Nursery Model Scenarios: How Recommended Best Management Practices Pencil Out for Two Fictional Nurseries

To demonstrate resource and cost savings potential for recommended best management practices (BMPs) described in a way that will be as meaningful as possible for all nurseries utilizing the Best Management Practices Guide for Climate Friendly Nurseries, we have created two fictitious model nurseries. For each of the top six BMPs highlighted in the guide, we present costs and savings according to these model nurseries. While these model nurseries are completely fabricated, we used our interaction with Climate Friendly Nursery Project (CFNP) participants to ensure that they were realistic and meaningful in nature. By providing savings calculations captured by a nursery with a certain set of parameters, a nursery will have the opportunity to gain a general sense of the savings they can derive by implementing each BMP at their own facility.

It is important to note that the model nursery scenarios presented here are a work in progress. We welcome your feedback and comments on this work; it is our hope that with your help, we can present scenarios that are as applicable as possible to how a real nursery might function.

The parameters for Nursery Models A and B are described on the following pages. For additional information regarding each highlighted best management practice, please refer to the Best Management Practice Guide for Climate Friendly Nurseries at www.climatefriendlynurseries.org.

Model A Nursery (40 Acres)

Table 1: Model A Organizational Assumptions

Organizational Details	
Nursery Type	60% Container/ 40% Field
Acreage	40
Revenue	$ 450,000
Cost of Goods Sold (labor included)	$ 337,500
Selling, General and Administrative	$ 45,000
Income from Operations	$ 67,500
Assumed Net Profit (after tax and less interest expenses)	$ 49,500
Energy Costs as Percent of Revenue	1.7%
Energy Costs as Percent of COGS	2.2%
Energy Costs as Percent of Net Profit	15%
20% Reduction in Energy Costs	$ 1,491
Energy Savings as Percent of Net Profit	3.0%
Energy Savings as Sales	$ 13,555

Table 2: Model A Energy Use Assumptions

Fuel Source	Unit of Measure	Annual Use	GHG Emissions Scope	Function	Fuel Cost (2009 Average)	Annual Cost
Electric	kWh	40,000	2	Lighting, Cooling, Irrigation	$0.09	$3,600
Propane	gal	500	1	Trucks, cars for operations and delivery	$1.80	$900
Gas	gal	700	1	Heat greenhouses	$2.40	$1,680
Diesel	gal	500	1	Trucks, cars for operations and delivery	$2.55	$1,275
Total						**$7,455**

Figure 1: Model A Total Energy Use Assumption Profile (% of Annual Cost)

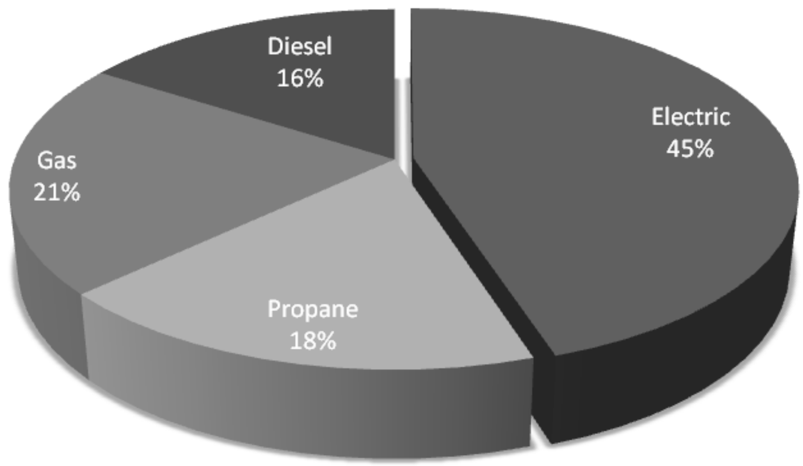
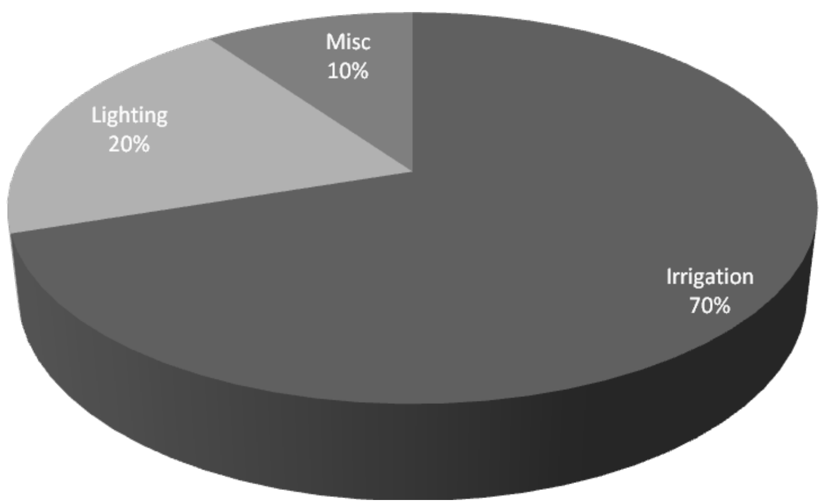


Figure 2: Model A Electricity Use Assumption Profile (kWh)



Model B Nursery (400 Acres)

Table 3: Model B Organizational Assumptions

Organizational Details	
Nursery Type	70% field-bare root; 30% container
Acreage	400
Revenue	$ 4,800,000
Cost of Goods Sold (labor included)	$ 3,840,000
Selling, General and Administrative	$ 240,000
Income from Operations	$ 720,000
Assumed Net Profit (after tax and less interest expenses)	$ 384,000
Energy Costs as Percent of Revenue	2.9%
Energy Costs as Percent of COGS	3.6%
Energy Costs as Percent of Net Profit	36%
20% Reduction in Energy Costs	$ 27,630
Energy Savings as Percent of Net Profit	7.2%
Energy Savings as Sales	$ 345,375

Table 4: Model B Energy Use Assumptions

Fuel Source	Unit of Measure	Annual Use	GHG Emissions Scope	Function	Fuel Cost (2009 Average)	Annual Cost
Electric	kWh	600,000	2	Irrigation, Buildings, Lighting	$0.09	$54,000
Gas	gal	25,000	1	Trucks, cars for operations and delivery	$2.40	$60,000
Natural Gas	therms	10,500	1	Heat greenhouses	$1.70	$17,850
Propane-Mobile	gal	3,500	1	Forklifts and other farm equipment	$1.80	$6,300
Total						**$138,150**

Figure 3: Model B Total Energy Use Assumption Profile (% of Annual Cost)

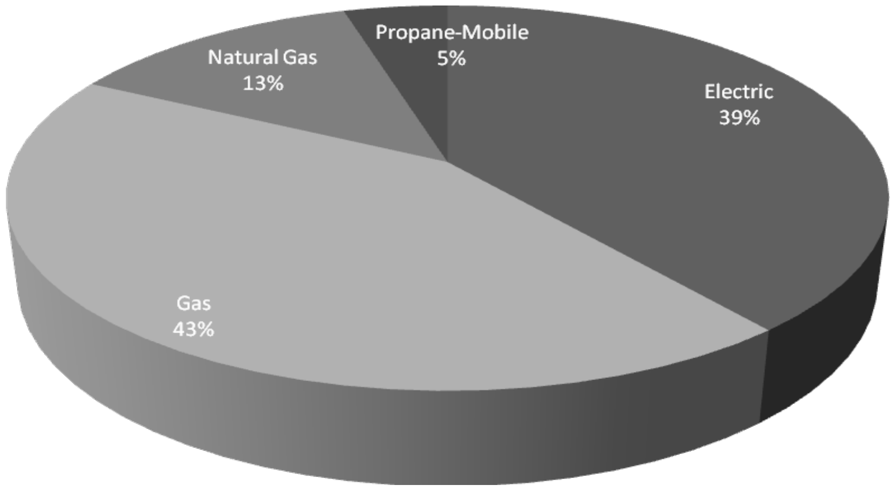
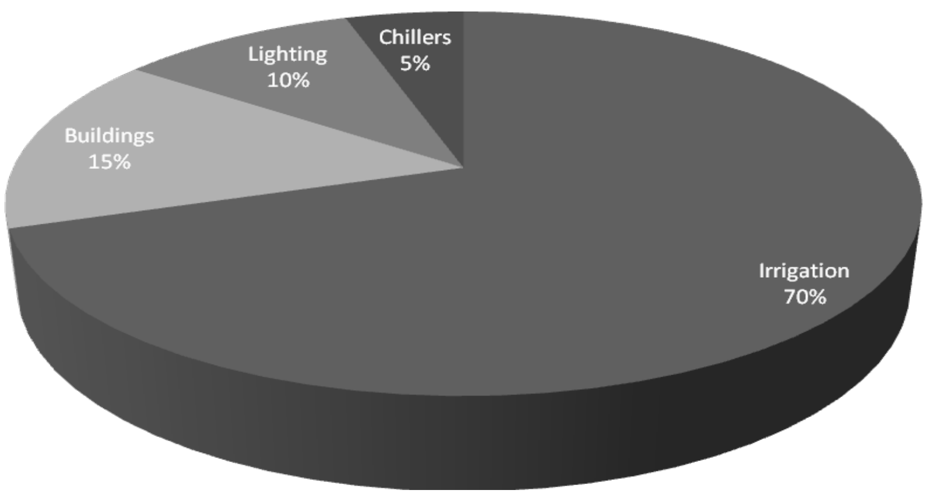


Figure 4: Model B Electricity Use Assumption Profile (kWh)



1. Lighting and Sensors Retrofit

Complete a Lighting Retrofit

Lighting retrofits tend to be one of the simplest and most direct ways to save energy and see tangible electricity bill savings. An average incandescent bulb lasts one or two years and consumes 66 kWh per year; an average compact fluorescent lamp (CFL), alternatively, lasts six years and consumes 16 kWh per year, bringing an average cost savings of $5 per bulb per year in electricity charges. In addition, maintenance costs are far less for efficient lighting, since bulbs last up to ten times longer, and fixture hardware tends to last an average of twenty years. Likewise, the conversion of any halide lights or T12 fluorescent lamps to T5 or T8 lamps will capture substantial electricity savings.

Install Occupancy Sensors

The installation of motion sensors, or occupancy sensors, is also strongly recommended. Motion sensors have integrated adjustable timers that automatically turn off the light fixture when no motion is detected. Since this feature is integrated into each fixture, the light in occupied areas will remain lit, while those in unoccupied portions of the same space will turn themselves off – automatically saving energy. Burn time is generally reduced by approximately 25 percent when utilizing occupancy sensors.

Model A Results

Table 5: Model A Savings Assumptions from Lighting Retrofit and Lighting Sensors

Location Area	Fixt Qty	Existing Equipment	Existing Watts per Fixture	Proposed Measure Description	Proposed Watts per Fixture	Annual Op Hours	Adjusted Op Hours with Controls	Retrofit Savings (kWh)	Control Savings (kWh)	Retrofit Savings ($)	Control Savings ($)	Total Savings ($)
Office	4	4 lamp acrylic lens, recessed	164	2 lamp F32 T8	64	2,600	2,200	1,040	102	$94	$9	$103
Office	6	Incandescant	75	Compact Fluorescent (CFL)	20	2,600	2,200	858	48	$77	$4	$82
Office	6	Incandescant	60	Compact Fluorescent (CFL)	12	2,600	2,200	749	29	$67	$3	$70
Warehouse	2	400 Watt Metal Halide	465	6 lamp F32 T8 highbay	192	2,600	2,000	1,420	230	$128	$21	$149
Warehouse	2	8 ' industrial strip T12	138	8' F32 T8 industrial strip	64	2,600	2,000	385	77	$35	$7	$42
Exterior	1	400 Watt Metal Halide-	465	320 pulse start bi-level	175	2,600	2,200	754	70	$68	$6	$74

Table 6: Lighting Retrofit with Occupancy Sensor (~8,000 kWh annual usage) for Model A

	Retrofit	Controls	Total
kWh Savings	5,205	556	5,762
Annual Savings Opportunity	$468	$50	$519
Upfront Investment	$1,200	$250	$1,450
Available Incentives	$400	$50	$450
Total Cost	$800	$200	$1,000
Simple Payback	**~ 1.7 years**	**~ 4.0 years**	**~ 1.9 years**

Model B Results

Table 7: Model B Savings Assumptions from Lighting Retrofit and Lighting Sensors

Location Room	Fixt Qty	Existing Equipment	Existing Watts per Fixture	Proposed Measure Description	Proposed Watts per Fixture	Annual Op Hours	Adjusted Op Hours with Controls	Retrofit Savings (kWh)	Plus Control Savings (kWh)	Retrofit Savings ($)	Control Savings ($)	Total Savings ($)
Office	12	4 lamp acrylic lens, recessed	164	2 lamp F32 T8	64	2,600	2,200	3,120	307	$281	$28	$308
Office	20	Incandescant	75	Compact Fluorescent	20	2,600	2,200	2,860	160	$257	$14	$272
Office	10	Incandescant	60	Compact Fluorescent	12	2,600	2,200	1,248	48	$112	$4	$117
Warehouse	20	400 Watt Metal Halide	465	6 lamp F32 T8 highbay	192	2,600	2,000	14,196	2,304	$1,278	$207	$1,485
Warehouse	18	250 Watt Metal Halide	295	3 lamp F32	96	2,600	2,000	9,313	1,037	$838	$93	$932
Warehouse	12	8 ' industrial strip T12	138	8' F32 T8 industrial strip	64	2,600	2,000	2,309	461	$208	$41	$249
Exterior	**6**	**400 Watt Metal Halide-pole**	**465**	**320 pulse start bi-level**	**175**	**2600**	**2200**	**4524**	**420**	**407.16**	**37.8**	**444.96**

Table 8: Lighting Retrofit with Occupancy Sensor (~600,000 kWh annual usage) for Model B

	Retrofit	Controls	Total
kWh Savings	37,570	4,737	42,307
Annual Savings Opportunity	$3,381	$426	$3,808
Upfront Investment	$6,000	$1,200	$7,200
Available Incentives	$2,100	$200	$2,300
Total Cost	$3,900	$1,000	$4,900
Simple Payback	**~1.2 years**	**~2.3 years**	**~1.3 years**

2. Variable Frequency Drives (VFDs)

Install VFDs on all Relevant Irrigation Pumps

Whether or not the installation of a VFD is operationally and financially appropriate depends upon the following conditions: if the irrigation pump is required to operate with varying flow and pressure needs; if the pump must operate at varying well depths; and if the pump is oversized for the required task. If any three of these factors are present, then the installation of a VFD should make both financial and operational sense.

Model A Results

Table 9: Model A Savings Assumptions for VFD Installations

Operating Details	Pump A	Pump B	Total
Horsepower	10	5	15
Operating Hours	2500	2500	
KW per hp	0.746	0.746	
KW conversion	7.46	3.73	
Annual kwh Usage	18,650	9,325	27,975
VFD Savings Rate	30%	30%	
VFD Savings (kWh)	5,595	2,798	8,393
Annual Savings ($0.09/kWh)	$504	$252	$755
Cost with Installation	$5,500	$4,000	$9,500
ETO Incentive	$800	$400	$1,200
BETC Incentive	$1,925	$1,400	$3,325
Total Cost after Incentives	$2,775	$2,200	$4,975
Payback	**~5.5years**	**~8.7 years**	**~6.6 years**

Model B Results

Table 10: Model B Savings Assumptions for VFD Installations

Operating Details	Pump A	Pump B	Pump C	Pump D	Pump E	Pump F	Total
Horsepower	50	40	25	15	10	7.5	147.5
Operating Hours	2500	3000	2500	3000	2500	3200	16700
KW per hp	0.746	0.746	0.746	0.746	0.746	0.746	
KW conversion	37.3	29.84	18.65	11.19	7.46	5.595	
Annual kwh Usage	93,250	89,520	46,625	33,570	18,650	17,904	299,519
VFD Savings Rate	30%	30%	30%	30%	30%	30%	
VFD Savings (kWh)	27,975	26,856	13,988	10,071	5,595	5,371	89,856
Annual Savings ($0.09/kWh)	$2,518	$2,686	$1,399	$1,007	$560	$537	$8,706
Cost with Installation	$12,000	$10,000	$9,000	$7,500	$6,500	$4,500	$49,500
ETO Incentive	$4,000	$3,200	$2,000	$1,200	$800	$600	$11,800
BETC Incentive	$4,200	$3,500	$3,150	$2,625	$2,275	$1,575	$17,325
Total Cost after Incentives	$3,800	$3,300	$3,850	$3,675	$3,425	$2,325	$20,375
Payback	**~ 1.5 years**	**~ 1.2 years**	**~2.8 years**	**~3.7 years**	**~ 6.2 years**	**~4.3 years**	**~2.3 years**

3. Irrigation Efficiency Measures

Schedule Irrigation

Irrigation scheduling is a relatively low-cost measure that, as a rule of thumb, can reduce water consumption by 30 percent. Importantly, reducing water consumption leads to a reduction in the energy used to pump from ponds and wells as well as energy required to pump water for recycling and treatment.

Install Drip Irrigation System

Conversion to drip irrigation will drastically reduce the amount of water required for crops. However, the upfront capital cost of drip irrigation systems is significant and other benefits aside from reduced energy and water consumption, such as labor savings and the ability to use fertigation, need to be assessed.

Model Results

Model scenarios for this measure are complex, due to the numerous variables involved with irrigation system design and efficiency. We are in the process of building the models for this measure, and will include the results in a later version of this document. For additional information regarding these measures, including the calculations that can be used to derive system efficiencies, please see "Irrigation Efficiency for Containerized Crops in the Willamette Valley," at www.climatefriendlynurseries.org.

4. Heating, Ventilation, and Air Condition (HVAC): Boiler Maintenance

Tune Boiler

The first recommended measure with potential for significant energy savings and fast payback is to have the boiler tuned so that an appropriate mix of fuel and oxygen are in the system, which reduces the amount of oxygen required for combustion to a safe and practical level. Most systems are set for too much oxygen to be in the system, because the consequences from too little oxygen can be quite serious. However, if a professional hypothetically deems that the system should be operating at a level of 4 percent surplus oxygen, rather than the current 7 percent, then a boiler tune is a cost-effective path to energy savings. Importantly, each 1 percent of unnecessary oxygen in a system can lead to a 2.5 percent reduction in efficiency (leading to a 2.5 percent increase in fuel input and cost). If a boiler tune eliminates 3 percent surplus oxygen, therefore, you could conceivably see a reduction of 7.5 percent in fuel costs.

Clean Boiler System

Proper maintenance of a boiler should include routine cleaning of both the fire and water side of the system. Each millimeter of fouling or scale can lead to a 2 percent reduction in system efficiency.

Model A Results

Table 11: Model A Savings Assumptions from Boiler Maintenance Measures

Measure	Preexisting Condition	Action Taken	End Result	$ Savings	Implementation Cost	Payback
Boiler Tune	Set point at 7% oxygen	Reduce set point to 4% oxygen	Efficiency of overall system is improved by 7.5%	$216	$400	~ 1.9 years
Cleaning	Over 1 mm of fouling	Clean fire and water sides	Remove 1 mm of fouling, increase system efficiency by 2%	$58	$200	~3.5 years
TOTAL				**$274**	**$600**	**~ 2.2 years**

Model B Results

Table 12: Model B Savings Assumptions from Boiler Maintenance Measures

Measure	Preexisting Condition	Action Taken	End Result	$ Savings	Implementation Cost	Payback
Boiler Tune	Set point at 7% oxygen	Reduce set point to 4% oxygen	Efficiency of overall system is improved by 7.5%	$2,276	$1,200	~6 months
Cleaning	Over 1 mm of fouling	Clean fire and water sides	Remove 1 mm of fouling, increase system efficiency by 2%	$607	$800	~1.4 years
TOTAL				**$2,883**	**$2,000**	**~8 months**

5. Greenhouse Insulation

Install Thermal Blankets

Thermal blankets are the most comprehensive solution for preventing heat loss. Savings from thermal blankets range from 20 percent to 50 percent. The typical cost for thermal blankets is approximately $1.00 to $2.50 per square foot.

Insulate Greenhouse Sidewalls and Unused Ends

Insulation with a high R-value should be used to insulate greenhouse sidewalls (typically 3 feet in height). In addition, there may be additional opportunities to insulate greenhouse ends and reduce energy costs if they are unused.

Model A Results

Table 13: Model A Savings Assumptions from Greenhouse Insulation Measures

Operating Details	Install Shade Curtain	Insulate Unused End of Greenhouse	Total
Sq Ft per Greenhouse	3,000	3,000	
Number of Greenhouses	1	1	
Sq Ft per Measure, per Greenhouse	3,000	750	
Total Applicable Sq Ft	2,250	750	
Cost of Measure per Sq Ft	2.0	1.5	
Preliminary Cost	$4,500	$1,125	$5,625
Annual Heating Cost per Greenhouse	$1,200	$1,200	
Total Heating Cost	$1,200	$1,200	
Savings (%)	35%	15%	
Savings ($)	$420	$180	$600
BETC Incentive	$1,575	$394	$1,969
Total Actual Cost	$2,925	$731	$3,656
Payback	**~ 7 years**	**~4 years**	**~ 6 years**

Model B Results

Table 14: Model B Savings Assumptions from Greenhouse Insulation Measures

Operating Details	Install Shade Curtain	Insulate Unused End of Greenhouse	Total
Sq Ft per Greenhouse	3,000	3,000	
Number of Greenhouses	18	12	
Sq Ft per Measure, per Greenhouse	2,250	750	
Total Applicable Sq Ft	40,500	9,000	
Cost of Measure per Sq Ft	2.0	1.5	
Preliminary Cost	$81,000	$13,500	$94,500
Annual Heating Cost per Greenhouse	$1,350	$1,350	
Total Heating Cost	$24,300	$16,200	
Savings (%)	35%	15%	
Savings ($)	$8,505	$2,430	$10,935
BETC Incentive	$28,350	$4,725	$33,075
Total Actual Cost	$52,650	$8,775	$61,425
Payback	**~6.2 years**	**~3.6 years**	**~5.6 years**

6. Reuse and Recycling of All Wastes

Install an Onsite Container Cleaning Center

An on-site cleaning center allows for the reuse for the majority of nursery containers in such a way that simultaneously reduces labor costs. While the upfront capital investment required can be significant, the payback can be relatively quick (~1 year) depending upon your baseline consumption and turnover of containers. The combination of reduced cost for new containers, reduced container waste disposal fees, and reduced labor costs associated with weeding is a cost-effective sustainability trifecta!

Model A Results

Table 15: Model A Savings Assumptions from Container Cleaning Station

Measure	Cost of Purchased Containers	Cost of Disposal	Total Cost- Business As Usual	Implementation Cost	Payback
Business As Usual	$1,200	$800	$1,500		
Create cleaning center for the reuse of containers				$6,000	~ 4 years

Model B Results

Table 16: Model B Savings Assumptions from Container Cleaning Station

Measure	Cost of Purchased Containers	Cost of Disposal	Total Cost- Business As Usual	Implementation Cost	Payback
Business As Usual	$2,500	$1,500	$4,000		
Create cleaning center for the reuse of containers				$8,000	~2 years

Comparison Tables f or All Best Management Practices

It is important to remember that cost savings and payback periods will vary for each nursery. These model nursery scenarios are meant to give you a sense of possible savings, but please remember that each nursery must carefully examine its own costs and potential savings from a best management practice before deciding whether to proceed.

Lighting Retrofit and Occupancy Sensor Installation		
	40 Acre Nursery	400 Acre Nursery
Cost (After Incentives)	$1,000	$4,900
Savings	$520	$3,800
Payback	**~1.9 years**	**~1.3 years**

VFD Irrigation Pump Installations		
	40 Acre Nursery	400 Acre Nursery
Cost (After Incentives)	$5,000	$20,500
Savings	$750	$8,700
Payback	**~6.6 years**	**~2.3 years**

Boiler Maintenance		
	40 Acre Nursery	400 Acre Nursery
Cost (After Incentives)	$600	$2,000
Savings	$275	$2,900
Payback	**~2.2 years**	**~ 8 months**

Greenhouse Insulation		
	40 Acre Nursery	400 Acre Nursery
Cost (After Incentives for implementing thermal curtains and insulation)	$3,600	$61,425
Savings	$600	$10,800
Payback	**~6 years**	**~ 5.7 years**

Container Cleaning Set Up		
	40 Acre Nursery	400 Acre Nursery
Cost	$6,000	$8,000
Savings	$1,000	$6,000
Payback	**~ 4 years**	**~ 2 years**