Practice: 372 - Combustion System Improvement

Scenario: #1 - IC Engine Repower, < 50 bhp

Scenario Description:

Older diesel engine replaced with new diesel engine repower (< 50 bhp). The existing diesel engine may be stationary or portable operating an irrigation pump or an auxiliary engine providing mechanical function for agricultural/forestry equipment.
Resource Concerns: Air Quality Impacts - Emissions of Ozone Precursors; Air Quality Impacts - Emissions of Particulate Matter (PM) and PM Precursors; Inefficient Energy Use - Equipment and Facilities; Inefficient Energy Use - Farming/Ranching Practices and Field Operations.
Associated Practices include: 374 - Farmstead Energy Improvement; 533 - Pumping Plant; 430 - Irrigation Pipeline; 441 - Irrigation System, Microirrigation; 442 - Irrigation System, Sprinkler; 447 - Irrigation System, Tailwater Recovery; 449 - Irrigation Water Management; 516 - Pipeline; 313 - Waste Storage Facility; 634 - Waste Transfer; 614 - Watering Facility; 642 - Water Well, CAP 126 Comprehensive Air Quality Management Plan, CAP 122 Agricultural Energy Management Plan - Headquarters, and CAP 124 Agricultural Energy Management Plan - Landscape.

Before Situation:

An old or inefficient diesel engine powers an irrigation pumping plant or grain dryer fan, or is a backup power generation for a farming operation. The emissions of oxides of nitrogen and/or particulate matter from the engine are identified to contribute to an air quality resource concern OR the existing diesel engine is energy inefficient due to a conversion of the irrigation system, reduction in required pump capacity, or age of the power unit.
Air Quality Impacts: The existing internal combustion engine emissions are identified to contribute to an air quality resource concern.
Inefficient Energy Use: The existing internal combustion engine uses excess fuel to operate an existing irrigation pump, off-road agricultural vehicle or other auxillary engine providing a mechanical function for agricultural/forestry equipment.

After Situation:

The repowered diesel engine (< 50 bhp) replaces the existing older engine; the engine being replaced will be disabled and a certificate of inoperability submitted prior to certification of practice completion. The existing engine is supported by a concrete pad; no costs have been included for a new pad. Additional costs may be incurred if a concrete pad is not present.
For Air Quality: The repower diesel engine will be cleaner-burning and will emit less particulate matter and/or oxides of nitrogen than the previous existing engine.
For Energy: Energy efficiency will be improved by at least 20%; the increase in energy efficiency for the modified unit must be supported by an energy analysis.

Scenario Feature Measure: Size of Replacement Engine

Scenario Unit: Brake Horse Power

Scenario Typical Size: 30

Scenario Cost: $5,945.72 **Scenario Cost/Unit:** $198.19

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	8	$315.92
Materials						
Motor, IC Engine, 25-49 HP	1428	Most current Tier-level Diesel or Cleaner Engine and required appurtenances. 25 to 49 bhp. Materials only.	Horsepower	$187.66	30	$5,629.80

Practice: 372 - Combustion System Improvement

Scenario: #2 - IC Engine Repower, 50-99 bhp

Scenario Description:

Older diesel engine replaced with new diesel engine repower (50-99 bhp). The existing diesel engine may be stationary or portable operating an irrigation pump or an auxiliary engine providing mechanical function for agricultural/forestry equipment.
Resource Concerns: Air Quality Impacts - Emissions of Ozone Precursors; Air Quality Impacts - Emissions of Particulate Matter (PM) and PM Precursors; Inefficient Energy Use - Equipment and Facilities; Inefficient Energy Use - Farming/Ranching Practices and Field Operations.
Associated Practices include: 374 - Farmstead Energy Improvement; 533 - Pumping Plant; 430 - Irrigation Pipeline; 441 - Irrigation System, Microirrigation; 442 - Irrigation System, Sprinkler; 447 - Irrigation System, Tailwater Recovery; 449 - Irrigation Water Management; 516 - Pipeline; 313 - Waste Storage Facility; 634 - Waste Transfer; 614 - Watering Facility; 642 - Water Well, CAP 126 Comprehensive Air Quality Management Plan, CAP 122 Agricultural Energy Management Plan - Headquarters, and CAP 124 Agricultural Energy Management Plan - Landscape.

Before Situation:

An old or inefficient diesel engine powers an irrigation pumping plant or grain dryer fan, or is a backup power generation for a farming operation. The emissions of oxides of nitrogen and/or particulate matter from the engine are identified to contribute to an air quality resource concern OR the existing diesel engine is energy inefficient due to a conversion of the irrigation system, reduction in required pump capacity, or age of the power unit.
Air Quality Impacts: The existing internal combustion engine emissions are identified to contribute to an air quality resource concern.
Inefficient Energy Use: The existing internal combustion engine uses excess fuel to operate an existing irrigation pump, off-road agricultural vehicle or other auxillary engine providing a mechanical function for agricultural/forestry equipment.

After Situation:

The repowered diesel engine (50-99 bhp) replaces the existing older engine; the engine being replaced will be disabled and a certificate of inoperability submitted prior to certification of practice completion. The existing engine is supported by a concrete pad; no costs have been included for a new pad. Additional costs may be incurred if a concrete pad is not present.
For Air Quality: The repower diesel engine will be cleaner-burning and will emit less particulate matter and/or oxides of nitrogen than the previous existing engine.
For Energy: Energy efficiency will be improved by at least 20%; the increase in energy efficiency for the modified unit must be supported by an energy analysis.

Scenario Feature Measure: Size of Replacement Engine

Scenario Unit: Brake Horse Power

Scenario Typical Size: 75

Scenario Cost: $14,806.09 **Scenario Cost/Unit:** $197.41

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	16	$631.84
Materials						
Motor, IC Engine, 50-99 HP	1429	Most current Tier-level Diesel or Cleaner Engine and required appurtenances. 50 to 99 bhp. Materials only.	Horsepower	$188.99	75	$14,174.25

Practice: 372 - Combustion System Improvement

Scenario: #3 - IC Engine Repower, 100-199 bhp

Scenario Description:

Older diesel engine replaced with new diesel engine repower (100-199 bhp). The existing diesel engine may be stationary or portable operating an irrigation pump or an auxiliary engine providing mechanical function for agricultural/forestry equipment.
Resource Concerns: Air Quality Impacts - Emissions of Ozone Precursors; Air Quality Impacts - Emissions of Particulate Matter (PM) and PM Precursors; Inefficient Energy Use - Equipment and Facilities; Inefficient Energy Use - Farming/Ranching Practices and Field Operations.
Associated Practices include: 374 - Farmstead Energy Improvement; 533 - Pumping Plant; 430 - Irrigation Pipeline; 441 - Irrigation System, Microirrigation; 442 - Irrigation System, Sprinkler; 447 - Irrigation System, Tailwater Recovery; 449 - Irrigation Water Management; 516 - Pipeline; 313 - Waste Storage Facility; 634 - Waste Transfer; 614 - Watering Facility; 642 - Water Well, CAP 126 Comprehensive Air Quality Management Plan, CAP 122 Agricultural Energy Management Plan - Headquarters, and CAP 124 Agricultural Energy Management Plan - Landscape.

Before Situation:

An old or inefficient diesel engine powers an irrigation pumping plant or grain dryer fan, or is a backup power generation for a farming operation. The emissions of oxides of nitrogen and/or particulate matter from the engine are identified to contribute to an air quality resource concern OR the existing diesel engine is energy inefficient due to a conversion of the irrigation system, reduction in required pump capacity, or age of the power unit.
Air Quality Impacts: The existing internal combustion engine emissions are identified to contribute to an air quality resource concern.
Inefficient Energy Use: The existing internal combustion engine uses excess fuel to operate an existing irrigation pump, off-road agricultural vehicle or other auxillary engine providing a mechanical function for agricultural/forestry equipment.

After Situation:

The repowered diesel engine (100-199 bhp) replaces the existing older engine; the engine being replaced will be disabled and a certificate of inoperability submitted prior to certification of practice completion. The existing engine is supported by a concrete pad; no costs have been included for a new pad. Additional costs may be incurred if a concrete pad is not present.
For Air Quality: The repower diesel engine will be cleaner-burning and will emit less particulate matter and/or oxides of nitrogen than the previous existing engine.
For Energy: Energy efficiency will be improved by at least 20%; the increase in energy efficiency for the modified unit must be supported by an energy analysis.

Scenario Feature Measure: Size of Replacement Engine

Scenario Unit: Brake Horse Power

Scenario Typical Size: 150

Scenario Cost: $30,847.84 **Scenario Cost/Unit:** $205.65

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	16	$631.84
Materials						
Motor, IC Engine, 100-199 HP	1430	Most current Tier-level Diesel or Cleaner Engine and required appurtenances. 100 to 199 bhp. Materials only.	Horsepower	$201.44	150	$30,216.00

Practice: 372 - Combustion System Improvement

Scenario: #4 - IC Engine Repower, >=200 bhp

Scenario Description:

Older diesel engine replaced with new diesel engine repower (>= 200 bhp). The existing diesel engine may be stationary or portable operating an irrigation pump or an auxiliary engine providing mechanical function for agricultural/forestry equipment.
Resource Concerns: Air Quality Impacts - Emissions of Ozone Precursors; Air Quality Impacts - Emissions of Particulate Matter (PM) and PM Precursors; Inefficient Energy Use - Equipment and Facilities; Inefficient Energy Use - Farming/Ranching Practices and Field Operations.
Associated Practices include: 374 - Farmstead Energy Improvement; 533 - Pumping Plant; 430 - Irrigation Pipeline; 441 - Irrigation System, Microirrigation; 442 - Irrigation System, Sprinkler; 447 - Irrigation System, Tailwater Recovery; 449 - Irrigation Water Management; 516 - Pipeline; 313 - Waste Storage Facility; 634 - Waste Transfer; 614 - Watering Facility; 642 - Water Well, CAP 126 Comprehensive Air Quality Management Plan, CAP 122 Agricultural Energy Management Plan - Headquarters, and CAP 124 Agricultural Energy Management Plan - Landscape.

Before Situation:

An old or inefficient diesel engine powers an irrigation pumping plant or grain dryer fan, or is a backup power generation for a farming operation. The emissions of oxides of nitrogen and/or particulate matter from the engine are identified to contribute to an air quality resource concern OR the existing diesel engine is energy inefficient due to a conversion of the irrigation system, reduction in required pump capacity, or age of the power unit.
Air Quality Impacts: The existing internal combustion engine emissions are identified to contribute to an air quality resource concern.
Inefficient Energy Use: The existing internal combustion engine uses excess fuel to operate an existing irrigation pump, off-road agricultural vehicle or other auxillary engine providing a mechanical function for agricultural/forestry equipment.

After Situation:

The repowered diesel engine (>= 200 bhp) replaces the existing older engine; the engine being replaced will be disabled and a certificate of inoperability submitted prior to certification of practice completion. The existing engine is supported by a concrete pad; no costs have been included for a new pad. Additional costs may be incurred if a concrete pad is not present.
For Air Quality: The repower diesel engine will be cleaner-burning and will emit less particulate matter and/or oxides of nitrogen than the previous existing engine.
For Energy: Energy efficiency will be improved by at least 20%; the increase in energy efficiency for the modified unit must be supported by an energy analysis.

Scenario Feature Measure: Size of Replacement Engine

Scenario Unit: Brake Horse Power

Scenario Typical Size: 350

Scenario Cost: $59,830.84 **Scenario Cost/Unit:** $170.95

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	16	$631.84
Materials						
Motor, IC Engine, 300-399 HP	1433	Most current Tier-level Diesel or Cleaner Engine and required appurtenances. 300 to 399 bhp. Materials only.	Horsepower	$169.14	350	$59,199.00

Practice: 372 - Combustion System Improvement

Scenario: #5 - Reverse Osmosis <=250 GPH

Scenario Description:

A reverse osmosis (RO) unit, installed before the evaporator, filters the sap and removes ~ 75% of the water prior to getting to the evaporator. The unit is sized in gallons per hour. The size of the RO is determined based on the existing maple sugaring operation (number of taps and the capacity of the evaporator). This scenario includes units that process <= 250 gallons of sap per hour. With a RO unit able to remove excess water,it takes less time to boil the sap down, thus saving significant energy (oil & wood fuel) used in the process.

Before Situation:

A maple sugaring operation uses an evaporator (pan over a furnace) to boil sap to remove water to create syrup. It takes ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water has to be boiled off. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

With an efficient RO installed in the process, ~ 75% of the water is removed from the sap, thus cutting the boil time down by ~75%. An efficiency of 1 gallon fuel oil (or equivalent wood) per gallon of maple syrup is possible, thereby reducing energy consumption by 65-75%. Less fuel used yields decreased air emissions.

Scenario Feature Measure: capacity of unit

Scenario Unit: Gallon per Hour

Scenario Typical Size: 250

Scenario Cost: $6,160.92 **Scenario Cost/Unit:** $24.64

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	3	$118.47
Materials						
Reverse Osmosis unit, fixed cost portion	2224	Fixed cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Each	$1,542.45	1	$1,542.45
Reverse Osmosis unit, variable cost portion	2225	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$18.00	250	$4,500.00

Practice: 372 - Combustion System Improvement

Scenario: #6 - Reverse Osmosis >250 to <1000 GPH

Scenario Description:

A reverse osmosis (RO) unit, installed before the evaporator, filters the sap and removes ~ 75% of the water prior to getting to the evaporator. The unit is sized in gallons per hour. The size of the RO is determined based on the existing maple sugaring operation (number of taps and the capacity of the evaporator). This scenario includes units that process >250 to <1000 gallons of sap per hour. With a RO unit able to remove excess water,it takes less time to boil the sap down, thus saving significant energy (oil & wood fuel) used in the process.

Before Situation:

A maple sugaring operation uses an evaporator (pan over a furnace) to boil sap to remove water to create syrup. It takes ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water has to be boiled off. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

With an efficient RO installed in the process, ~ 75% of the water is removed from the sap, thus cutting the boil time down by ~75%. An efficiency of 1 gallon fuel oil (or equivalent wood) per gallon of maple syrup is possible, thereby reducing energy consumption by 65-75%. Less fuel used yields decreased air emissions.

Scenario Feature Measure: capacity of unit

Scenario Unit: Gallon per Hour

Scenario Typical Size: 600

Scenario Cost: $11,689.70 **Scenario Cost/Unit:** $19.48

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	3	$118.47
Materials						
Reverse Osmosis unit, fixed cost portion	2224	Fixed cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Each	$1,542.45	0.5	$771.23
Reverse Osmosis unit, variable cost portion	2225	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$18.00	600	$10,800.00

Practice: 372 - Combustion System Improvement

Scenario: #7 - Reverse Osmosis >=1000 GPH

Scenario Description:

A reverse osmosis (RO) unit, installed before the evaporator, filters the sap and removes ~ 75% of the water prior to getting to the evaporator. The unit is sized in gallons per hour. The size of the RO is determined based on the existing maple sugaring operation (number of taps and the capacity of the evaporator). This scenario includes units that process >= 1000 gallons of sap per hour. With a RO unit able to remove excess water,it takes less time to boil the sap down, thus saving significant energy (oil & wood fuel) used in the process.

Before Situation:

A maple sugaring operation uses an evaporator (pan over a furnace) to boil sap to remove water to create syrup. It takes ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water has to be boiled off. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

With an efficient RO installed in the process, ~ 75% of the water is removed from the sap, thus cutting the boil time down by ~75%. An efficiency of 1 gallon fuel oil (or equivalent wood) per gallon of maple syrup is possible, thereby reducing energy consumption by 65-75%. Less fuel used yields decreased air emissions.

Scenario Feature Measure: capacity of unit

Scenario Unit: Gallon per Hour

Scenario Typical Size: 1,200

Scenario Cost: $21,718.47 **Scenario Cost/Unit:** $18.10

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	3	$118.47
Materials						
Reverse Osmosis unit, variable cost portion	2225	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$18.00	1200	$21,600.00

Practice: 372 - Combustion System Improvement

Scenario: #8 - Steam Enhanced Preheater, <=24 SF

Scenario Description:

The unit sets over the evaporator pan and uses steam from the evaporator pan to pre-heat the sap to as high as 200ºF while at the same time injecting air into the sap to promote evaporation. Evaporation rates are increased by 65-75%, based on vendor analysis, leading to 40-43% energy savings. Sap is concentrated from Brix 2% to 4% or more before it enters the flue pan. Steam-enhanced systems require at least 9 feet from floor to ceiling. This scenario includes units <= 24 sq. ft. With increased evaporation, it takes less time to boil the sap down, thus saving significant energy (oil & wood fuel) used in the process, as well as labor.

Before Situation:

The evaporative process time for making concentrated maple syrup requires boiling ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water have to be boiled off, using more fuel and labor. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

The evaporative process time for making concentrated maple syrup requires boiling ~6 gallons of sap to make 1 gallon of syrup, which means 14 gallons of water were removed by the steam-enhanced system, using less fuel and labor. A typical oil-fired evaporator with a steam pan consumes 2.1 to 2.7 gallons of fuel oil for each gallon of maple syrup produced to remove water from the sap, improving the fuel efficiency and saving labor.

Scenario Feature Measure: Square Foot of steam pan

Scenario Unit: Square Foot

Scenario Typical Size: 24

Scenario Cost: $9,781.42 **Scenario Cost/Unit:** $407.56

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	6	$236.94
Materials						
Sap Pre-Heater, High efficiency, fixed cost	2254	High efficiency sap pre-heater device, fixed cost portion. Materials only.	Each	$4,358.08	1	$4,358.08
Sap Pre-Heater, High efficiency, variable cost	2255	High efficiency sap pre-heater device, variable cost portion. Materials only.	Square Foot	$216.10	24	$5,186.40

Practice: 372 - Combustion System Improvement

Scenario: #9 - Steam Enhanced Preheater, >24 SF

Scenario Description:

The unit sets over the evaporator pan and uses steam from the evaporator pan to pre-heat the sap to as high as 200ºF while at the same time injecting air into the sap to promote evaporation. Evaporation rates are increased by 65-75%, based on vendor analysis, leading to 40-43% energy savings. Sap is concentrated from Brix 2% to 4% or more before it enters the flue pan. Steam-enhanced systems require at least 9 feet from floor to ceiling. This scenario includes units > 24 sq. ft. installed. With increased evaporation, it takes less time to boil the sap down, thus saving significant energy (oil & wood fuel) used in the process, as well as labor.

Before Situation:

The evaporative process time for making concentrated maple syrup requires boiling ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water have to be boiled off, using more fuel and labor. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

The evaporative process time for making concentrated maple syrup requires boiling ~6 gallons of sap to make 1 gallon of syrup, which means 14 gallons of water were removed by the steam-enhanced system, using less fuel and labor. A typical oil-fired evaporator with a steam pan consumes 2.1 to 2.7 gallons of fuel oil for each gallon of maple syrup produced to remove water from the sap, improving the fuel efficiency and saving labor.

Scenario Feature Measure: Square Foot of steam pan

Scenario Unit: Square Foot

Scenario Typical Size: 40

Scenario Cost: $11,138.96 **Scenario Cost/Unit:** $278.47

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	8	$315.92
Materials						
Sap Pre-Heater, High efficiency, fixed cost	2254	High efficiency sap pre-heater device, fixed cost portion. Materials only.	Each	$4,358.08	0.5	$2,179.04
Sap Pre-Heater, High efficiency, variable cost	2255	High efficiency sap pre-heater device, variable cost portion. Materials only.	Square Foot	$216.10	40	$8,644.00

Practice: 372 - Combustion System Improvement

Scenario: #10 - Sap Preheater

Scenario Description:

The unit sets over the evaporator pan and uses steam from the evaporator pan to pre-heat the sap prior to entering the boiling pan. Heated sap takes much less time to boil, therfore decreases the process combustion time. Decreased combustion time means less fuel used and also results in less air emissions released. This device can increase the efficency of an evaporator pan by 15-20%. This scenario is for units <= 25 sq. ft installed. Resource concerns are energy efficieny and air quality.

Before Situation:

The evaporative process time for making concentrated maple syrup requires boiling ~20 gallons of sap to make 1 gallon of syrup, which means 19 gallons of water have to be boiled off, using much fuel and labor. A typical oil-fired evaporator consumes 3.5 to 4.5 gallons of fuel oil for each gallon of maple syrup produced.

After Situation:

A sap pre-heater device is installed over the evaporator pan and sap is boiled much faster. Decreasing the boiling time decreases combustion time saving both fuel and reducing air emissions.

Scenario Feature Measure: Size of preheater in SF

Scenario Unit: Square Foot

Scenario Typical Size: 10

Scenario Cost: $981.78 **Scenario Cost/Unit:** $98.18

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	3	$118.47
Materials						
Sap Pre-Heater Device, ≤ 25 SF	1443	Install sap pre-heater device to reduce atmospheric emissions with an area of 25 square feet or less. Materials only.	Square Foot	$123.33	7	$863.31

Practice: 372 - Combustion System Improvement

Scenario: #11 - GH Furnace, Dual Fuel

Scenario Description:

In New England nursery operations need to heated during the winter months. Wood and oil fueled furnaces have been commonly used which may not be efficient and yield particulate matter emissions. A new more efficient dual fuel furnace is installed to efficiently burn fuel and reduce the amount of particulate matter coming from the chimney. Typical scneario is based on an average furnace used to heat a 30 by 200 greenhouse. The resource concern is air quality. Converting from wood to either distillate oil or natural gas can reduce total PM emissions by >90%.

Before Situation:

A greenhouse operation has an inefficient wood or oil burning furnace. Particulate matter from combustion is released into the air.

After Situation:

The furnace is replaced with an efficiant wood/oil or gas furnace, resulting in reduced emissions of particulate matter.

Scenario Feature Measure: Furnace output rating

Scenario Unit: 1,000 BTU/Hour

Scenario Typical Size: 1,000

Scenario Cost: $30,609.60 **Scenario Cost/Unit:** $30.61

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	40	$1,579.60
Materials						
Furnace, duel fuel	1441	Duel fuel furnace in-lieu of wood/oil heating. Includes materials and shipping only.	Thousand BTU	$29.03	1000	$29,030.00

Practice: 372 - Combustion System Improvement

Scenario: #12 - GH Heater, Oil to Gas

Scenario Description:

Greenhouse operation replaces oil boilers with natural gas boilers to decrease CO2 production, particulate matter and improve air quality. Natural Gas also has less particulate matter production than oil. DATA SOURCES: The EPA Voluntary Reporting of Greenhouse Gases Program Fuel Carbon Dioxide Emission Coefficients shows that distillate fuel oil accounts for 10.1 kg (22.4 lb) of CO2 per gallon (73.15 kg/MMBtu or 161 lb/MMBtu or 16.1 lb per 100,000 Btu). For natural gas, the coefficient is 5.3 kg (11.7 lb) of CO2 per therm (117 lb of CO2 per MCF or 11.7 lbs per 100,000 Btu). Note that this number does not change across the country. Converting from wood to either distillate oil or natural gas can reduce total PM emissions by >90%. Typical scneario is based on an average furnace used to heat a 30 by 200 greenhouse.

Before Situation:

Greenhouse operation uses oil burners for greenhouse heating. Particulate matter is expelled into the air and local air quality is affected. CT is a non-attainment state.

After Situation:

Oil burners have been replaced by gas burners and CO2 has been reduced by 25% (see data sources above).

Scenario Feature Measure: Furnace output rating

Scenario Unit: 1,000 BTU/Hour

Scenario Typical Size: 1,000

Scenario Cost: $10,060.62 **Scenario Cost/Unit:** $10.06

Cost Details (by category):

Component Name	ID	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor						
Skilled Labor	230	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.49	38	$1,500.62
Materials						
Heater, high efficiency	1165	Natural gas, propane, or fuel oil unit heater or boiler and venting materials. Based on input kBTU/hour. Includes materials and shipping only.	1,000 BTU/Hour	$8.56	1000	$8,560.00