ($ 5,104) | 1 | ($ 12,760) | |
| Minisplit Depreciation | ($ 2,400) | ($ 1,600) | 4 | ($ 16,000) | |
| | | | Net Implementation Cost: | $ 5,440 | |
| Implementation Costs: | 20,520 | 13,680 | $ 34,200 | = 48.5 years payback | |
| Annual Energy Savings: | | | $ 705 | | |
| Implementation Costs (incl. depreciation): | 3,264 | 2,176 | $ 5,440 | = 7.7 years payback | |
| Annual Energy Savings: | | | $ 705 | | |

# ECM-6 Calculations

## CALCULATIONS TO INSULATE ATTIC
**ECM-6 Town of Newfield**

**INPUT DATA:**

| | Roof | Walls | | |
|---|---|---|---|---|
| Surface to be insulated: | | | | |
| Area: | 7,474 | 3,346 | sq ft | |
| Present R value: | 25.2 | 5.3 | | |
| Revised R value | 50.2 | 5.3 | | |
| Present U factor:: | 0.040 | 0.188 | Btuh/sq ft-deg F | |
| Revised U factor: | 0.020 | 0.188 | Btuh/sq ft-deg F | |
| Present U x Area | 296 | 629 | 925 | UA Total present |
| Proposed U x Area | 149 | 629 | 777 | UA Total proposed |

| **CALCULATIONS:** | Occupied | Unoccupied | **Fuel Data** | Heating | Cooling |
|---|---|---|---|---|---|
| Heating Setpoint: | 61 | 61 | Type: | Natural Gas | Electricity |
| Cooling Setpoint: | 75 | 75 | Units: | therm | kwh |
| Q internal gains (Btuh): | 8,418 | 1,204 | Unit cost: | $ 1.321 | $ 0.09 |
| BLC (Btuh/degree F): | 1,203 | 1,503 | BTU/unit | 100,000 | 3,412 |
| T Balance (°F.): | 54.0 | 60.2 | Efficiency/ COP: | 91.5% | 3.22 |
| T Balance = T Setpoint - (Q internal gains / BLC) | | | EER: | | 11.0 |

| Bin Mid-Pt. | Occupied Hours | Unoccupied Hours | Change in Occupied Heat Loss | Change in Unoccupied Heat Loss | Heating Savings therm | Cooling Savings kwh |
|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 10,118 | 10,118 | 0 | 0 |
| (2.5) | 1 | 6 | 9,380 | 9,380 | 1 | 0 |
| 2.5 | 3 | 17 | 8,642 | 8,642 | 2 | 0 |
| 7.5 | 3 | 30 | 7,904 | 7,904 | 3 | 0 |
| 12.5 | 12 | 91 | 7,166 | 7,166 | 8 | 0 |
| 17.5 | 49 | 258 | 6,428 | 6,428 | 22 | 0 |
| 22.5 | 76 | 387 | 5,690 | 5,690 | 29 | 0 |
| 27.5 | 90 | 481 | 4,952 | 4,952 | 31 | 0 |
| 32.5 | 141 | 581 | 4,213 | 4,213 | 33 | 0 |
| 37.5 | 213 | 774 | 3,475 | 3,475 | 37 | 0 |
| 42.5 | 141 | 628 | 2,737 | 2,737 | 23 | 0 |
| 47.5 | 199 | 637 | 1,999 | 1,999 | 18 | 0 |
| 52.5 | 169 | 452 | 1,261 | 1,261 | 9 | 0 |
| 57.5 | 148 | 566 | 0 | 523 | 3 | 0 |
| 62.5 | 263 | 758 | 0 | 0 | 0 | 0 |
| 67.5 | 225 | 470 | 0 | 0 | 0 | 0 |
| 72.5 | 155 | 262 | 0 | 0 | 0 | 0 |
| 77.5 | 124 | 179 | (369) | (369) | 0 | 0 |
| 82.5 | 74 | 85 | (1,107) | (1,107) | 0 | 0 |
| 87.5 | 2 | 9 | (1,845) | (1,845) | 0 | 0 |
| 92.5 | 0 | 0 | (2,583) | (2,583) | 0 | 0 |
| 97.5 | 0 | 0 | (3,321) | (3,321) | 0 | 0 |
| 102.5 | 0 | 0 | (4,059) | (4,059) | 0 | 0 |
| 107.5 | 0 | 0 | (4,797) | (4,797) | 0 | 0 |
| | 8,760 hours | | | Energy Savings: | 219 | 0 |
| | | | | | $ 289 | $ 0 |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 2,593 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 2,593 | lb $CO_2$/yr |
| | 8.8% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material ($ / sq ft) | Labor | Quantity | Total |
|---|---|---|---|---|
| Roof | $ 0.82 | $ 0.89 | 7,474 | $ 12,781 |

| | | |
|---|---|---|
| Implementation Cost: | $ 12,781 | = 44.3 year payback |
| Annual Energy Savings: | $ 289 | |

# ECM-7 Calculations

## CALCULATIONS TO INSULATE WALLS

**ECM-7 Town of Newfield**

**INPUT DATA:**

| Surface to be insulated: | Roof | Walls | | |
|---|---|---|---|---|
| Area: | 7,474 | 3,346 | sq ft | |
| Present R value: | 25.2 | 5.3 | | |
| Revised R value | 25.2 | 18.3 | | |
| Present U factor:: | 0.040 | 0.188 | Btuh/sq ft-deg F | |
| Revised U factor: | 0.040 | 0.055 | Btuh/sq ft-deg F | |
| Present U x Area | 296 | 629 | 925 | UA Total present |
| Proposed U x Area | 296 | 183 | 479 | UA Total proposed |

| **CALCULATIONS:** | Occupied | Unoccupied |
|---|---|---|
| Heating Setpoint: | 61 | 61 |
| Cooling Setpoint: | 75 | 75 |
| Q internal gains (Btuh): | 8,418 | 1,204 |
| BLC (Btuh/degree F): | 1,203 | 1,503 |
| T Balance (°F.): | 54.0 | 60.2 |

T Balance = T Setpoint - (Q internal gains / BLC)

| **Fuel Data** | Heating | Cooling |
|---|---|---|
| Type: | Natural Gas | Electricity |
| Units: | therm | kwh |
| Unit cost: | $ 1.321 | $ 0.09 |
| BTU/unit | 100,000 | 3,412 |
| Efficiency/ COP: | 91.5% | 3.22 |
| EER: | | 11.0 |

| Bin Mid-Pt. | Occupied Hours | Unoccupied Hours | Change in Occupied Heat Loss | Change in Unoccupied Heat Loss | Heating Savings therm | Cooling Savings kwh |
|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 30,572 | 30,572 | 0 | 0 |
| (2.5) | 1 | 6 | 28,342 | 28,342 | 2 | 0 |
| 2.5 | 3 | 17 | 26,112 | 26,112 | 6 | 0 |
| 7.5 | 3 | 30 | 23,882 | 23,882 | 9 | 0 |
| 12.5 | 12 | 91 | 21,652 | 21,652 | 24 | 0 |
| 17.5 | 49 | 258 | 19,422 | 19,422 | 65 | 0 |
| 22.5 | 76 | 387 | 17,191 | 17,191 | 87 | 0 |
| 27.5 | 90 | 481 | 14,961 | 14,961 | 93 | 0 |
| 32.5 | 141 | 581 | 12,731 | 12,731 | 100 | 0 |
| 37.5 | 213 | 774 | 10,501 | 10,501 | 113 | 0 |
| 42.5 | 141 | 628 | 8,271 | 8,271 | 69 | 0 |
| 47.5 | 199 | 637 | 6,041 | 6,041 | 55 | 0 |
| 52.5 | 169 | 452 | 3,811 | 3,811 | 26 | 0 |
| 57.5 | 148 | 566 | 0 | 1,581 | 10 | 0 |
| 62.5 | 263 | 758 | 0 | 0 | 0 | 0 |
| 67.5 | 225 | 470 | 0 | 0 | 0 | 0 |
| 72.5 | 155 | 262 | 0 | 0 | 0 | 0 |
| 77.5 | 124 | 179 | (1,115) | (1,115) | 0 | 0 |
| 82.5 | 74 | 85 | (3,345) | (3,345) | 0 | 0 |
| 87.5 | 2 | 9 | (5,575) | (5,575) | 0 | 0 |
| 92.5 | 0 | 0 | (7,805) | (7,805) | 0 | 0 |
| 97.5 | 0 | 0 | (10,036) | (10,036) | 0 | 0 |
| 102.5 | 0 | 0 | (12,266) | (12,266) | 0 | 0 |
| 107.5 | 0 | 0 | (14,496) | (14,496) | 0 | 0 |
| | 8,760 hours | | | Energy Savings: | 660 | 0 |
| | | | | | $ 873 | $ 0 |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 7,834 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 7,834 | lb $CO_2$/yr |
| | 27% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material ($ / sq ft) | Labor ($ / sq ft) | Quantity | Total |
|---|---|---|---|---|
| Walls | $ 2.82 | $ 1.79 | 3,346 | $ 15,406 |

| | | |
|---|---|---|
| Implementation Cost: | $ 15,406 | = 17.7 year payback |
| Annual Energy Savings: | $ 873 | |

# ECM-8 Calculations

## CALCULATIONS FOR INSTALL AIR CURTAINS

**ECM-8** **Town of Newfield**

**INPUT DATA:**

| | | | Peak | Average |
|---|---|---|---|---|
| | Outside Temperature | (°F) | -3 | 36 |
| | Inside Temperature | (°F) | 61 | 61 |

| | Space | | N Garage | E Garage | S Garage | Office | Total |
|---|---|---|---|---|---|---|---|
| | Door Width | (ft) | 14 | 20 | 14 | 3 | |
| | Door Height | (ft) | 13 | 13 | 12 | 7 | |
| | Qty | (#) | 2 | 1 | 2 | 1 | |
| | Period | (min/open) | 2.0 | 2.0 | 2.0 | 0.5 | |
| | Openings/Day | (#/day) | 2 | 2 | 2 | 10 | |
| | Volume | ($ft^3$) | 33,306 | 29,890 | 19,600 | 12,480 | 95,276 |
| Peak | Infiltration | (cfm) | 33,486 | 23,919 | 29,698 | 1,418 | 88,520 |
| | Velocity | (ft/s) | 92.0 | 92.0 | 88.4 | 67.5 | |
| | Time to Empty Space | (min) | 1.0 | 1.2 | 0.7 | 8.8 | |
| | Total Infiltration | ($ft^3$/open) | 33,306 | 29,890 | 19,600 | 709 | |
| | Heat Loss | (BTU/open) | 61,043 | 54,782 | 35,923 | 1,299 | 153,046 |
| | 30 Min Heat Recovery | (BTU/hr) | 122,085 | 109,564 | 71,845 | 2,598 | 306,092 |
| | Heat Pump Surplus Capacity | (BTU/hr) | 13,984 | 12,549 | 8,229 | 5,240 | 40,002 |
| | Heat Pump Recovery Rate | (hr) | 4.4 | 4.4 | 4.4 | 0.2 | |
| Average | Infiltration | (cfm) | 21,457 | 15,327 | 19,030 | 908 | 56,722 |
| | Velocity | (ft/s) | 58.9 | 58.9 | 56.6 | 43.3 | |
| | Time to Empty Space | (min) | 1.6 | 2.0 | 1.0 | 13.7 | |
| | Total Infiltration | ($ft^3$/open) | 33,306 | 29,890 | 19,600 | 454 | |
| | Average Infiltration Rate | (cfh) | 7,837 | 7,033 | 4,612 | 534 | 20,016 |

**CALCULATIONS:**

Infiltration = 13.26 x Door Area x ( 1 - Outdoor Temp (absolute) / Indoor Temp (absolute) ) ^ 1/2 x ( Std Gravity x Door Height ) ^ 1/2 x ( 2 / ( 1 + ( Indoor Temp (absolute) / Outdoor Temp (absolute) ) ^ 1/3 ) ) ^ 3/2
Heat Loss = 13.1 x Infiltration Volume / Outdoor Temp (absolute) * ( Indoor Temp - Outdoor Temp )
Energy Savings = (Present Leakage - New Leakage) x Accum Hours x Temp Difference x CF2
Energy Cost Savings = (Energy Savings / CF1) x (Unit cost / Efficiency)

| | Occupied | Unoccupied | |
|---|---|---|---|
| T Setpoint: | 60 | 60 | °F |
| Q internal gains: | 12,268 | 1,754 | Btuh |
| BLC: | 1,203 | 1,503 | Btuh/°F |
| T Balance: | 49.8 | 58.8 | °F. T Balance = T Setpoint - (Q internal gains / BLC) |
| Bin Data for Elmira, 43 hrs./week | | | |
| Accumulated Hours | 928 | 4,909 | below balance temp. |
| Avg. OAT | 35.8 | 38.5 | °F below balance temp. |
| (T Set- Avg OAT) | 24.2 | 21.5 | °F difference |

| | | |
|---|---|---|
| Type: | Natural Gas | |
| Units: | therm | |
| Unit cost: | $ 1.321 | /therm |
| CF1 | 100,000 | Btu/therm |
| Efficiency: | 92% | |
| CF2 | 0.018 | Btu/hr-°F-cfh |
| % Savings | 60% | |

| Energy Savings - Btu/year | | | Total Savings | |
|---|---|---|---|---|
| Occupied | Unoccupied | Total | therm / yr | $ |
| 4,851,939 | 0 | 4,851,939 | 53 | $ 70 |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 629 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 629 | lb $CO_2$/yr |
| | 2.1% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Materials ($) | Labor ($) | Total ($) | Savings ($) | |
|---|---|---|---|---|---|
| N Garage Door Air Curtains | $ 10,600.00 | $ 3,000.00 | $ 13,600 | $ 27 | = 496 year payback |
| E Garage Door Air Curtains | $ 8,000.00 | $ 1,500.00 | $ 9,500 | $ 25 | = 386 year payback |
| S Garage Door Air Curtains | $ 10,600.00 | $ 3,000.00 | $ 13,600 | $ 16 | = 843 year payback |
| Office Door Air Curtain | $ 900.00 | $ 1,000.00 | $ 1,900 | $ 2 | = 1016 year payback |
| | | **Totals:** | $ 38,600 | $ 70 | = 551 year payback |
| | 30,100 | 8,500 | | | |

## ECM-9 Calculations

### CALCULATIONS TO IMPLEMENT DEEPER SETBACK

**EEM-9 Town of Newfield**

**INPUT DATA:** 100% of Building to be Setback

| | | Current | Proposed | |
|---|---|---|---|---|
| Heating T Setpoint: | Occupied | 60 | 60 | deg. F. |
| | Unoccupied | 60 | 50 | deg. F. |
| Cooling T Setpoint: | Occupied | 95 | 95 | deg. F. |
| | Unoccupied | 95 | 95 | deg. F. |
| HVAC Schedule | Occupied | 42.5 | 42.5 | Hours per week |
| | Unoccupied | 125.5 | 125.5 | Hours per week |
| Q internal gains: | Occupied | 8,418 | 8,418 | Btuh |
| | Unoccupied | 1,204 | 1,204 | Btuh |
| Q internal gains: | Schedule | 43 | 43 | Hours per week |
| BLC: | Occupied | 1,203 | 1,203 | Btuh/deg. F. |
| (excludes DOAS) | Unoccupied | 1,503 | 1,503 | Btuh/deg. F. |
| Heating T Actual | Occupied | 60 | 60 | |
| (w/ thermal mass effects): | Unoccupied | 61 | 58 | |

| Fuel Data | Heating | Cooling | | |
|---|---|---|---|---|
| Type: | Natural Gas | Electricity | Economizer? | |
| Units: | therm | kwh | 0.0 | |
| Unit cost: | $ 1.299 | $ 0.06 | | |
| BTU/unit | 100,000 | 3,412 | | |
| Efficiency/ COP: | 91.5% | 4.17 | Avg. COP. EER: | 14.2 |
| | | 100.0% | of bldg. is cooled | |

**CALCULATIONS:**

Current Elmira, 43 hrs./week

| Bin Mid Pt. | Occupied Hours | Unoccupied Hours | Occ Net Heat Loss BTUH | Unocc Net Heat Loss BTUH | Heating Fuel Use therm | Cooling Energy kwh |
|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 0 | 98,912 | 1 | 0 |
| (2.5) | 1 | 6 | 72,636 | 91,246 | 7 | 0 |
| 2.5 | 3 | 17 | 46,259 | 40,817 | 9 | 0 |
| 7.5 | 3 | 30 | 62,534 | 78,501 | 28 | 0 |
| 12.5 | 12 | 91 | 57,122 | 71,518 | 79 | 0 |
| 17.5 | 49 | 258 | 49,920 | 63,320 | 205 | 0 |
| 22.5 | 76 | 387 | 44,017 | 55,487 | 271 | 0 |
| 27.5 | 90 | 481 | 39,016 | 48,780 | 295 | 0 |
| 32.5 | 141 | 581 | 33,523 | 42,142 | 319 | 0 |
| 37.5 | 213 | 774 | 27,524 | 34,478 | 356 | 0 |
| 42.5 | 141 | 628 | 19,996 | 26,125 | 210 | 0 |
| 47.5 | 199 | 637 | 11,244 | 17,529 | 146 | 0 |
| 52.5 | 169 | 452 | 9,808 | 13,414 | 84 | 0 |
| 57.5 | 148 | 566 | 4,261 | 7,370 | 52 | 0 |
| 62.5 | 263 | 758 | (570) | 1,251 | 10 | 0 |
| 67.5 | 225 | 470 | (1,978) | 842 | 4 | 0 |
| 72.5 | 155 | 262 | (2,170) | 417 | 1 | 0 |
| 77.5 | 124 | 179 | (1,805) | (68) | 0 | 0 |
| 82.5 | 74 | 85 | (1,313) | (754) | 0 | 0 |
| 87.5 | 2 | 9 | (3,247) | (842) | 0 | 0 |
| 92.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 2,078 | 0 |

## CALCULATIONS TO IMPLEMENT DEEPER SETBACKCONTINUED

**EEM-9 Town of Newfield**

| Proposed | | Elmira, 43 hrs./week | | | | |
|---|---|---|---|---|---|---|
| Bin Mid Pt. | Occupied | Unoccupied | Occ Net Heat | Unocc Net Heat | Heating Fuel | Cooling Energy kwh |
| (7.5) | 0 | 1 | 0 | 90,755 | 1 | 0 |
| (2.5) | 1 | 6 | 64,966 | 83,945 | 6 | 0 |
| 2.5 | 3 | 17 | 40,379 | 35,400 | 8 | 0 |
| 7.5 | 3 | 30 | 55,620 | 70,529 | 25 | 0 |
| 12.5 | 12 | 91 | 50,042 | 62,683 | 69 | 0 |
| 17.5 | 49 | 258 | 46,188 | 55,344 | 181 | 0 |
| 22.5 | 76 | 387 | 41,527 | 48,034 | 238 | 0 |
| 27.5 | 90 | 481 | 36,973 | 42,296 | 259 | 0 |
| 32.5 | 141 | 581 | 31,661 | 37,324 | 286 | 0 |
| 37.5 | 213 | 774 | 26,402 | 31,280 | 326 | 0 |
| 42.5 | 141 | 628 | 19,159 | 23,841 | 193 | 0 |
| 47.5 | 199 | 637 | 10,924 | 16,452 | 138 | 0 |
| 52.5 | 169 | 452 | 9,692 | 12,841 | 81 | 0 |
| 57.5 | 148 | 566 | 4,088 | 7,108 | 51 | 0 |
| 62.5 | 263 | 758 | (591) | 1,216 | 10 | 0 |
| 67.5 | 225 | 470 | (1,978) | 842 | 4 | 0 |
| 72.5 | 155 | 262 | (2,170) | 417 | 1 | 0 |
| 77.5 | 124 | 179 | (1,805) | (68) | 0 | 0 |
| 82.5 | 74 | 85 | (1,313) | (754) | 0 | 0 |
| 87.5 | 2 | 9 | (3,247) | (842) | 0 | 0 |
| 92.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 1,876 | 0 |

| | Present | Proposed | Savings | |
|---|---|---|---|---|
| Heating | 2,078 | 1,876 | 202 | therm |
| Cooling | 0 | 0 | 0 | kwh |
| Annual Energy $ | | | $ 262 | |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 2,396 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | 0 | lb $CO_2$/yr |
| Total Emissions Savings | 2,396 | lb $CO_2$/yr |
| | 8.1% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material $/unit | Labor $/unit | Quantity | Total |
|---|---|---|---|---|
| 7-day thermostat | $ 150 | $ 50 | 4 | $ 800 |
| | | | | $ 0 |
| | | | | $ 800 |

| | | |
|---|---|---|
| Implementation Cost: | $ 800 | = 3 year payback |
| Annual Energy Savings: | $262 | |

# ECM-10 Calculations

## CALCULATIONS TO INSTALL A TANKLESS WATER HEATER

**ECM-10 Town of Newfield**

**INPUT DATA:**

| | Present Fuel | | Proposed Fuel | |
|---|---|---|---|---|
| Fuel: | **Natural Gas** | | Electricity | |
| Units: | therm | | kwh | |
| Fuel Cost: | $ 1.32 | per therm | $ 0.09 | per kwh |
| BTU / unit: | 100,000 | Btu per therm | 3,412 | Btu per kwh |
| kW Demand cost: | $ 0.00 | per kW | $ 9.43 | per kW |
| Average kW demand: | **0.0** | kW | **0.1** | kW |
| Demand Diversity: | **33%** | | **33%** | |
| Net kW Demand Savings: | - | kW per month | 0.0 | kW per month |
| Months of demand: | **12** | per year | **0** | per year |

| Annual DHW Consumption: | Present | | Proposed | |
|---|---|---|---|---|
| Hot Water Usage: | **0.5** | Gallons/person/day | 0.5 | Gallons/person/day |
| Number of persons: | **10** | ( estimate) | 10 | ( estimate) |
| Days of Usage: | **250** | per year | 250 | per year |
| Hours of Usage per Day: | 8 | hours | 8 | hours |
| Average inlet water Temp: | 54 | degrees F | 54 | degrees F |
| Average hot water temp: | 125 | degrees F | 125 | degrees F |

| Storage Tank Losses: | Present Tank | | Proposed Tank | |
|---|---|---|---|---|
| Tank U factor: | 0.15 | Btu/SF/Hour | 0.15 | Btu/SF/Hour |
| Height of Tank: | 45.0 | inches | 46.7 | inches |
| Diameter of Tank: | 18.0 | inches | 20.0 | inches |
| | 38 | gallons/tank | 50 | gallons/tank |
| # of Tanks | 1 | Qty. | 0 | Qty. |
| Hours Tank is Hot: | 8,760 | Hours | 8,760 | |
| Water Temperature: | 125 | Deg. F. | 125 | |
| Ambient Temperature: | 65 | Deg. F. | 65 | |

| | | | | | |
|---|---|---|---|---|---|
| Recirculation Losses: | 0.0% | of boiler capacity = | 0 | BTUh | |
| | 8,760 | hours/year | 8,760 | hours/year = | 100% |

| Boiler Jacket & Flue Losses: | | | | | |
|---|---|---|---|---|---|
| Burner Input | 40,000 | BTUH | 44,360 | BTUH | |
| Efficiency: | **95.0%** | | 100.0% | | |
| Boiler Output Capacity | 38,000 | BTU output | 44,360 | BTU output | |
| Jacket & Flue Losses: | 5.0% | of boiler capacity | 0.0% | of boiler capacity | |
| Boiler is Hot: | 8,760 | hours/year | 8,760 | hours/year = | 100% |

**CALCULATIONS:**

| | Present | | Proposed | |
|---|---|---|---|---|
| Consumption Energy: | 741,129 | BTU output rqd/yr | 741,129 | BTU output rqd/yr |
| Tank Energy Losses: | 1,668,210 | BTU/year | 0 | BTU/year |
| Recirculation Losses: | 0 | BTU/year | 0 | BTU/year |
| Boiler Jacket Losses: | 16,777,152 | BTU/year | 0 | BTU/year |
| Output BTU/Year | 19,186,490 | | 741,129 | |
| | | | | |
| Annual Fuel Consumption | 202 | therm | 217 | kwh |
| Demand | 0 | billed kW /yr. | 0 | kW |
| Annual Fuel Cost | $ 266.8 | | $ 18.5 | |
| **Annual Savings:** | **202** | **therm** | **$ 248** | **per year** |
| | **(217)** | **kwh** | | |
| | **0** | billed kW /yr. | | |

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 2,395 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | -51 | lb $CO_2$/yr |
| Total Emissions Savings | 2,344 | lb $CO_2$/yr |
| | 8.0% | |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Quantity | Material Costs | Labor Costs | Total |
|---|---|---|---|---|
| Tankless Electric Water Heater | 1 | $ 600 | $ 1,200 | $ 1,800 |
| | **Implementation Cost:** | | | **$ 1,800** = **7.2 year payback** |
| | **Annual Energy Savings:** | | | **$ 248** |

# ECM-11 Calculations

**CALCULATIONS TO REPLACE HVAC SYSTEM with DUCTLESS HEAT PUMP**
**EEM-11 Town of Newfield**

**INPUT DATA**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Present HVAC system: | Present Fuels | Type: | Units: | Unit cost: | BTU/unit | COP | Rated at | EER |
| Forced Air | Heating 1 | Natural Gas | therm | $ 1.321 | 100,000 | 0.915 | Et | |
| non-heat pump | Heating 2 | | | $ 0.000 | 0 | | | |
| 100% of the building | Cooling | Electricity | kwh | $ 0.085 | 3,412 | 3.224 | 95° OAT | 11.0 |
| Proposed HVAC system: | Proposed Fuel | Type: | Units: | Unit cost: | BTU/unit | COP | Rated at | EER |
| Ductless Heat Pump | Heating 1 | Electricity | kwh | $ 0.085 | 3,412 | 4.000 | 47° OAT | |
| heat pump | Heating 2 | ambient air | | $ 0.000 | 0 | | | |
| Below (8) °F. OA Temp | Cooling | Electricity | kwh | $ 0.085 | 3,412 | 3.810 | 95° OAT | 13.0 |
| All heat is provided by | Heating 2 Low | | | $ 0.000 | 0 | | | |

| HVAC Loads (excluding any DOAS system) | | | Present HVAC system: Forced Air | | | | | | Proposed HVAC system: Ductless Heat Pump | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bin Mid Pt. | Occupied Hours | Occ Net Heat Loss BTUH | Heating 1 Et or COP Natural Gas | Heating 2 Et or COP | Cooling COP Electricity | Heating 1 Natural Gas therm | Heating 2 | Cooling Electricity kwh | Heating 1 Et or COP Electricity | Heating 2 Et or COP ambient air | Cooling Et or COP Electricity | Heating 1 Electricity kwh | Heating 2 ambient air | Cooling Electricity kwh |
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during occupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Present heating system efficiency) | (NA) | (Present cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in therms) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) | (Proposed heating system efficiency) | (NA) | (Proposed cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in kWh) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) |
| (7.5) | 0 | 74,011 | 0.92 | | | 0 | 0 | 0 | 2.10 | 0.00 | | 0 | 0 | 0 |
| (2.5) | 1 | 67,998 | 0.92 | | | 1 | 0 | 0 | 2.21 | 0.00 | | 9 | 0 | 0 |
| 2.5 | 3 | 61,985 | 0.92 | | | 2 | 0 | 0 | 2.34 | 0.00 | | 23 | 0 | 0 |
| 7.5 | 3 | 55,972 | 0.92 | | | 2 | 0 | 0 | 2.48 | 0.00 | | 20 | 0 | 0 |
| 12.5 | 12 | 49,959 | 0.92 | | | 7 | 0 | 0 | 2.64 | 0.00 | | 67 | 0 | 0 |
| 17.5 | 49 | 43,947 | 0.92 | | | 24 | 0 | 0 | 2.81 | 0.00 | | 225 | 0 | 0 |
| 22.5 | 76 | 37,934 | 0.92 | | | 31 | 0 | 0 | 3.00 | 0.00 | | 282 | 0 | 0 |
| 27.5 | 90 | 31,921 | 0.92 | | | 31 | 0 | 0 | 3.20 | 0.00 | | 263 | 0 | 0 |
| 32.5 | 141 | 25,908 | 0.92 | | | 40 | 0 | 0 | 3.42 | 0.00 | | 313 | 0 | 0 |
| 37.5 | 213 | 19,895 | 0.92 | | | 46 | 0 | 0 | 3.65 | 0.00 | | 340 | 0 | 0 |
| 42.5 | 141 | 13,882 | 0.92 | | | 21 | 0 | 0 | 3.90 | 0.00 | | 147 | 0 | 0 |
| 47.5 | 199 | 7,869 | 0.92 | | | 17 | 0 | 0 | 4.16 | 0.00 | | 110 | 0 | 0 |
| 52.5 | 169 | 1,856 | 0.92 | | | 3 | 0 | 0 | 4.44 | 0.00 | | 21 | 0 | 0 |
| 57.5 | 148 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 62.5 | 263 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 67.5 | 225 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 72.5 | 155 | (5,412) | | | 4.6 | 0 | 0 | 0 | | 0.00 | 4.9 | 0 | 0 | 0 |
| 77.5 | 124 | (11,424) | | | 4.3 | 0 | 0 | 0 | | 0.00 | 4.5 | 0 | 0 | 0 |
| 82.5 | 74 | (17,437) | | | 3.9 | 0 | 0 | 0 | | 0.00 | 4.2 | 0 | 0 | 0 |
| 87.5 | 2 | (23,450) | | | 3.6 | 0 | 0 | 0 | | 0.00 | 3.8 | 0 | 0 | 0 |
| 92.5 | 0 | (29,463) | | | 3.3 | 0 | 0 | 0 | | 0.00 | 3.6 | 0 | 0 | 0 |
| 97.5 | 0 | (35,476) | | | 3.0 | 0 | 0 | 0 | | 0.00 | 3.3 | 0 | 0 | 0 |
| 102.5 | 0 | (41,489) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |
| 107.5 | 0 | (47,502) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |

| Bin Mid Pt. | Unoccupied Hours | Unocc Net Heat Loss BTUH | Heating Eff./COP Electricity | Heating Eff./COP | Cooling Eff. EER | Heating 1 Natural Gas therm | Heating 2 | Cooling Electricity kwh | Heating 1 Et or COP Electricity | Heating 2 Et or COP ambient air | Cooling Et or COP Electricity | Heating 1 Electricity kwh | Heating 2 ambient air | Cooling Electricity kwh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during unoccupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Present heating system efficiency) | (NA) | (Present cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in therms) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) | (Proposed heating system efficiency) | (NA) | (Proposed cooling system efficiency) | Heat Loss / Efficiency x Hrs/yr (in kWh) | (NA) | Heat Gain / Efficiency x Hrs/yr (in kWh) |
| (7.5) | 1 | 101,833 | 0.92 | | | 1 | 0 | 0 | 2.10 | 0.00 | | 14 | 0 | 0 |
| (2.5) | 6 | 94,317 | 0.92 | | | 6 | 0 | 0 | 2.21 | 0.00 | | 75 | 0 | 0 |
| 2.5 | 17 | 86,800 | 0.92 | | | 16 | 0 | 0 | 2.34 | 0.00 | | 185 | 0 | 0 |
| 7.5 | 30 | 79,284 | 0.92 | | | 26 | 0 | 0 | 2.48 | 0.00 | | 281 | 0 | 0 |
| 12.5 | 91 | 71,768 | 0.92 | | | 71 | 0 | 0 | 2.64 | 0.00 | | 726 | 0 | 0 |
| 17.5 | 258 | 64,252 | 0.92 | | | 181 | 0 | 0 | 2.81 | 0.00 | | 1,729 | 0 | 0 |
| 22.5 | 387 | 56,736 | 0.92 | | | 240 | 0 | 0 | 3.00 | 0.00 | | 2,147 | 0 | 0 |
| 27.5 | 481 | 49,220 | 0.92 | | | 259 | 0 | 0 | 3.20 | 0.00 | | 2,168 | 0 | 0 |
| 32.5 | 581 | 41,704 | 0.92 | | | 265 | 0 | 0 | 3.42 | 0.00 | | 2,078 | 0 | 0 |
| 37.5 | 774 | 34,188 | 0.92 | | | 289 | 0 | 0 | 3.65 | 0.00 | | 2,125 | 0 | 0 |
| 42.5 | 628 | 26,672 | 0.92 | | | 183 | 0 | 0 | 3.90 | 0.00 | | 1,260 | 0 | 0 |
| 47.5 | 637 | 19,155 | 0.92 | | | 133 | 0 | 0 | 4.16 | 0.00 | | 860 | 0 | 0 |
| 52.5 | 452 | 11,639 | 0.92 | | | 57 | 0 | 0 | 4.44 | 0.00 | | 347 | 0 | 0 |
| 57.5 | 566 | 4,123 | 0.92 | | | 25 | 0 | 0 | 4.73 | 0.00 | | 145 | 0 | 0 |
| 62.5 | 758 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 67.5 | 470 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 72.5 | 262 | 0 | | | | 0 | 0 | 0 | | 0.00 | | 0 | 0 | 0 |
| 77.5 | 179 | (4,962) | | | 4.3 | 0 | 0 | 0 | | 0.00 | 4.5 | 0 | 0 | 0 |
| 82.5 | 85 | (12,478) | | | 3.9 | 0 | 0 | 0 | | 0.00 | 4.2 | 0 | 0 | 0 |
| 87.5 | 9 | (19,994) | | | 3.6 | 0 | 0 | 0 | | 0.00 | 3.8 | 0 | 0 | 0 |
| 92.5 | 0 | (27,510) | | | 3.3 | 0 | 0 | 0 | | 0.00 | 3.6 | 0 | 0 | 0 |
| 97.5 | 0 | (35,026) | | | 3.0 | 0 | 0 | 0 | | 0.00 | 3.3 | 0 | 0 | 0 |
| 102.5 | 0 | (42,542) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |
| 107.5 | 0 | (50,058) | | | 2.8 | 0 | 0 | 0 | | 0.00 | 3.1 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Present Energy units: | 1,979 | 0 | 0 | | | | Proposed Energy units: | 15,959 | 0 | 0 |
| | | | | Energy types | Natural Gas | 0 | Electricity | | | | Energy types | Electricity | ambient air | Electricity |
| | | | | Units | therm | | kwh | | | | Units | kwh | | kwh |
| | | | | BTU/unit | 100,000 | 0 | 3,412 | | | | BTU/unit | 3,412 | 0 | 3,412 |
| | | | | mmBtu | 198 | 0 | 0 | | | | mmBtu | 54 | 0 | 0 |
| | | | | mmBtu | | 198 | mmBtu | | | | mmBtu | | 54 | mmBtu |
| | | | | Unit Cost | $ 1.321 | $ 0.000 | $ 0.085 | | | | Unit Cost | $ 0.085 | $ 0.000 | $ 0.085 |
| | | | | Annual Cost | $ 2,614 | $ 0 | $ 0 | | | | Annual Cost | $ 1,357 | $ 0 | $ 0 |
| | | | | Pumps & Fans: | | $ 60 | | | | | Pumps & Fans: | | $ 0 | |
| | | | | Total Annual Costs | Present | | $ 2,674 | ann. Cost | | | Total Annual Costs | Proposed | | $ 1,357 ann. Cost |

**HVAC system replacement - continued**

**Calculation of Loop Pumps & Heat Rejection Fan Loads**

| Present: | Forced Air | | | | Proposed: | Ductless Heat Pump | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Loop 1 | Loop 2 | Heat Rejection | | | Loop 1 | Loop 2 | Heat Rejection | |
| Type | none | none | Fan | | Type | none | none | Fan | |
| Assumed Delta T deg. | 20 | 0 | 0 | GPM/HP min. | Assumed Delta T deg. | 0 | 0 | 0 | GPM/HP min. |
| Estimated GPM | 2 | 0 | 0 | | Estimated GPM | 0 | 0 | 0 | |
| Estimated Pump BHP | 0.05 | 0.00 | 0.00 | Fan BHP | Estimated Pump BHP | 0.00 | 0.00 | 0.00 | Fan BHP |
| Estimated Motor Eff. | 45% | | | | Estimated Motor Eff. | | | | |
| Estimated kW | 0.08 | 0.00 | 0.00 | | Estimated kW | 0.00 | 0.00 | 0.00 | |

| | | | | | Present Pump & Fan Loads | | | | # months | Proposed Pump & Fan Loads | | | | Billed kW/yr. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bin Mid | Occupied | Occ Net Heat | Unoccupied | Unocc Net | Loop 1 kWh | Loop 2 kWh | Heat | Present kW | Bin is peak | Loop 1 kWh | Loop 2 | Heat Rejection | Proposed kW | savings |
| (Outdoor temp +/- 2.5 °F) | (Hrs/yr at this outdoor temp during occupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | (Hrs/yr at this outdoor temp during unoccupied times) | BLC x (Indoor - Outdoor temp) - Internal Gains | "Estimated kW" x Occ + Unocc Hours | (NA) | (NA) | (Loop kWh + Heat kWh + Cool kWh) / Bin Hours | (# Months the high temp falls within this bin) | "Estimated kW" x Occ + Unocc Hours | (NA) | (NA) | (Loop kWh + Heat kWh + Cool kWh) / Bin Hours | Present kW - Proposed kW |
| (7.5) | 0 | 74,011 | 1 | 101,833 | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| (2.5) | 1 | 67,998 | 6 | 94,317 | 1 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 9.0 | (8.9) |
| 2.5 | 3 | 61,985 | 17 | 86,800 | 2 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 7.8 | 0.0 |
| 7.5 | 3 | 55,972 | 30 | 79,284 | 3 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 6.6 | (6.5) |
| 12.5 | 12 | 49,959 | 91 | 71,768 | 8 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 5.6 | (5.5) |
| 17.5 | 49 | 43,947 | 258 | 64,252 | 25 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 4.6 | (9.0) |
| 22.5 | 76 | 37,934 | 387 | 56,736 | 37 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 3.7 | 0.0 |
| 27.5 | 90 | 31,921 | 481 | 49,220 | 46 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 2.9 | 0.0 |
| 32.5 | 141 | 25,908 | 581 | 41,704 | 58 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 2.2 | (6.4) |
| 37.5 | 213 | 19,895 | 774 | 34,188 | 79 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 1.6 | 0.0 |
| 42.5 | 141 | 13,882 | 628 | 26,672 | 62 | 0 | 0 | 0.1 | 1 | 0 | 0 | 0 | 1.0 | (1.0) |
| 47.5 | 199 | 7,869 | 637 | 19,155 | 67 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0.6 | (1.4) |
| 52.5 | 169 | 1,856 | 452 | 11,639 | 50 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0.1 | 0.0 |
| 57.5 | 148 | 0 | 566 | 4,123 | 57 | 0 | 0 | 0.1 | 1 | 0 | 0 | 0 | 0.0 | 0.2 |
| 62.5 | 263 | 0 | 758 | 0 | 82 | 0 | 0 | 0.1 | 1 | 0 | 0 | 0 | 0.0 | 0.1 |
| 67.5 | 225 | 0 | 470 | 0 | 56 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 72.5 | 155 | (5,412) | 262 | 0 | 34 | 0 | 0 | 0.1 | 2 | 0 | 0 | 0 | 0.0 | 0.2 |
| 77.5 | 124 | (11,424) | 179 | (4,962) | 24 | 0 | 0 | 0.1 | 1 | 0 | 0 | 0 | 0.0 | 0.1 |
| 82.5 | 74 | (17,437) | 85 | (12,478) | 13 | 0 | 0 | 0.1 | 4 | 0 | 0 | 0 | 0.0 | 0.3 |
| 87.5 | 2 | (23,450) | 9 | (19,994) | 1 | 0 | 0 | 0.1 | 2 | 0 | 0 | 0 | 0.0 | 0.2 |
| 92.5 | 0 | (29,463) | 0 | (27,510) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 97.5 | 0 | (35,476) | 0 | (35,026) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 102.5 | 0 | (41,489) | 0 | (42,542) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| 107.5 | 0 | (47,502) | 0 | (50,058) | 0 | 0 | 0 | 0.0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 |
| | | | | | 704 | 0 | 0 | 0.1 | | 0 | 0 | 0 | 0.0 | (37.8) |
| | | | | | Present Pump & Fans | | 704 | kwh | | Proposed Pump & Fans | | 0 | kwh | |

**SUMMARY OF CALCULATED ENERGY USE AND COSTS**

| | Present: | Forced Air | | | Proposed | Ductless Heat Pump | | |
|---|---|---|---|---|---|---|---|---|
| Heating 1 | Natural Gas | 1,979 | therm | $ 2,614 | Electricity | 15,959 | kwh | $ 1,357 |
| Heating 2 | 0 | 0 | | $ 0 | ambient air | 0 | | $ 0 |
| Cooling | Electricity | 0 | kwh | $ 0 | Electricity | 0 | kwh | $ 0 |
| Loop Pump & Heat Rejection Fans | Electricity | 704 | kwh | $ 60 | Electricity | 0 | kWh | $ 0 |
| | Demand | 1.9 | billed kW/yr. | $ 18 | Demand | 39.7 | billed kW/yr. | $ 375 |
| Totals | | | | $ 2,692 | | | | $ 1,731 |

$ 961

| | NY Upstate | |
|---|---|---|
| Natural Gas Emissions Rates | 11.86 | lb $CO_2$/therm |
| Natural Gas Emissions Savings | 23,471 | lb $CO_2$/yr |
| Electricity Emissions Rates | 235 | lb $CO_2$/MWh |
| Electricity Emissions Savings | -3,577 | lb $CO_2$/yr |
| Total Emissions Savings | 19,893 | lb $CO_2$/yr |
| | 67% | |

**Savings**

| | | |
|---|---|---|
| 1,979 | therm | $ 2,614 |
| -15,255 | kWh | ($ 1,297) |
| -37.8 | kW | ($ 356) |

**IMPLEMENTATION COST & PAYBACK PERIOD:**

| Item | Material ($ / unit) | Labor ($ / unit) | Quantity | Total | |
|---|---|---|---|---|---|
| Ductless Heat Pump | $ 15,120 | $ 10,080 | 2 | $ 50,400 | |
| Boiler Depreciation | ($ 3,864) | ($ 2,576) | 1 | ($ 6,440) | |
| Unit Heater Depreciation | ($ 3,036) | ($ 2,024) | 2 | ($ 10,120) | |
| | | | Net Implementation Cost: | $ 33,840 | |
| Implementation Costs: | 30,240 | 20,160 | $ 50,400 | = 52.4 years payback | |
| Annual Energy Savings: | | | $ 961 | | |
| Implementation Costs (incl. depreciation): | 20,304 | 13,536 | $ 33,840 | = 35.2 years payback | |
| Annual Energy Savings: | | | $ 961 | | |

# Town Hall Utility Analysis Calculations

## Analysis of Energy Usage

Town of Newfield
166 Main St
Newfield, NY 14867

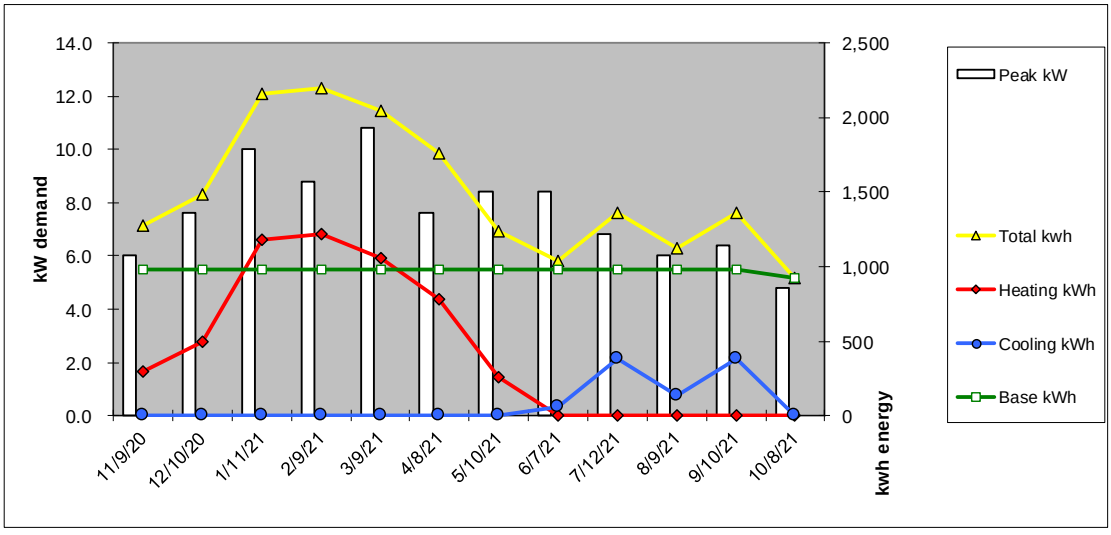
**Fuel Data**

| Total Energy Use and Cost | | | | | | *Describe the Energy Used for Heating* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy Type | Energy Type Data | | | **Total Annual** | | % used for Heating: | Default Eff. | Total units | Units by by DOAS | Units by non-HP | mmBtu to Space |
| | Units | btu/unit | $/unit | Cost | Use | | | | | | |
| Natural Gas | therm | 100,000 | $ 1.30 | $ 1,271 | 751 | 100% | 80.0% | 751 | 0 | 751 | 60 |
| Oil - No. 2 | gal. | 138,000 | $ 0.00 | $ 0 | 0 | 100% | 83.0% | 0 | 0 | 0 | 0 |
| LPG | gal. | 92,000 | $ 0.00 | $ 0 | 0 | 100% | 92.0% | 0 | 0 | 0 | 0 |
| Electricity | kwh | **3,412** | $ 0.06 | $ 2,210 | 17,960 | 30% | 100.0% | 5,300 | 0 | 5,300 | 18 |
| Multiple | mmBtu | 1,000,000 | $ 13.94 | | | | 83.9% | 93 | | | 78 |
| Water | kGal. | 0 | $ 0.98 | $ 6,040 | 5,045 | | | | | | |

| | | |
|---|---|---|
| | 52% | based on equipment defined on the Equipment tab |
| For ground or air source HP systems | 30% | of annual electricity use used by the HPs in heating mode. |

**Extraction of Electric Heating/Cooling**

| | | | | Estimate Electric Heating? | | Yes | Estimate Electric Cooling? | | Yes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | First month of heating fall | | 10 | First month of cooling | | 5 |
| Metered Electricity Use & Demand | | | | Last month of heating spring | | 4 | Last month of cooling | | 9 |
| Month Ending | Days | Energy kWh | Demand kW | Month | Enter "X" for base months | Heating kwh | Enter "X" for base months | Cooling kwh | Base kwh |
| 11/9/20 | 30 | 1,280 | 6.0 | **10** | | 300 | | 0 | 980 |
| 12/10/20 | 31 | 1,480 | 7.6 | **11** | | 500 | | 0 | 980 |
| 1/11/21 | 32 | 2,160 | 10.0 | **12** | | 1,180 | | 0 | 980 |
| 2/9/21 | 29 | 2,200 | 8.8 | **1** | | 1,220 | | 0 | 980 |
| 3/9/21 | 28 | 2,040 | 10.8 | **2** | | 1,060 | | 0 | 980 |
| 4/8/21 | 30 | 1,760 | 7.6 | **3** | | 780 | | 0 | 980 |
| 5/10/21 | 32 | 1,240 | 8.4 | **4** | | 260 | | 0 | 980 |
| 6/7/21 | 28 | 1,040 | 8.4 | **5** | X | 0 | X | 60 | 980 |
| 7/12/21 | 35 | 1,360 | 6.8 | **6** | | 0 | | 380 | 980 |
| 8/9/21 | 28 | 1,120 | 6.0 | **7** | | 0 | | 140 | 980 |
| 9/10/21 | 32 | 1,360 | 6.4 | **8** | | 0 | | 380 | 980 |
| 10/8/21 | 28 | 920 | 4.8 | **9** | X | 0 | X | 0 | 920 |
| | 363 | 17,960 | | Annual Heating kwh: | | 5,300 | Annual AC: | 960 | kwh / year |
| | | | | Non-heat Base | 980 | kwh/month | Base Usage: | 980 | kwh / month |



# Town Barn Utility Analysis Calculations

## Analysis of Energy Usage

Town of Newfield
166 Main St
Newfield, NY 14867

**Fuel Data**

| Total Energy Use and Cost | | | | | | *Describe the Energy Used for Heating* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy Type | Energy Type Data | | | **Total Annual** | | % used for Heating: | Default Eff. | Total units | Units by by DOAS | Units by non-HP | mmBtu to Space |
| | Units | btu/unit | $/unit | Cost | Use | | | | | | |
| Natural Gas | therm | 100,000 | $ 1.32 | $ 3,177 | 2,181 | 91% | 91.5% | 1,979 | 0 | 1,979 | 181 |
| Oil - No. 2 | gal. | 138,000 | $ 0.00 | $ 0 | 0 | 100% | 83.0% | 0 | 0 | 0 | 0 |
| LPG | gal. | 92,000 | $ 0.00 | $ 0 | 0 | 100% | 92.0% | 0 | 0 | 0 | 0 |
| Electricity | kwh | **3,412** | $ 0.09 | $ 2,005 | 15,420 | 0% | 100.0% | 0 | 0 | 0 | 0 |
| Multiple | mmBtu | 1,000,000 | $ 13.21 | | | | 91.5% | 198 | | | 181 |
| Water | kGal. | 0 | $ 0.98 | $ 6,040 | 5,045 | | | | | | |

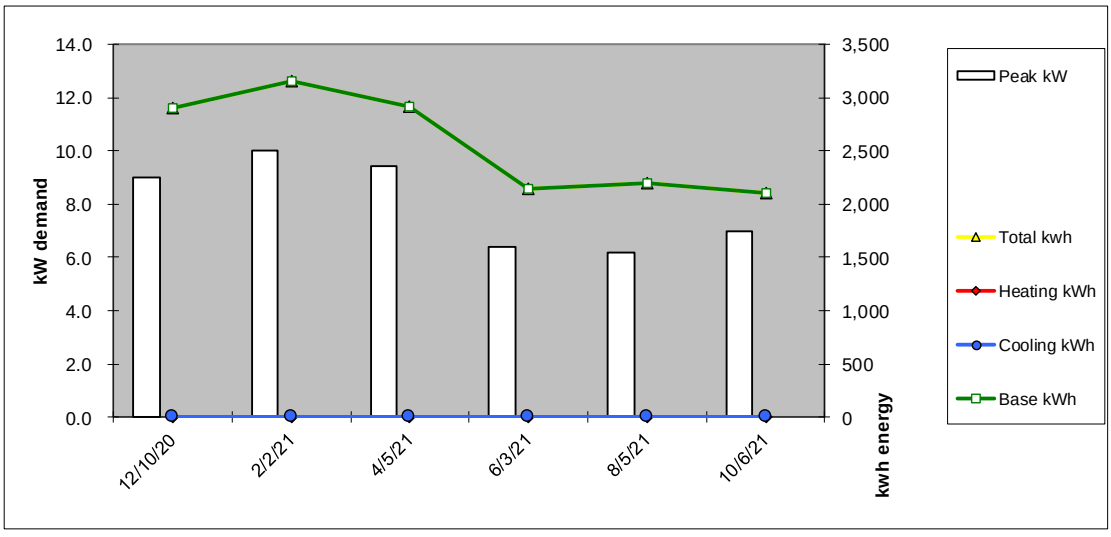
| | | |
|---|---|---|
| | 0% | based on equipment defined on the Equipment tab |
| For ground or air source HP systems | 0% | of annual electricity use used by the HPs in heating mode. |

**Disaggregation of Monthly Metered Energy: Natural Gas**

Base Usage = 17 therm / month

| Month Ending | # Days | therm | Usage Month | Enter "X" for base months | Htg. Use therm | Base therm | other therm |
|---|---|---|---|---|---|---|---|
| 11/4/20 | 30 | 177 | **10** | | 160 | 17 | 0 |
| 12/8/20 | 34 | 82 | **11** | | 65 | 17 | 0 |
| 1/7/21 | 30 | 430 | **12** | | 413 | 17 | 0 |
| 2/2/21 | 26 | 504 | **1** | | 487 | 17 | 0 |
| 3/5/21 | 31 | 390 | **2** | | 373 | 17 | 0 |
| 4/5/21 | 31 | 395 | **3** | | 378 | 17 | 0 |
| 5/6/21 | 31 | 96 | **4** | | 79 | 17 | 0 |
| 6/3/21 | 28 | 34 | **5** | | 17 | 17 | 0 |
| 7/7/21 | 34 | 18 | **6** | X | 1 | 17 | 0 |
| 8/5/21 | 29 | 18 | **7** | X | 1 | 17 | 0 |
| 9/7/21 | 33 | 15 | **8** | X | 0 | 15 | 0 |
| 10/6/21 | 29 | 22 | **9** | | 5 | 17 | 0 |
| | 366 | 2,181 | For Months Shown: | | 1,979 | 202 | 0 |

| Breakdown of Heating Energy Use | | |
|---|---|---|
| DOAS/MUA therm | FA therm | Non-FA therm |
| 0 | 0 | 160 |
| 0 | 0 | 65 |
| 0 | 0 | 413 |
| 0 | 0 | 487 |
| 0 | 0 | 373 |
| 0 | 0 | 378 |
| 0 | 0 | 79 |
| 0 | 0 | 17 |
| 0 | 0 | 1 |
| 0 | 0 | 1 |
| 0 | 0 | 0 |
| 0 | 0 | 5 |
| 0 | 0 | 1,979 |



# Town Hall Building Load Coefficient Calculations

## ESTIMATE OF BUILDING LOAD COEFFICIENT & TRUE-UP TO BILLED ENERGY USE

Town of Newfield
166 Main St
Newfield, NY 14867

### Building Information

| | | | | | |
|---|---|---|---|---|---|
| Width (typical) | 30 | feet | Building Floor Area | 3,480 | sq. ft. |
| Equivalent Length | 58 | feet | Roof Area | 1,740 | sq. ft. |
| Number of Floors | 1.5 | floors | Gross Wall Area | 2,376 | sq. ft. |
| Avg. Floor to Floor Height | 9 | feet per floor | Building Volume | 31,320 | cubic feet |
| Roof or Ceiling rise is | 0 | feet in 12' run | | | |

### Estimate of Conductive Heat Loss

| Surface | | | Area | R-value | U Factor | U x A Btuh/deg. F. | % of BLC w/o ventilation |
|---|---|---|---|---|---|---|---|
| Roof | n/a | | 1,740 | 20.3 | 0.049 | 86 | 15% |
| Walls | 86.6% | of GWA | 2,058 | 10.6 | 0.095 | 195 | 34% |
| Glazing 1 | 6.3% | of GWA | 150 | 1.7 | 0.588 | 88 | 15% |
| Glazing 2 | 0.0% | of GWA | 0 | 0.9 | 1.111 | 0 | 0% |
| Doors 1 | 8 | 3x7 doors | 168 | 2.0 | 0.500 | 84 | 15% |
| Doors 2 | 0 | 3x7 doors | 0 | 1.7 | 0.588 | 0 | 0% |
| | Total Exterior Surface Area | | 4,116 | sq.ft. | | 452 | 79% |

| | | ACH | equiv. cfm | Btuh/deg. F. | BLC (without ventilation) | |
|---|---|---|---|---|---|---|
| Est. Infiltration Rate | Occupied | 0.40 | 209 | 226 | 576 | Btuh/deg. F. Occupied |
| Est. Infiltration Rate | Unoccupied | 0.40 | 209 | 226 | 678 | Btuh/deg. F. Unoccupied |

| | | cfm | Fraction | Btuh/deg. F. | **Total BLC with Ventilation** | |
|---|---|---|---|---|---|---|
| Est. Ventilation Rate | Occupied | | 100% | 0 | **576** | **Btuh/deg. F. Occupied** |
| Est. Ventilation Rate | Unoccupied | | 100% | 0 | **678** | **Btuh/deg. F. Unoccupied** |

### Heat Gain Estimation

Estimated Solar Gain — 15% of building heat loss during occupied periods will be met by solar gains

| | | kW | # People | Total BTUH | Hours/wk. |
|---|---|---|---|---|---|
| Loads & People | Occupied | **3.1** | **10** | 13,002 | 41.0 |
| | Unoccupied | **0.6** | **0** | 1,885 | 127.0 |

## Heat Loss Study - continued

Town of Newfield
166 Main St
Newfield, NY 14867

| | | Current | |
|---|---|---|---|
| Heating T Setpoint: | Occupied | 68 | deg. F. |
| | Unoccupied | 62 | deg. F. |
| Cooling T Setpoint: | Occupied | 72 | deg. F. |
| | Unoccupied | 72 | deg. F. |
| HVAC Schedule | Occupied | 41 | Hrs. per week |
| | Unoccupied | 127 | Hrs. per week |
| Q internal gains: | Occupied | 13,002 | Btuh |
| | Unoccupied | 1,885 | Btuh |
| Q internal gains: | Schedule | 41 | Hrs. per week |
| BLC: | Occupied | 576 | Btuh/deg. F. |
| | Unoccupied | 678 | Btuh/deg. F. |

| **Fuel Data** | Heating | Cooling | |
|---|---|---|---|
| Type: | Multiple | Electricity | Economizer? |
| Units: | mmBtu | kwh | No |
| Unit cost: | $ 13.939 | $ 0.06 | |
| BTU/unit | 1,000,000 | 3,412 | |
| Nom. Eff, COP | 0.816 | 2.93 | COP |
| Avg. Eff, COP | 0.798 | 4.25 | Avg. COP |
| | | 10.0 | EER |
| | | 100% | of bldg. cooled |

| DOAS Energy Use | |
|---|---|
| 0 | cfm |
| 0% | heat recov. Eff. |
| Heating 0 | |
| 0 | |
| 0% | eff. |
| 0.00 | COP cool |
| 0 | hrs/week |

Current Elmira, 41 hrs./week

| Bin Mid Pt. | Occupied Hours | Unoccupied Hours | Occ Net Heat Loss BTUH | Unocc Net Heat Loss BTUH | Heating Fuel Use mmBtu | Cooling Energy kwh | DOAS Hours | DOAS Heating kBtu/yr. |
|---|---|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 30,504 | 45,231 | 0 | 0 | 0 | 0 |
| (2.5) | 0 | 7 | 27,623 | 41,842 | 0 | 0 | 0 | 0 |
| 2.5 | 1 | 19 | 24,742 | 38,452 | 1 | 0 | 0 | 0 |
| 7.5 | 2 | 31 | 21,861 | 35,062 | 1 | 0 | 0 | 0 |
| 12.5 | 9 | 94 | 18,980 | 31,673 | 4 | 0 | 0 | 0 |
| 17.5 | 37 | 270 | 16,098 | 28,283 | 10 | 0 | 0 | 0 |
| 22.5 | 73 | 390 | 13,217 | 24,894 | 13 | 0 | 0 | 0 |
| 27.5 | 84 | 487 | 10,336 | 21,504 | 14 | 0 | 0 | 0 |
| 32.5 | 136 | 586 | 7,455 | 18,114 | 15 | 0 | 0 | 0 |
| 37.5 | 217 | 770 | 4,574 | 14,725 | 15 | 0 | 0 | 0 |
| 42.5 | 141 | 628 | 1,692 | 11,335 | 9 | 0 | 0 | 0 |
| 47.5 | 194 | 642 | 0 | 7,945 | 6 | 0 | 0 | 0 |
| 52.5 | 185 | 436 | (1,765) | 4,556 | 2 | 23 | 0 | 0 |
| 57.5 | 147 | 567 | (4,646) | 1,166 | 1 | 47 | 0 | 0 |
| 62.5 | 264 | 757 | (7,527) | 0 | 0 | 137 | 0 | 0 |
| 67.5 | 239 | 456 | (10,409) | 0 | 0 | 172 | 0 | 0 |
| 72.5 | 177 | 240 | (13,290) | (2,224) | 0 | 199 | 0 | 0 |
| 77.5 | 144 | 159 | (16,171) | (5,613) | 0 | 222 | 0 | 0 |
| 82.5 | 88 | 71 | (19,052) | (9,003) | 0 | 160 | 0 | 0 |
| 87.5 | 2 | 9 | (21,933) | (12,393) | 0 | 11 | 0 | 0 |
| 92.5 | 0 | 0 | (24,815) | (15,782) | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | (27,696) | (19,172) | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | (30,577) | (22,562) | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | (33,458) | (25,951) | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 94 | 970 | DOAS fuel use | 0 |
| | | | | | | | DOAS cool use | 0 |

### Cross Check Against Historic Consumption

| | Historic | | Calculated | Difference |
|---|---|---|---|---|
| Present Annual Heating Fuel Use is | 93 | mmBTU | 94 | 100% of present fuel use |
| AC energy use from Utility Analysis tab: | 960 | kwh / year | 970 | 101% of present fuel use |

# Town Barn Building Load Coefficient Calculations

## ESTIMATE OF BUILDING LOAD COEFFICIENT & TRUE-UP TO BILLED ENERGY USE

Town of Newfield
166 Main St
Newfield, NY 14867

### Building Information

| | | | | | |
|---|---|---|---|---|---|
| Width (typical) | 74 | feet | Building Floor Area | 7,474 | sq. ft. |
| Equivalent Length | 101 | feet | Roof Area | 7,474 | sq. ft. |
| Number of Floors | 1.0 | floors | Gross Wall Area | 4,426 | sq. ft. |
| Avg. Floor to Floor Height | 12.6 | feet per floor | Building Volume | 94,514 | cubic feet |
| Roof or Ceiling rise is | 0 | feet in 12' run | | | |

### Estimate of Conductive Heat Loss

| Surface | | | Area | R-value | U Factor | U x A Btuh/deg. F. | % of BLC w/o ventilation |
|---|---|---|---|---|---|---|---|
| Roof | n/a | | 7,474 | 25.2 | 0.040 | 296 | 25% |
| Walls | 75.6% | of GWA | 3,346 | 5.3 | 0.188 | 629 | 52% |
| Glazing 1 | 1.3% | of GWA | 57 | 1.7 | 0.588 | 34 | 3% |
| Glazing 2 | 0.0% | of GWA | 0 | 0.9 | 1.111 | 0 | 0% |
| Doors 1 | 3 | 3x7 doors | 63 | 5.0 | 0.200 | 13 | 1% |
| Doors 2 | 5.7 | 14x12 rollup | 960 | 9.0 | 0.111 | 107 | 9% |
| | Total Exterior Surface Area | | 11,900 | sq.ft. | | 1,078 | 90% |
| | 29% | | 1.59 | | | | |

| | | ACH | equiv. cfm | Btuh/deg. F. | BLC (without ventilation) | |
|---|---|---|---|---|---|---|
| Est. Infiltration Rate | Occupied | 0.25 | 394 | 425 | 1,203 | Btuh/deg. F. Occupied |
| Est. Infiltration Rate | Unoccupied | 0.25 | 394 | 425 | 1,503 | Btuh/deg. F. Unoccupied |

| | | cfm | Fraction | Btuh/deg. F. | **Total BLC with Ventilation** | |
|---|---|---|---|---|---|---|
| Est. Ventilation Rate | Occupied | | 100% | 0 | **1,203** | **Btuh/deg. F. Occupied** |
| Est. Ventilation Rate | Unoccupied | | 100% | 0 | **1,503** | **Btuh/deg. F. Unoccupied** |

### Heat Gain Estimation

Estimated Solar Gain — 20% of building heat loss during occupied periods will be met by solar gains

| | | kW | # People | Total BTUH | Hours/wk. |
|---|---|---|---|---|---|
| Loads & People | Occupied | **1.8** | **10** | 8,418 | 42.5 |
| | Unoccupied | **0.4** | **0** | 1,204 | 125.5 |

## Heat Loss Study - continued

Town of Newfield
166 Main St
Newfield, NY 14867

| | | Current | |
|---|---|---|---|
| Heating T Setpoint: | Occupied | 61 | deg. F. |
| | Unoccupied | 61 | deg. F. |
| Cooling T Setpoint: | Occupied | 75 | deg. F. |
| | Unoccupied | 75 | deg. F. |
| HVAC Schedule | Occupied | 43 | Hrs. per week |
| | Unoccupied | 126 | Hrs. per week |
| Q internal gains: | Occupied | 8,418 | Btuh |
| | Unoccupied | 1,204 | Btuh |
| Q internal gains: | Schedule | 43 | Hrs. per week |
| BLC: | Occupied | 1,203 | Btuh/deg. F. |
| | Unoccupied | 1,503 | Btuh/deg. F. |

| **Fuel Data** | Heating | Cooling | |
|---|---|---|---|
| Type: | Natural Gas | Electricity | Economizer? |
| Units: | therm | kwh | 0.0 |
| Unit cost: | $ 1.321 | $ 0.09 | |
| BTU/unit | 100,000 | 3,412 | |
| Nom. Eff, COP | 0.915 | 3.22 | COP |
| Avg. Eff, COP | 0.915 | 4.17 | Avg. COP |
| | | 11.0 | EER |
| | | 0% | of bldg. cooled |

| DOAS Energy Use | |
|---|---|
| 0 | cfm |
| 0% | heat recov. Eff. |
| Heating 0 | |
| 0 | |
| 0% | eff. |
| 0.00 | COP cool |
| 0 | hrs/week |

Current Elmira, 43 hrs./week

| Bin Mid Pt. | Occupied Hours | Unoccupied Hours | Occ Net Heat Loss BTUH | Unocc Net Heat Loss BTUH | Heating Fuel Use therm | Cooling Energy kwh | DOAS Hours | DOAS Heating kBtu/yr. |
|---|---|---|---|---|---|---|---|---|
| (7.5) | 0 | 1 | 74,011 | 101,833 | 1 | 0 | 0 | 0 |
| (2.5) | 1 | 6 | 67,998 | 94,317 | 7 | 0 | 0 | 0 |
| 2.5 | 3 | 17 | 61,985 | 86,800 | 18 | 0 | 0 | 0 |
| 7.5 | 3 | 30 | 55,972 | 79,284 | 28 | 0 | 0 | 0 |
| 12.5 | 12 | 91 | 49,959 | 71,768 | 78 | 0 | 0 | 0 |
| 17.5 | 49 | 258 | 43,947 | 64,252 | 205 | 0 | 0 | 0 |
| 22.5 | 76 | 387 | 37,934 | 56,736 | 271 | 0 | 0 | 0 |
| 27.5 | 90 | 481 | 31,921 | 49,220 | 290 | 0 | 0 | 0 |
| 32.5 | 141 | 581 | 25,908 | 41,704 | 305 | 0 | 0 | 0 |
| 37.5 | 213 | 774 | 19,895 | 34,188 | 335 | 0 | 0 | 0 |
| 42.5 | 141 | 628 | 13,882 | 26,672 | 204 | 0 | 0 | 0 |
| 47.5 | 199 | 637 | 7,869 | 19,155 | 150 | 0 | 0 | 0 |
| 52.5 | 169 | 452 | 1,856 | 11,639 | 61 | 0 | 0 | 0 |
| 57.5 | 148 | 566 | 0 | 4,123 | 25 | 0 | 0 | 0 |
| 62.5 | 263 | 758 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67.5 | 225 | 470 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72.5 | 155 | 262 | (5,412) | 0 | 0 | 0 | 0 | 0 |
| 77.5 | 124 | 179 | (11,424) | (4,962) | 0 | 0 | 0 | 0 |
| 82.5 | 74 | 85 | (17,437) | (12,478) | 0 | 0 | 0 | 0 |
| 87.5 | 2 | 9 | (23,450) | (19,994) | 0 | 0 | 0 | 0 |
| 92.5 | 0 | 0 | (29,463) | (27,510) | 0 | 0 | 0 | 0 |
| 97.5 | 0 | 0 | (35,476) | (35,026) | 0 | 0 | 0 | 0 |
| 102.5 | 0 | 0 | (41,489) | (42,542) | 0 | 0 | 0 | 0 |
| 107.5 | 0 | 0 | (47,502) | (50,058) | 0 | 0 | 0 | 0 |
| | 8,760 | hours | | | 1,979 | 0 | DOAS fuel use | 0 |
| | | | | | | | DOAS cool use | 0 |

### Cross Check Against Historic Consumption

| | Historic | | Calculated | Difference | |
|---|---|---|---|---|---|
| Present Annual Heating Fuel Use is | 198 | mmBTU | 198 | 100% | of present fuel use |
| AC energy use from Utility Analysis tab: | 0 | kwh / year | 0 | #DIV/0! | of present fuel use |