Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	7
Scenario Name	IC Engine Replacement, 100 to 299 bhp
Scenario Description	A 5-year old or older functioning 75-180 HP gas or diesel engine is removed from use and replaced with new diesel engine repower. The existing diesel engine may be stationary or portable operating an irrigation pump, mobile by propelling an off-road agricultural vehicle, or an auxiliary engine providing mechanical function for agricultural/forestry equipment. Purchasing a smaller engine due to the improved operating efficiency is encouraged. A larger engine could be purchased at the operator's expense. Used in any eligible agricultural setting where inefficient engines are used and replacement will significantly improve air quality. 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 May Iinclude: 374 - Farmstead Energy Improvement; 533 - Pumping Plant; 430 - Irrigation Pipeline; 441 - Irrigation System, Microirrigation; 442 - Irrigation System, Sprinkler; 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
Before Practice Situation	An old or inefficient diesel engine powers an irrigation pumping plant, is a backup power generation, or provides power for other farming operations. 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 Practice Situation	The repowered diesel engine (100 to 299 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 may be supported by a concrete pad; no cost 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	Horse Power
Scenario Typical Size	150

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$21,990.00	$146.60
Equipment/Installation	$0.00	$0.00
Labor	$158.16	$1.05
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$22,148.16	$147.65

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	1430	Motor, IC Engine, 100-199 HP	Most current Tier-level Diesel or Cleaner Engine and required appurtenances. 100 to 199 bhp. Materials only.	Horsepower	$146.60	150	$21,990.00
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	4	$158.16

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	4
Scenario Name	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 Practice 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 Practice 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

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$8,931.48	$372.15
Equipment/Installation	$0.00	$0.00
Labor	$237.24	$9.89
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$9,168.72	$382.03

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	2254	Sap Pre-Heater, High efficiency, fixed cost	High efficiency sap pre-heater device, fixed cost portion. Materials only.	Each	$4,078.20	1	$4,078.20
Materials	2255	Sap Pre-Heater, High efficiency, variable cost	High efficiency sap pre-heater device, variable cost portion. Materials only.	Square Foot	$202.22	24	$4,853.28
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	6	$237.24

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	5
Scenario Name	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 Practice 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 Practice 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

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$10,127.90	$253.20
Equipment/Installation	$0.00	$0.00
Labor	$316.32	$7.91
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$10,444.22	$261.11

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	2254	Sap Pre-Heater, High efficiency, fixed cost	High efficiency sap pre-heater device, fixed cost portion. Materials only.	Each	$4,078.20	0.5	$2,039.10
Materials	2255	Sap Pre-Heater, High efficiency, variable cost	High efficiency sap pre-heater device, variable cost portion. Materials only.	Square Foot	$202.22	40	$8,088.80
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	8	$316.32

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	8
Scenario Name	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 Practice Situation	A greenhouse operation has an inefficient wood or oil burning furnace. Particulate matter from combustion is released into the air.
After Practice 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	1000 BTU/Hour
Scenario Typical Size	1000

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$27,030.00	$27.03
Equipment/Installation	$0.00	$0.00
Labor	$1,581.60	$1.58
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$28,611.60	$28.61

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	1441	Furnace, duel fuel	Duel fuel furnace in-lieu of wood/oil heating. Materials only.	Thousand BTU	$27.03	1000	$27,030.00
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	40	$1,581.60

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	9
Scenario Name	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 Practice 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 Practice 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	1000 BTU/Hour
Scenario Typical Size	1000

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$11,030.00	$11.03
Equipment/Installation	$0.00	$0.00
Labor	$1,502.52	$1.50
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$12,532.52	$12.53

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	1165	Heater, high efficiency	Natural gas, propane, or fuel oil unit heater or boiler and venting materials.	1,000 BTU/Hour	$11.03	1000	$11,030.00
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	38	$1,502.52

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	3
Scenario Name	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 Practice 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 Practice 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/Hour
Scenario Typical Size	1200

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$18,656.00	$15.55
Equipment/Installation	$0.00	$0.00
Labor	$158.16	$0.13
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$18,814.16	$15.68

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	2225	Reverse Osmosis unit, variable cost portion	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$16.96	1100	$18,656.00
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	4	$158.16

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	1
Scenario Name	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 Practice 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 Practice 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/Hour
Scenario Typical Size	250

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$9,200.60	$36.80
Equipment/Installation	$0.00	$0.00
Labor	$118.62	$0.47
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$9,319.22	$37.28

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	3	$118.62
Materials	2224	Reverse Osmosis unit, fixed cost portion	Fixed cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Each	$4,960.60	1	$4,960.60
Materials	2225	Reverse Osmosis unit, variable cost portion	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$16.96	250	$4,240.00

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	2
Scenario Name	Reverse Osmosis 600 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 600 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 Practice 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 Practice 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/Hour
Scenario Typical Size	600

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$12,656.30	$21.09
Equipment/Installation	$0.00	$0.00
Labor	$118.62	$0.20
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$12,774.92	$21.29

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	3	$118.62
Materials	2224	Reverse Osmosis unit, fixed cost portion	Fixed cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Each	$4,960.60	0.5	$2,480.30
Materials	2225	Reverse Osmosis unit, variable cost portion	Variable cost portion of a reverse osmosis unit used for maple syrup processing. Materials only.	Gallons per Hour	$16.96	600	$10,176.00

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	New England
State	Connecticut
Discipline Group	Engineering General
Practice Code/Name	372 - Combustion System Improvement
Scenario ID	6
Scenario Name	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 Practice 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 Practice 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

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	$807.30	$80.73
Equipment/Installation	$0.00	$0.00
Labor	$118.62	$11.86
Mobilization	$0.00	$0.00
Acquisition of Technical Knowledge	$0.00	$0.00
Foregone Income	$0.00	$0.00
Total	$925.92	$92.59

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price ($/unit)	Quantity	Cost
Materials	1443	Sap Pre-Heater Device, ≤ 25 SF	Install sap pre-heater device to reduce atmospheric emissions with an area of 25 square feet or less. Materials only.	Square Foot	$80.73	10	$807.30
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	$39.54	3	$118.62