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U.S. Endowment for Forestry & Communities, Inc.

Oregon Army National Guard: Biomass Energy Case Study

Grant 2012-002: Next Steps in Scaling-up Woody Biomass Energy: Learning & Priorities

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Introduction
This case study highlights seven Oregon Army National Guard biomass energy projects that are in the process of being designed and installed. These projects provide valuable lessons learned and best practices related to project aggregation from a design-to-implementation perspective. This case study describes the benefits (economies of scale, efficiencies, etc.) and drawbacks of carrying out multiple geographically clustered biomass projects under the same financial bundle. It highlights factors associated with successful biomass energy projects as well as best practices that can be translated into applications in other locations.

The Oregon National Guard Biomass Project
The Oregon Army National Guard (ORARNG) is designing seven wood pellet biomass energy systems that will be installed and operational by 2013 at seven National Guard facilities located across central Oregon. The National Guard's project illustrates a large-scale, aggregated approach to biomass conversion as all seven systems are being installed concurrently.

Craig Volz, Resource Efficiency Manager of Tetra Tech, is facilitating the development of the current phase of the ORARNG's biomass energy project. Volz believes the project is a good opportunity for both the National Guard and Forest Service to achieve multiple goals. "There is a nexus between forest health, biomass fuel sources, and also local economics and job creation through having a locally provided fuel source," he said. Converting to biomass presents an opportunity to create a synergy between the National Guard's objectives related to energy security, renewable energy, energy efficiency, and fuel cost savings and the Forest Service's goals in regard to forest health, hazardous fuels reduction, and local economic development. Additionally, as a renewable and locally available fuel source, biomass helps the ORARNG improve its energy security.

The following seven National Guard buildings are involved in this initiative:

- Youth Challenge Facility
- Central Oregon Unit Training and Equipment Site
- Biak Training Center
- Burns Armory
- Umatilla Training Center, Building #30, Simulation Center
- Umatilla Training Center, Building #36, Dining Hall
- Umatilla Training Center, Building #53, Barracks

Pellet Systems and Fuel

Table 1. Estimated Equipment Specifications for the ORARNG Biomass Systems

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
Manufacturer (basis of design)	Köb	Köb	Köb	Köb	Köb	Köb	Köb
Model	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot
Output kW	540	300	220	220	300	540	220
Output MMBtu/hr	1.84	1.02	0.75	0.75	1.02	1.84	0.75
Efficiency LHV	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%
Efficiency HHV	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%
Components	Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning
Biomass Percent of Building Heating & DHW	100%	100%	100%	100%	100%	100%	100%
Backup Unit	Propane	Propane	Propane	Propane	Propane	Propane	Propane

To determine where the biggest energy cost savings could be achieved, Tetra Tech examined the National Guard's sites scattered throughout the state. Biomass fuel turned out to be the most cost effective energy solution for seven of the ORARNG's buildings because they are all dependent on costly propane (with costs at the time of this study at about $20.00/MMBtu) and do not have access to natural gas. Additionally, biomass helps meet the ORARNG's Net Zero Energy Goal renewable energy requirement. The Guard was selected as one of eight US Army Pilot Net Zero Energy Installations given the charge to reduce their energy use by sixty-five percent from a 2003 baseline and achieve the remaining thirty-five percent offset by using renewables.

The existing propane systems in the seven buildings will be replaced with pellet boilers, with a goal of providing one hundred percent of the heat load for the facilities. Tetra Tech outlined a number of reasons why going with pellet systems is the best strategy. The National Guard needs a very automated and reliable system because it operates and maintains a large number of facilities across Oregon and because the state budget and the Guard's maintenance staff are spread thin. Consequently, it would not be economical to install wood chip systems at the seven National Guard facilities because of the small scale of the conversions and because wood chip systems are much more hands-on from an operations standpoint (more material handling and higher operation and maintenance costs) than pellet systems.

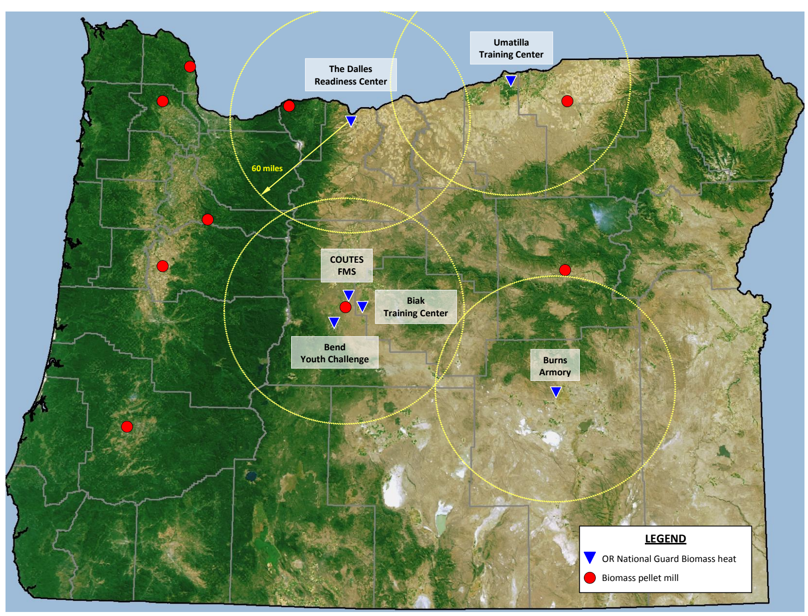

Figure 1. Map of Oregon National Guard Biomass Facilities and Pellet Mills (Tetra Tech)

While there are a number of local biomass boiler manufacturers based in Oregon, the Guard is looking at a Kob/Viessmann unit that is manufactured in Europe as an initial design. Tetra Tech believes that there are a number of advantages in using imported European biomass boilers versus relying on biomass boilers that are currently manufactured in the U.S. The Kob/ Viessmann unit they are considering is very automated in terms of ash extraction and tube cleaning, representing a clear advantage from an operational and maintenance standpoint (key advantages in terms of the ORARNG's needs). "The Europeans have been designing and manufacturing biomass systems for decades and you can really see it," said Volz. "In the U.S., manufacturers are smaller . . . and they are more fabricators. While their systems can be robust and heavy duty, they just aren't as sophisticated."

Tetra Tech also recommends consideration of a containerized design (where the boiler is housed in a shipping container outside of the facility rather than stored in a boiler room), which could be beneficial in certain installations. Some of the National Guard's buildings do not have a lot of extra indoor space, and a containerized design would also allow them to easily renovate buildings and relocate the boilers where needed.

Table 2. Estimated Fuel Specifications

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
Composition	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets
Source	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction
Supply Radius	154	135	129	73	155	155	155
Delivery Frequency Per Year	4	2	0	1	2	4	0
Quantity Delivered (tons)	28	28	28	28	28	28	28
Cost Per Ton (BDT) Delivered	$ 160	$ 160	$ 160	$ 160	$ 160	$ 160	$ 160
Moisture Content	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%
Fuel Storage Capacity (tons)	50	50	35	35	50	50	35
Annual Consumption (tons)	90	38	24	25	43	85	20
Annual Biomass Fuel Cost	$ 14,400	$ 6,080	$ 3,840	$ 4,000	$ 6,880	$ 13,600	$ 3,200

There are six or seven local pellet fuel manufacturers and distributors clustered in a relatively tight geographical area near the ORARNG sites. To insulate against supply interruptions, the ORARNG intends to maintain two sources of pellet fuel. This diverse fuel supply should help the Guard meet its objective in achieving greater energy security versus remaining dependent on imported propane. "Because woody biomass is plentiful throughout the state, pellets are a good strategy to replace our fossil fuel thermal loads with a renewable source," Volz said.

The Guard expects to pay around $160.00 per ton of pellets, and in total the facilities will consume about 325 tons of pellets annually, representing an annual biomass fuel cost of approximately $52,000 between all of the facilities.

Project Economics

Table 3. Estimated Project Economics[1]

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
PROJECT FUNDING							
2012 Hazardous Fuels Woody Biomass Utilization Grant (design)	$ 71,863	$ 36,419	$ 33,014	$ 30,097	$ 25,118	$ 30,810	$ 22,679
State Funds	$ 99,369	$ 13,641	$ 12,366	$ 100,456	$ 9,408	$ 11,540	$ 8,494
Federal Funds	$ 298,106	$ 275,466	$ 207,253	$ 100,456	$ 265,607	$ 374,907	$ 144,515
OR Dept Energy Commercial Thermal Incentive	$ 281,293	$ 188,124	$ 148,467	$ 135,711	$ 169,727	$ 235,962	$ 99,352
Total project funding	**$ 750,630**	**$ 513,650**	**$ 401,100**	**$ 366,720**	**$ 469,860**	**$ 653,220**	**$ 275,040**
PROJECT COSTS							
Construction Cost	$ 655,000	$ 448,211	$ 350,000	$ 320,000	$ 410,000	$ 570,000	$ 240,000
SIOH	$ 19,650	$ 13,446	$ 10,500	$ 9,600	$ 12,300	$ 17,100	$ 7,200
Contingencies	$ 32,750	$ 22,411	$ 17,500	$ 16,000	$ 20,500	$ 28,500	$ 12,000
Design	$ 39,300	$ 26,893	$ 21,000	$ 19,200	$ 24,600	$ 34,200	$ 14,400
Commissioning	$ 3,930	$ 2,689	$ 2,100	$ 1,920	$ 2,460	$ 3,420	$ 1,440
Public Utility Company Rebate	($ 463,646)	($ 225,799)	($ 218,314)	($ 204,143)	($ 198,038)	($ 273,518)	($ 123,470)
Total Investment	**$ 286,984**	**$ 287,851**	**$ 182,786**	**$ 162,577**	**$ 271,822**	**$ 379,702**	**$ 151,570**
PROJECT ECONOMICS							
Fuel Replaced by Biomass	Propane	Propane	Propane	Propane	Propane	Propane	Propane
Annual Heating Cost Savings	$ 35,231	$ 16,008	$ 9,995	$ 9,763	$ 18,683	$ 37,343	$ 8,786
Annual O&M Savings	$ 2,782	$ 1,565	$ 1,159	$ 1,159	$ 1,565	$ 2,782	$ 1,159
Savings to Investment Ratio	2.19	1.00	1.00	1.11	1.24	1.75	1.07
Annualized Rate of Return (10yr)	10.4%	5.9%	5.8%	6.2%	6.9%	8.9%	6.0%
Internal Rate of Return (25yr)	18.2%	9.0%	8.9%	9.8%	11.0%	15.1%	9.4%
Simple Payback (years)	**8.1**	**18.0**	**18.3**	**16.7**	**14.5**	**10.2**	**17.3**

To finance the design phase of the seven biomass sites, the ORARNG received a $250,000 Woody Biomass Utilization Grant (WBUG) from the USDA Forest Service, which covers seventy-three percent of the design phase cost for the project. The state is covering the remaining twenty-seven percent ($83,000) of the design cost. The total investment for the project as a whole (including design, construction, SIOH, contingencies, and commissioning) will be around $3,430,220. Overall, the average simple payback for the entire project is equal to 14.7 years. Table 3 highlights additional current project funding and cost estimates for each of the seven ORARNG facilities along with a couple financial analysis figures.

Presently, all of the selected ORARNG sites are dependent on propane for heating, which provided the main financial incentive for converting to pellet boilers. The Guard pays around $20.00 per MMBtu for propane whereas wood pellets should be less than half the cost (roughly $9.30 per MMBtu). Switching from propane to pellet fuel is expected to save the Oregon Army National Guard an average of $19,401 per year (per facility) in heating costs and on average $1,739 annually (per facility) in maintenance costs.

There are various methods that can be employed to analyze a project's financial viability. One financial analysis tool is the annualized rate of return (ARR). The purpose of the ARR is to

[1] The simple payback figures included in Table 1 are calculated using the total project investment divided by annual heating cost savings. These payback estimates are greater than the ones included in the more detailed financial analysis section in Appendices A-J, which are based on a different calculation (total investment/first year dollar savings). Please see Appendices A-J for a more detailed financial analysis of each facility.

identify the potential rate at which an investment will increase (or decrease) each year. Calculating a ten year ARR is valuable for investors because this timeframe best reflects their shorter term focus. The ARR is calculated using a project's return on investment (ROI), which acts as a multiplier at which an investment is estimated to grow over a set time period.[2]

Another useful financial analysis calculation is the internal rate of return (IRR). The IRR estimates a facility's expected return from an investment over time (a measurement of the efficiency of the investment). The IRR is useful for facility owners and calculating it over a twenty-five year time period coincides with the typical projected life of a wood-energy system (twenty-five to thirty years). It is calculated as comparison of fuel savings for term to total project investment.[3]

A basic financial analysis of the National Guard's biomass project shows that the project's average ten year annualized rate of return (ARR) equals 7.2% and its average twenty-five year internal rate of return (IRR) is equal to 11.6%. These figures help indicate that the National Guard's project is financially favorable (current markets look for a range between five to ten percent ARR figures).

The Youth Challenge Program Facility (YCF) is especially financially favorable with a ten year ARR of 10.4%, a twenty-five year IRR of 18.2%, a savings to investment ratio of 2.19, and an expected payback of 8.1 years. In comparison to the rest of the ORARNG sites, the least financially attractive facility appears to be the Biak Training Center with a ten year ARR of 5.8%, a twenty-five year IRR of 8.9%, a savings to investment ratio of one, and a payback period of 18.3 years. In this analysis, inflation rates of 1.5% for wood and 5.6% for propane were used.[4]

Overall, these calculations indicate that the National Guard's project as a whole is favorable from a financial investment perspective. All of the facilities have a calculated ARR greater than five percent, and current markets are looking for an ARR between five to ten percent. Additionally, the project's IRR indicates positive growth across all seven facilities. Please see Appendices A-J for a more detailed financial analysis of each facility.

According to Tetra Tech, a basic take away lesson comparing the financial viability of the seven ORARNG facilities is the greater their annual energy expenses, the greater the economic benefit because of the relatively high fixed costs for the biomass boiler installations. As required boiler sizes increase, incremental project costs are reduced as project costs increase at a slower rate compared to fuel cost savings. Therefore, the return on investment for the ORARNG's project is primarily driven by the annual heating cost. The greater a facility's energy requirements and change in cost of using biomass versus an alternative fuel, the greater the potential savings will

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[2] ARR Formula: $((1+ROI)^{1/N})-1$

N = # of years   ROI = Return on investment = B – C/P

B – C = Cumulative fuel cost savings added up over a set period of time   P = Total project investment.

[3] IRR Formula: $PNW = 0 = F_a/(1 + R)^a$

PNW = Present Net Worth = 0   F = Income Each Year = Fuel Savings Each Year   a = Year   R = Rate of Return

[4] U.S. Energy Information Administration for all inflation estimates except wood. Wood inflation estimate was provided by local expert Andrew Haden (www.Wisewood.US)

be—compared to the effect of capital construction costs, which are only marginally greater between each of the sites.

Incentives can also significantly affect a project's payback. For example, comparing the Burns Armory's project to YCF's, the armory has a much lower annual heating expense versus YCF. Additionally, the armory's total project cost is close to half of YCF's cost. Nevertheless, because Oregon biomass incentives are calculated as a percentage of project costs, YCF's payback period is reduced significantly more than the armory's. Consequently, projects with a higher total cost like YCF can receive a greater incentive benefit, and combined with greater annual heating cost savings, this can lead to significantly reduced payback periods.

Facility Background

Table 4. General Information for the ORARNG Converted Facilities

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
Building Area (ft^2)	71,439	10,464	20,560	12,426	15,787	6,920	72,114
Year Built	1984	1989	1984	1954	1942	1943	1942
Project Type	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit

Following are brief descriptions of each of the facilities to be served by biomass heating systems:

Youth Challenge Program Facility

Located in Bend, Oregon, the Youth Challenge Program Facility was built in the early '80s. Originally a night vision testing facility, the building has been repurposed and now acts as an academy for at-risk youth. The building operates continuously for ten months during the academic year and it has very high use from a heating and domestic hot water standpoint. Because of these characteristics, the economics (the ARR, IRR, savings to investment ratio, and payback period) of converting this facility are especially favorable compared to some of their other smaller National Guard facilities without year-round heating demand.

Figure 2. Youth Challenge Program Facility

Central Oregon Unit Training and Equipment Site

Located in Redmond, Oregon, the Central Oregon Unit Training and Equipment Site (COUTES) is a 10,000 square foot metal building that houses a high bay maintenance shop where the ORARNG does military vehicle maintenance along with having some office space. Volz said they are looking into putting in some ceiling radiant panels in the high bay area along with the biomass boiler. He explained that three of the ORARNG sites (the Youth Challenge Facility, Biak Training Center, and Burns Armory) already have hot water boilers installed, which are pretty simple to change out. However, the COUTES site has direct-fired radiant heating and it does not have an existing hydronic boiler system, making things a little more complicated.

Biak Training Center

Nearby the COUTES site and located in Powell Butte is the Biak Training Center. The center supports a wide variety of military branches in addition to other emergency response agencies. The army carries out training exercises on the 22,255 acres of federal land located nearby. The pellet system will heat a simulation center, classroom, and an administrative building, totaling a little over 20,000 square feet for the three facilities.

Burns Armory

The Burns Armory is a typical older armory. It is a 12,000 square foot facility that was built around 1954.

Figure 4. Biak Training Center

Figure 3. Burns Armory

Umatilla Training Center Facilities (Buildings #30, #36, and #53)

There are three different facilities (referred to as Buildings #30, #36, and #53) located at the Umatilla Training Center in Hermiston, Oregon that will be converted to biomass heating systems. Building #30 is a 15,000 square foot metal building that serves as a simulation center for training exercises. The building has a steam boiler that will be converted along with hot water piping. Building #36 is a 7,000 square foot dining hall. Another building, next to the dining hall, Building #53 is a barracks that does not have continuous occupancy but does include an existing steam system.

The Oregon Department of Energy recently awarded a Wood Energy Cluster grant to ORARNG to conduct a biomass district heating feasibility study at the Umatilla Training Center.[5] Volz explained that Tetra Tech will perform the feasibility study to determine whether installing a biomass district heating network would make more sense from an economic and efficiency standpoint versus replacing individual boilers on a building-by-building basis. Since many of the buildings at the Umatilla Training Center are in close proximity to one another, it could be advantageous to install one or more central heating plants that would serve clusters of buildings.

The Training Center's current building stock, heating systems, and steam piping infrastructure are growing old and will need replacing. In the long-term, there are plans to completely replace buildings constructed during the '40s, and there are near-term plans to renovate and upgrade other existing buildings. Taken together, these development plans provide a good opportunity to examine the feasibility of constructing a biomass district heating system at the site.

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[5] For more information about the grant, please see http://www.oregon.gov/energy/RENEW/Biomass/Pages/Wood-Energy-Cluster-Pilot-Project.aspx

Currently, under the Base Realignment and Closure process, the Umatilla site is transferring from the U.S. Army to ORARNG occupancy. The ultimate heating configuration of the site will be determined over the next five to ten years, so Tetra Tech will be proposing "strategies that are flexible, and scalable—allowing us to use a modular approach so we can supply short term needs and expand the system as the site is redeveloped."

Figure 5. Umatilla Building #30 Simulation Center

Figure 6. Umatilla Site Aerial View

Figure 7. Umatilla Buildings #36 Dining Hall and #53 Barracks

Readiness Center

The National Guard also evaluated another potential project outside of the WBUG grant at the Readiness Center, a new 60,000 square foot LEED certified building. The goal is for this Center is to be the first completely net zero facility within the ORARNG. The Center is located in The Dalles, Oregon in the northern part of the state along the scenic Columbia Gorge. The facility has a drill hall, assembly area, and administrative offices.

The ORARNG will use a wide variety of technologies to make the building as energy efficient as possible. In contrast to the other seven WBUG facilities, a ground-source heat pump will act as the primary heating source for the Readiness Center. The ground-source heat pump will provide about ninety percent of the site's heat load, along with a condensing high efficiency natural gas boiler for supplemental heating. A dual-fuel biomass pellet boiler was proposed to meet the remaining ten percent of heating demand, but this option was not selected due to project funding constraints. The ground-source heat pump could be augmented with biomass heating, so that all of the thermal loads will be covered one hundred percent using renewables. They are also planning to install a solar PV system to offset the building's electrical usage.

Building Envelope Upgrades

In conjunction with converting existing buildings to biomass systems, the ORARNG is considering some building envelope upgrades. As mentioned earlier, the Guard was selected as one of eight US Army Pilot Net Zero Energy Installations charged with reducing energy use by sixty-five percent from a 2003 baseline and to achieve the remaining thirty-five percent offset by using renewables. The building envelope upgrades will not only help them achieve their goals in terms of utilizing renewable biomass energy, but will also help with energy efficiency improvements. It is fortuitous that the timing of these energy efficiency upgrades coincides with the HVAC conversions. The Guard could potentially gain additional cost reductions by minimizing the design size of their pellet boilers, which could then help offset the cost of the building envelope upgrades. Biomass also helps meet the Net Zero Energy Goal's renewable energy requirement.

Tetra Tech believes that the drive for renewable energy adoption in support of the Net Zero Energy Goal creates a premium incentive over natural gas, making it more feasible to replace aging gas boilers with biomass systems. Currently, a key barrier to wider biomass adoption is cheaper natural gas. Power is generally inexpensive in the Northwest—especially if there is access to natural gas—but Volz thinks that natural gas prices may rapidly accelerate if liquid natural gas is exported to other countries—much faster price increases than biomass—which will make biomass look more advantageous as time goes on.

Project Aggregation and Clustered Facility Efficiencies

The Oregon Army National Guard's seven projects provide valuable lessons from a design-to-implementation perspective related to project aggregation (multiple biomass projects under the same financial bundle) and in terms of the efficiencies that can be achieved through geographically clustered facilities.

According to Tetra Tech, there are many more advantages than disadvantages being part of a larger scale aggregated effort to convert to biomass. For example, carrying out multiple projects simultaneously allows the ORARNG to achieve many *economies of scale* from a design perspective such as the ability to standardize design between many facilities. Given the large number of National Guard buildings, standardization is also important from a maintenance and performance perspective (which are key in terms of meeting the Guard's needs). Additional economies of scale result because the projects are clustered in a compact geographical range. Because the sites are in close proximity to one another, the Guard should be able to obtain a *multi-year contract for fuel pricing*, allowing them to save on fuel costs.

However, there are also a number of potential disadvantages that should be noted with being part of a large-scale, aggregated biomass project. For instance, a higher level of effort is required to develop and implement all of the details and logistics for a project cluster versus a single project. Furthermore, converting seven buildings at once means there is more risk if things are not done correctly the first time. "It is not a rearview mirror look where we've actually designed and built these systems . . . .So, we don't have all of the [hands on] experience, and some of this will be based on estimates," Volz explained. Ideally, there would be a pilot project before implementing a large number of projects, and the pilot would provide a year's worth of experience and lessons learned that could then be applied to a larger number of buildings.

Volz noted that there are existing biomass project installations in their general geographical area and believes that there are *opportunities for collaboration* that would benefit all groups. As Volz points out, there are around twelve to fifteen biomass boiler installations in public buildings nearby (such as the cluster in John Day, Oregon, which is 70-120 miles away from the various ORARNG sites). They are considering collaboration with these sites through things like *cooperative fuel purchasing agreements*:

> "There is a regional airport and a U.S. Forest Service airbase that is close to this area and they have to buy fuel and there are also schools and hospitals in the area that also have to purchase fuel. [Cooperative fuel purchasing agreements] are something that weren't necessarily on our horizon, we probably would have just done a contract on our own, but it's an interesting concept to achieve some economies of scale that would benefit both the state and other public hospitals and schools."

Tetra Tech believes that Malheur Lumber located in John Day, Oregon is a solid option as a fuel supplier for some of their facilities. A lot of Malheur Lumber's fuel supply comes from National Forest land, which matches the restoration goals of the Forest Service included in the WBUG grant.

Quantified Aggregation Benefits[6]

Table 5. Fort Oregon Bundled Project Cost Estimates

EEM	SITE | BUILDING	AREA (ft^2)	DESCRIPTION	TOTAL COST
RE-1	COUTES FMS	10,464	Biomass radiant heating system	$ 513,650
RE-2	Biak Brett Hall	20,560	Biomass heating system	$ 401,100
RE-3	Umatilla Simulation Center	15,787	Biomass heating system	$ 469,860
RE-4	Umatilla Dining Hall	6,920	Biomass heating system	$ 653,220
RE-5	Umatilla Billeting	72,114	Biomass heating system	$ 275,040
RE-6	Bend YCF	71,439	Biomass radiant heating system	$ 750,630
RE-7	Burns Armory	17,180	Biomass heating system	$ 366,720
	TOTAL	**214,464**		**$ 3,430,220**

[6] Note: The data analysis in the "Quantified Aggregation Benefits" and "Biomass Energy Co-Benefits" sections was provided by Tetra Tech.

As it turns out, there are also quantifiable benefits from using a project bundling approach versus individual boiler installations. After running the numbers, Tetra Tech estimates that bundling all seven individual biomass pellet boilers into a single design-build procurement package should lead to a cost savings between five to ten percent versus individual procurements using a traditional design-bid-build approach. This represents an estimated savings in the range of $180,000 to $300,000 for the $3,430,220 project. This net overall savings includes volume discounts for major equipment, materials, and labor. The volume discount on major equipment will be a greater percentage (twelve to eighteen percent), but the installation labor accounts for more than half of the overall project cost because there is no corresponding discount on labor.

There could also be significant savings by going with a district heating system at the Umatilla Training Center versus relying on individual boiler installations:

- **34% Capital Expenditure Savings = $990,295**
  - $2,950,395 (eight individual building boilers & fuel silos)
  - $1,960,000 (one district central plant & fuel storage + piping network)
- **63% Operational Expenditure Fuel Savings = $70,000 per year**
  - 700 tons/year biomass pellets at $160 per ton = $112,000 per year
  - 700 tons/year biomass wood chips at $60 per ton = $42,000 per year

Biomass Energy Co-Benefits

According to Tetra Tech, beyond just providing heating cost savings to the Guard, there are additional co-benefits of using biomass systems that the ORARNG's project should provide. Some of these co-benefits are summarized below:

- *Wildfire Cost Reductions:* The average annual U.S. Forest Service fire suppression expenditures nationwide have exceeded $1,000,000,000 per year since 2000. Eighty-five percent of Oregon's large fire costs occur in the east-side region where ORARNG's proposed biomass cluster is located. For FY2002-FY2011 Oregon Department of Forestry spent over $197,000,000 on fire suppression with over $70,000,000 spent in the Central Oregon and Northeast Oregon districts where the ORARNG biomass cluster is located.[7]
- *Energy Security:* On-site biomass fuel storage provides a minimum six-month fuel supply. Existing propane storage tanks currently provide only two weeks to a month of reserve fuel supply.
- *Job Creation:* Individual biomass boiler installations create short-term constructions jobs, long-term service/maintenance jobs, and jobs in the forest products sector for woody biomass harvesting, fuel processing, and delivery. The proposed Fort Oregon Biomass cluster projects are expected to create approximately eighty-nine short-term construction jobs and sustain two long-term forest products jobs.
- *Economic development:* Rural Oregon unemployment in Crook (13.3 percent), Deschutes (10.5 percent), Harney (11.6 percent), and Umatilla (8.0 percent) counties is substantially higher than the state-wide (8.4 percent) and national rates (7.8 percent)[8]. Employment in the forest products industry in Oregon has been in decline for decades. The opportunity to create a local sustainable woody biomass based fuel industry offers a chance to reverse this negative trend. The ORARNG is exploring opportunities at the Umatilla Training

[7] Sources: http://www.oregon.gov/odf/fire/fpfc/cliffpres.pdf; http://www.oregon.gov/odf/fire/fpfc/dfc.pdf
[8] Unemployment rates as of 12/01/12

Center to work with the Oregon Department of Forestry (ODF), local county development agencies, the Confederated Tribe of the Umatilla Indian Reservation, and forest resource companies to develop a woody biomass fuel infrastructure to supply military, industrial, and community energy needs.

Lessons Learned

Based on the National Guard's experience, Tetra Tech emphasized that there are a number of key factors that facilities should pay attention to when considering converting to a biomass system:

1. *A fuel supply that is both economical and sustainable is of critical importance.* "You can have a perfect system but without an economic or reliable fuel supply, you can be very disappointed," Volz noted.
2. *The type and economics of biomass fuel and the operations and maintenance required.* Both pellets and chips were evaluated for the ORARNG sites. Volz explained that storage, material handling, and operation and maintenance requirements become more onerous with woodchips. Because most the ORARNG's sites are smaller and geographically distributed, the economics for woodchips did not look as favorable compared to pellets.
3. *The equipment selection.* There are a lot of biomass equipment manufacturers out there, but many of them are very small outlets. "[The U.S. is] decades behind the technology in Europe. We just have small fabricating systems, so the other challenge is doing your research and finding the right technology."
4. *Equipment support availability.* "Even if you get the right technology, you need to make sure it can be supported. If you get a really sophisticated system, you need to have someone who will be able to support and maintain it."
5. *Look to others who have installed similar biomass systems.* Learning from the success and failures of others will highlight best practices that can help a project succeed as well as point out pitfalls to avoid.

Conclusion

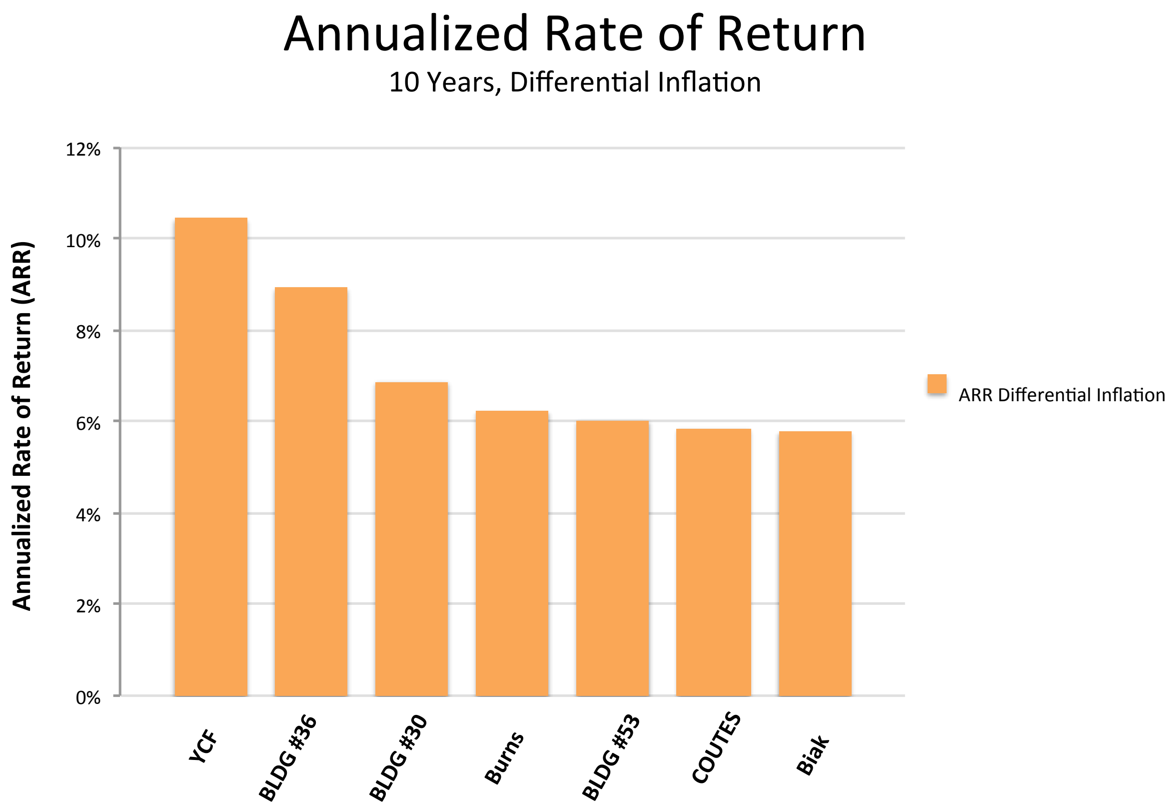
Currently, the next steps in the ORARNG's biomass project are being planned to carry the project forward from design to implementation. In 2013, pellet boiler design and construction are slated to begin at the Biak Training Center and COUTES in addition to conducting feasibility studies for installing a biomass district heating system and combined heat and power plant at the Umatilla Training Center. In 2014, pellet boiler design and construction is planned to begin at the Youth Challenge Program Facility and Burns Armory. Lastly, in 2015, assuming favorable feasibility study results, the current plan is to start Phase 1 design and construction of a biomass wood chip district heating plant at the Umatilla Training Center.

Overall, Tetra Tech believes that the ORARNG's biomass project will provide a wide range of benefits once completed. "We are excited about the biomass grant because there are benefits for the National Guard, for forest health, and for the local economy," he emphasized. However, Volz does not appear to want to stop with just these seven conversions to biomass systems. He is hopeful that the seven conversions are just the beginning of a larger plan to economically convert National Guard sites to biomass. If they can get the design funding, there are additional buildings around the state that the National Guard would like to convert to biomass. If the funding comes through, he said there are an additional five buildings that are good biomass conversion candidates that could be included as part the ORARNG project. As mentioned earlier, the ORARNG is evaluating the feasibility of developing a district-heating system at a 25,000 acre Umatilla Training Center in Umatilla, Oregon. Combined heat and power could be very advantageous because it would have favorable conditions with high demand and load. If approved, this combined heat and power plant could lead to another five buildings being hooked up to biomass at a central location as part of a 2nd phase build.

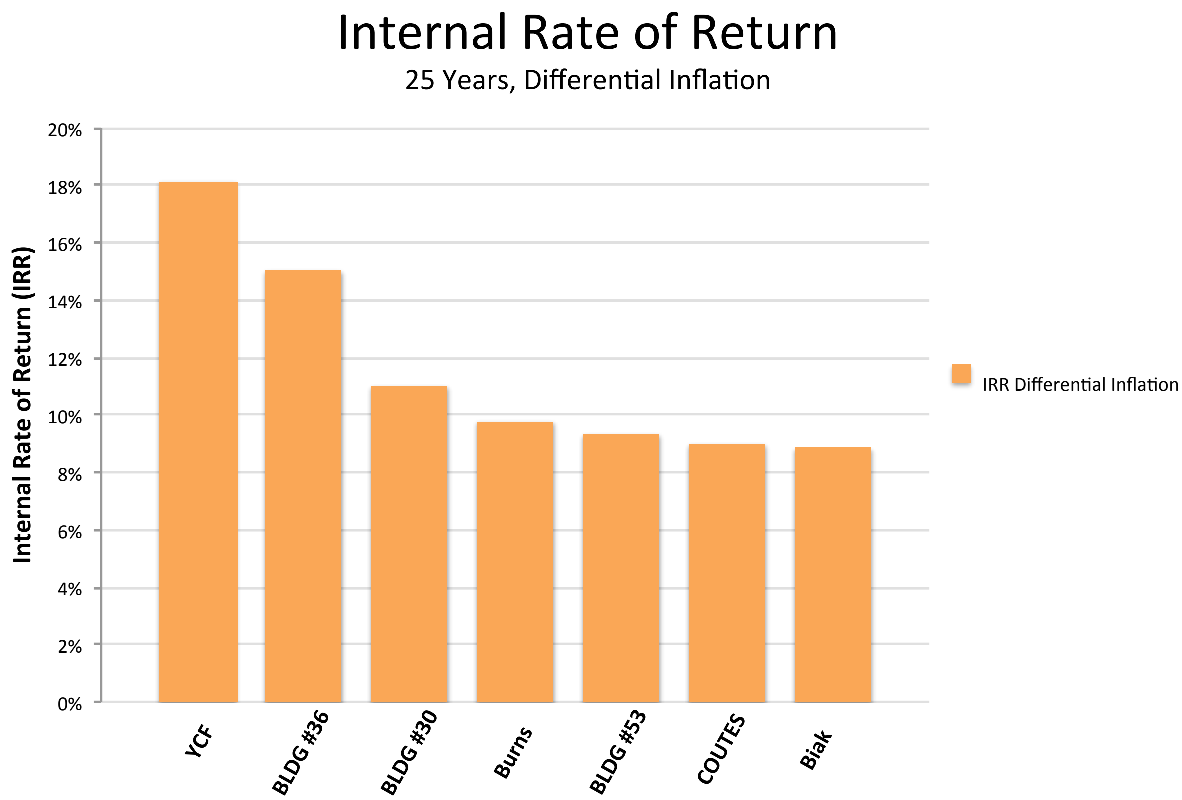
Lastly, it is worth noting that (from a policy perspective) the National Guard's biomass project highlights the uneven playing field that biomass energy faces within the policy realm. In fact, the major frustrations that Volz has experienced in working on the project are not related to the project design process, but are associated with policy incentives. More specifically, Volz, along with many others connected to the biomass industry, are frustrated that the public policies and incentives currently being used for biomass energy development are behind the curve. "There are federal and state incentive programs for renewable energy that generate power, but there's a real gap in terms of thermal energy," Volz said. He explained that they were not able to take advantage of renewable energy incentives for the ORARNG's project. There was a renewable energy grant through the Oregon Department of Energy, but the National Guard's project was ineligible because the grant was only for power production, not thermal energy. He went on to point out that the Federal Investment Tax Credit offers a payback for electricity, but again there is nothing for biomass thermal energy. There are Renewable Energy Certificates for renewable power production, but not a good, similar standard for thermal energy credits. "It would helpful if there was a more comprehensive approach on the federal and state basis to recognize the value of thermal energy," Volz said. Current policies do not recognize or match the technology, capabilities, and opportunities associated with biomass utilization—especially for biomass thermal applications.

As a footnote to this policy conundrum, The Oregon Department of Energy (ODOE) has recognized this gap and is proactively working to help level the playing field for biomass projects. ODOE has issued a new incentive for renewable thermal projects that do not generate electricity, but use renewable resources such as biomass to provide thermal energy. This new funding opportunity is first available beginning in March 2013. ORARNG's projects could be eligible for an incentive of up to thirty-five percent of the project cost under this new funding opportunity.

Appendix A: Financial Analysis Graphs



Examining the ARR graph above of the seven ORARNG facilities, YCF will likely experience the highest expected growth rate each year based on a ten year time period. YCF has the highest ten year ARR equal to 10.4% and Biak has the lowest ARR at 5.8%. The project's average ten year ARR equals 7.2%. All seven of the facilities are within the five to ten percent ARR range that investors typically look for, an indication that this project is favorable from a financial investment perspective.



Examining the IRR graph above, YCF will likely have the greatest return on investment (18.2%) over a twenty-five year time period and Biak Training Center will experience the lowest return (8.9%). The average twenty-five year IRR for the project as a whole equals 11.6%. Overall, the project as a whole appears to be financially attractive with the calculated IRRs indicating positive growth across all seven facilities.

Appendix B: Project Summary Tables[1]

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
General Information							
Building Area (ft^2)	71,439	10,464	20,560	12,426	15,787	6,920	72,114
Year Built	1984	1989	1984	1954	1942	1943	1942
Project Type	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit
Equipment Specifications							
Manufacturer (basis of design)	Köb	Köb	Köb	Köb	Köb	Köb	Köb
Model	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot	Pyrot
Output kW	540	300	220	220	300	540	220
Output MMBtu/hr	1.84	1.02	0.75	0.75	1.02	1.84	0.75
Efficiency LHV	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%	85.2%
Efficiency HHV	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%
Components	Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning	Containerized Storage tank Pellet silo Pellet Auger Boiler controls Auto ignition Ash extraction Tube cleaning
Biomass Percent of Building Heating & DHW	100%	100%	100%	100%	100%	100%	100%
Backup Unit	Propane	Propane	Propane	Propane	Propane	Propane	Propane
Fuel Specifications							
Composition	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets	Ponderosa Pine wood pellets
Source	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction	Forest Service stewardship contracts - thinning & fuels reduction
Supply Radius	154	135	129	73	155	155	155
Delivery Frequency Per Year	4	2	0	1	2	4	0
Quantity Delivered (tons)	28	28	28	28	28	28	28
Cost Per Ton (BDT) Delivered	$ 160	$ 160	$ 160	$ 160	$ 160	$ 160	$ 160
Moisture Content	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%	≤ 4%
Fuel Storage Capacity (tons)	50	50	35	35	50	50	35
Annual Consumption (tons)	90	38	24	25	43	85	20
Annual Biomass Fuel Cost	$ 14,400	$ 6,080	$ 3,840	$ 4,000	$ 6,880	$ 13,600	$ 3,200

[1] The tables on the following pages were created by Tetra Tech and summarize the details of the Oregon Army National Guard's biomass project.

LOCATION / BUILDING	Bend YOUTH CHALLENGE FACILITY	Redmond COUTES	Powell Butte BIAK TRAINING CENTER	Burns ARMORY	Umatilla BLDG # 30 SIM CENTER	Umatilla BLDG # 36 DINING HALL	Umatilla BLDG # 53 BARRACKS
PROJECT FUNDING							
2012 Hazardous Fuels Woody Biomass Utilization Grant (design)	$ 71,863	$ 36,419	$ 33,014	$ 30,097	$ 25,118	$ 30,810	$ 22,679
State Funds	$ 99,369	$ 13,641	$ 12,366	$ 100,456	$ 9,408	$ 11,540	$ 8,494
Federal Funds	$ 298,106	$ 275,466	$ 207,253	$ 100,456	$ 265,607	$ 374,907	$ 144,515
OR Dept Energy Commercial Thermal Incentive	$ 281,293	$ 188,124	$ 148,467	$ 135,711	$ 169,727	$ 235,962	$ 99,352
Total project funding	**$ 750,630**	**$ 513,650**	**$ 401,100**	**$ 366,720**	**$ 469,860**	**$ 653,220**	**$ 275,040**
PROJECT COSTS							
Construction Cost	$ 655,000	$ 448,211	$ 350,000	$ 320,000	$ 410,000	$ 570,000	$ 240,000
SIOH	$ 19,650	$ 13,446	$ 10,500	$ 9,600	$ 12,300	$ 17,100	$ 7,200
Contingencies	$ 32,750	$ 22,411	$ 17,500	$ 16,000	$ 20,500	$ 28,500	$ 12,000
Design	$ 39,300	$ 26,893	$ 21,000	$ 19,200	$ 24,600	$ 34,200	$ 14,400
Commissioning	$ 3,930	$ 2,689	$ 2,100	$ 1,920	$ 2,460	$ 3,420	$ 1,440
Public Utility Company Rebate	($ 463,646)	($ 225,799)	($ 218,314)	($ 204,143)	($ 198,038)	($ 273,518)	($ 123,470)
Total Investment	**$ 286,984**	**$ 287,851**	**$ 182,786**	**$ 162,577**	**$ 271,822**	**$ 379,702**	**$ 151,570**
PROJECT ECONOMICS							
Fuel Replaced by Biomass	Propane	Propane	Propane	Propane	Propane	Propane	Propane
Annual Heating Cost Savings	$ 35,231	$ 16,008	$ 9,995	$ 9,763	$ 18,683	$ 37,343	$ 8,786
Annual O&M Savings	$ 2,782	$ 1,565	$ 1,159	$ 1,159	$ 1,565	$ 2,782	$ 1,159
Savings to Investment Ratio	2.19	1.00	1.00	1.11	1.24	1.75	1.07
Annualized Rate of Return (10yr)	10.4%	5.9%	5.8%	6.2%	6.9%	8.9%	6.0%
Internal Rate of Return (25yr)	18.2%	9.0%	8.9%	9.8%	11.0%	15.1%	9.4%
Simple Payback (years)	**8.1**	**18.0**	**18.3**	**16.7**	**14.5**	**10.2**	**17.3**

Appendix C: Combined Projects Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION: FORT OREGON **REGION NO:** 4 **PROJECT NO.:** 411300
PROJECT TITLE: Renewable Energy - Biomass Heating Systems **FY:** 2014
ANALYSIS DATE: 11/29/12 **ECONOMIC LIFE:** 20 YEARS
PREPARED BY: Craig Volz **CHECKED BY:** Larry Hamburg

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 2,993,211		
B. SIOH	$ 257,416		*(Supervision + Inspection + Overhead)*
C. DESIGN COST	$ 179,593		
D. TOTAL COST (1A+1B+1C)		$ 3,430,220	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -	
F. PUBLIC UTILITY COMPANY REBATE		$ 1,706,927	
G. TOTAL INVESTMENT (1D-1E-1F)		$ 1,723,293	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: **09/01/11** REGION # **4**

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 20.10	9,306.7	$ 187,027	17.05	$ 3,188,814
F. BIOMASS	$ 9.30	(5,584.0)	$ (51,944)	15.61	$ (810,846)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		3,722.7	$ 135,083		$ 2,377,968

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 3,500		
1 DOE UPV DISCOUNT FACTOR		14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			$ 52,080

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4)	$ 52,080
#4 FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)	$ 138,583
#5 SIMPLE PAYBACK IN YEARS (1G/#4)	12.4
#6 TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)	$ 2,430,048
#7 SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]	1.41

LOCATION:	FORT OREGON	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:	Renewable Energy - Biomass Heating Systems			FISCAL YEAR:	2014
ANALYSIS DATE:	11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
				CHECKED BY:	Larry Hamburg

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST		$ 2,993,211
B.	SIOH	3.0%	$ 89,796
C.	CONTINGENCIES	5.0%	$ 149,661
C.	DESIGN	6.0%	$ 179,593
C.	COMMISSIONING	0.6%	$ 17,959
D.	TOTAL COST (1A+1B+1C)		$ 3,430,220
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		$ -
F.	PUBLIC UTILITY COMPANY REBATE		$ 1,706,927
G.	TOTAL INVESTMENT (1D-1E-1F)		$ 1,723,293

2. ENERGY SAVINGS (+)/COST (-):

DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS 09/01/11 Commercial

ENERGY SOURCE	COST $/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECTRIC	$ -	0.0	$ -	14.11	$ -
B. DISTILLATE	$ -	0.0	$ -	15.74	$ -
C. RESIDUAL	$ -	0.0	$ -	21.74	$ -
D. NAT. GAS	$ -	0.0	$ -	15.64	$ -
E. PROPANE/LPG	$ 20.096	9,306.7	$ 187,027	17.05	$ 3,188,814
F. BIOMASS PELLETS	$ 9.302	(5,584.0)	$ (51,944)	15.61	$ (810,846)
	$/k-gal	k-gal			
G. WATER	$ -	0.0	$ -	16.65	$ -
	$/kW/YR	kW			
H. DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I. TOTAL		3,722.7	$ 135,083		$ 2,377,968

3. NON-ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-)	$ 3,500	
(1) DISCOUNT FACTOR (TABLE A-2)	14.88	
(2) DISCOUNTED SAVINGS (3A X 3A1)		$ 52,080

B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)

ITEM	SAVINGS(+) COST (-)(1)	YEAR OF OCCUR (2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS/COST (+/-)(4)
a.	$ -		1.000	$ -
b.			1.000	$ -
c.			1.000	$ -
d. TOTAL	$ -			$ -

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d) $ 52,080

4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):	$ 138,583
5. SIMPLE PAYBACK (1G/4)	12.4
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):	$ 2,430,048
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:	1.41

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	101,501.80	=	9,306.70	Enter Cost / Gal------------->	$ 1.8426	=	$ 20.096
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(324.65)	=	(5,583.98)	Enter Cost / Unit----------->	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal-------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:
- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!

- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234
- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

NISTIR 85-3273-26, 9/2011 - United States Department of Energy, Federal Energy Management Program

Table Ba-4. FEMP UPV* Discount Factors adjusted for fuel price escalation, by end-use sector and fuel type - Discount Rate 3%

****** TABLE UPDATED FOR REGION 4 ONLY ******

http://www.wbdg.org/ccb/NIST/nistir85_3273_26.pdf

Region	Year	Electric	Dist	LPG	NtGas	Elec	Dist	Resid	NtGas	Coal	Elec	Dist	Resid	NtGas	Coal	GasIn
4	1	0.97	0.91	**0.99**	0.95	**0.97**	**0.88**	**1.10**	**0.96**	**0.97**	0.96	0.88	0.86	0.96	0.95	0.97
4	2	1.92	1.77	**1.97**	1.88	**1.91**	**1.71**	**2.24**	**1.87**	**1.92**	1.89	1.72	1.66	1.90	1.88	1.95
4	3	2.84	2.63	**2.94**	2.77	**2.81**	**2.53**	**3.38**	**2.73**	**2.85**	2.79	2.56	2.47	2.80	2.77	2.93
4	4	3.73	3.48	**3.89**	3.64	**3.68**	**3.35**	**4.53**	**3.57**	**3.75**	3.67	3.39	3.29	3.69	3.65	3.90
4	5	4.59	4.33	**4.82**	4.49	**4.52**	**4.17**	**5.69**	**4.39**	**4.63**	4.50	4.22	4.11	4.56	4.50	4.86
4	6	5.41	5.17	**5.75**	5.33	**5.32**	**5.00**	**6.86**	**5.20**	**5.49**	5.30	5.05	4.93	5.42	5.32	5.82
4	7	6.21	6.01	**6.66**	6.16	**6.08**	**5.82**	**8.02**	**5.99**	**6.33**	6.07	5.89	5.75	6.27	6.12	6.78
4	8	6.98	6.84	**7.55**	6.98	**6.82**	**6.64**	**9.16**	**6.78**	**7.14**	6.82	6.72	6.56	7.12	6.90	7.73
4	9	7.72	7.67	**8.44**	7.80	**7.53**	**7.46**	**10.30**	**7.57**	**7.94**	7.53	7.55	7.37	7.97	7.66	8.67
4	10	8.44	8.49	**9.31**	8.61	**8.22**	**8.26**	**11.43**	**8.36**	**8.72**	8.22	8.37	8.17	8.83	8.40	9.58
4	11	9.14	9.30	**10.16**	9.41	**8.89**	**9.07**	**12.55**	**9.14**	**9.48**	8.89	9.19	8.96	9.69	9.14	10.47
4	12	9.82	10.09	**11.00**	10.20	**9.54**	**9.86**	**13.65**	**9.90**	**10.22**	9.55	9.99	9.74	10.53	9.85	11.34
4	13	10.49	10.88	**11.81**	10.98	**10.18**	**10.64**	**14.73**	**10.66**	**10.96**	10.18	10.78	10.51	11.37	10.56	12.20
4	14	11.13	11.65	**12.62**	11.75	**10.80**	**11.41**	**15.79**	**11.40**	**11.67**	10.80	11.56	11.27	12.19	11.25	13.04
4	15	11.76	12.40	**13.40**	12.51	**11.40**	**12.17**	**16.84**	**12.14**	**12.36**	11.41	12.33	12.01	13.01	11.92	13.85
4	16	12.37	13.15	**14.17**	13.26	**11.99**	**12.91**	**17.87**	**12.86**	**13.04**	11.99	13.08	12.74	13.82	12.57	14.66
4	17	12.97	13.87	**14.91**	13.99	**12.55**	**13.64**	**18.88**	**13.58**	**13.71**	12.56	13.82	13.45	14.62	13.21	15.44
4	18	13.54	14.59	**15.64**	14.71	**13.09**	**14.36**	**19.86**	**14.28**	**14.36**	13.11	14.54	14.15	15.40	13.84	16.21
4	19	14.09	15.28	**16.35**	15.42	**13.61**	**15.06**	**20.81**	**14.97**	**14.99**	13.64	15.25	14.82	16.18	14.45	16.96
4	20	14.63	15.96	**17.05**	16.12	**14.11**	**15.74**	**21.74**	**15.64**	**15.61**	14.15	15.93	15.47	16.94	15.04	17.68
4	21	15.15	16.63	**17.72**	16.80	**14.60**	**16.40**	**22.63**	**16.31**	**16.22**	14.64	16.60	16.09	17.68	15.62	18.38
4	22	15.65	17.27	**18.37**	17.47	**15.07**	**17.04**	**23.50**	**16.96**	**16.81**	15.12	17.25	16.70	18.42	16.19	19.06
4	23	16.14	17.89	**19.01**	18.13	**15.53**	**17.67**	**24.34**	**17.60**	**17.39**	15.58	17.88	17.29	19.15	16.75	19.73
4	24	16.62	18.50	**19.62**	18.79	**15.98**	**18.28**	**25.16**	**18.24**	**17.95**	16.04	18.50	17.87	19.87	17.28	20.38
4	25	17.09	19.09	**20.22**	19.44	**16.41**	**18.87**	**25.96**	**18.87**	**18.50**	16.48	19.10	18.43	20.59	17.81	21.01
4	26	17.54	19.66	**20.80**	20.07	**16.83**	**19.45**	**26.73**	**19.49**	**19.03**	16.91	19.68	18.98	21.30	18.32	21.63
4	27	17.98	20.23	**21.37**	20.69	**17.24**	**20.02**	**27.49**	**20.09**	**19.55**	17.33	20.25	19.51	22.00	18.82	22.23
4	28	18.40	20.77	**21.92**	21.30	**17.63**	**20.57**	**28.23**	**20.69**	**20.05**	17.73	20.81	20.03	22.70	19.30	22.81
4	29	18.82	21.30	**22.45**	21.90	**18.02**	**21.10**	**28.95**	**21.28**	**20.54**	18.12	21.35	20.54	23.38	19.77	23.38
4	30	19.22	21.82	**22.97**	22.49	**18.39**	**21.62**	**29.65**	**21.85**	**21.01**	18.50	21.88	21.03	24.06	20.23	23.94

Appendix D: COUTES Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION: Redmond COUTES FMS **REGION NO:** 4 **PROJECT NO.:** 411300
PROJECT TITLE: Renewable Energy - Biomass Radiant Heating System **FY:** 2014
ANALYSIS DATE: 11/29/12 **ECONOMIC LIFE:** 20 YEARS
PREPARED BY: Craig Volz **CHECKED BY:** Larry Hamburg

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 448,211		
B. SIOH	$ 38,546	*(Supervision + Inspection + Overhead)*	
C. DESIGN COST	$ 26,893		
D. TOTAL COST (1A+1B+1C)		$ 513,650	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -	
F. PUBLIC UTILITY COMPANY REBATE		$ 225,799	
G. TOTAL INVESTMENT (1D-1E-1F)		$ 287,851	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: **09/01/11** REGION # **4**

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 20.33	1,085.5	$ 22,067	17.05	$ 376,237
F. BIOMASS	$ 9.30	(651.4)	$ (6,059)	15.61	$ (94,584)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		434.2	$ 16,008		$ 281,653

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 500		
1 DOE UPV DISCOUNT FACTOR		14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			$ 7,440

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4) $ 7,440

#4	**FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)**	$ 16,508
#5	**SIMPLE PAYBACK IN YEARS (1G/#4)**	17.4
#6	**TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)**	$ 289,093
#7	**SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]**	1.00

LOCATION:		Redmond COUTES F	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:		Renewable Energy - Biomass Radiant Heating Syst			FISCAL YEAR:	2014
ANALYSIS DATE:		11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
					CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:						
A.	CONSTRUCTION COST					$ 448,211
B.	SIOH				3.0%	$ 13,446
C.	CONTINGENCIES				5.0%	$ 22,411
C.	DESIGN				6.0%	$ 26,893
C.	COMMISSIONING				0.6%	$ 2,689
D.	TOTAL COST (1A+1B+1C)					$ 513,650
E.	SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F.	PUBLIC UTILITY COMPANY REBATE					$ 225,799
G.	TOTAL INVESTMENT (1D-1E-1F)					$ 287,851
2. ENERGY SAVINGS (+)/COST (-):						
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS					09/01/11	Commercial
ENERGY SOURCE		COST $/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A.	ELECTRIC	$ -	0.0	$ -	14.11	$ -
B.	DISTILLATE	$ -	0.0	$ -	15.74	$ -
C.	RESIDUAL	$ -	0.0	$ -	21.74	$ -
D.	NAT. GAS	$ -	0.0	$ -	15.64	$ -
E.	PROPANE/LPG	$ 20.328	1,085.5	$ 22,067	17.05	$ 376,237
F.	BIOMASS PELLETS	$ 9.302	(651.4)	$ (6,059)	15.61	$ (94,584)
		$/k-gal	k-gal			
G.	WATER	$ -	0.0	$ -	16.65	$ -
		$/kW/YR	kW			
H.	DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I.	TOTAL		434.2	$ 16,008		$ 281,653
3. NON-ENERGY SAVINGS (+) OR COST (-):						
A. ANNUAL RECURRING (+/-)				$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)				14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)						$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)						
ITEM		SAVINGS(+) COST (-)(1)	YEAR OF OCCUR (2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS/COST (+/-)(4)	
a.		$ -		1.000	$ -	
b.				1.000	$ -	
c.				1.000	$ -	
d.	TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)						$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):						$ 16,508
5. SIMPLE PAYBACK (1G/4)						17.4
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):						$ 289,093
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:						1.00

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	11,839.00	=	1,085.52	Enter Cost / Gal------------->	$ 1.8639	=	$ 20.328
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(37.87)	=	(651.36)	Enter Cost / Unit------------>	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00		Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0		Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:

- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!

- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234

- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix E: Biak Training Center Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION:	**Biak Training Center - Brett l**	**REGION NO:**	**4**	**PROJECT NO.:**	**411300**
PROJECT TITLE:	**Renewable Energy - Biomass Boiler**			**FY:**	**2014**
ANALYSIS DATE:	**11/29/12**	**ECONOMIC LIFE:**	**20 YEARS**		
PREPARED BY:	**Craig Volz**	**CHECKED BY:**	**Larry Hamburg**		

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	**$ 350,000**		
B. SIOH	**$ 30,100**		*(Supervision + Inspection + Overhead)*
C. DESIGN COST	**$ 21,000**		
D. TOTAL COST (1A+1B+1C)		**$ 401,100**	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		**$ -**	
F. PUBLIC UTILITY COMPANY REBATE		**$ 218,314**	
G. TOTAL INVESTMENT (1D-1E-1F)		**$ 182,786**	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: **09/01/11** REGION # **4**

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	**COST $/MMBTU (#1)**	**SAVINGS MMBTU/YR (#2)**	**ANNUAL $ SAVINGS (#3) (#1 X #2)**	**FEMP UPV DISCOUNT FACTOR (#4)**	**PRESENT VALUE SAVINGS (#5) (#3 X #4)**
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	**$ 20.33**	**677.7**	**$ 13,777**	**17.05**	**$ 234,897**
F. BIOMASS	**$ 9.30**	**(406.6)**	**$ (3,782)**	**15.61**	**$ (59,043)**
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		**271.1**	**$ 9,995**		**$ 175,854**

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	**$ 500**		
1 DOE UPV DISCOUNT FACTOR		**14.88**	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			**$ 7,440**

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4) **$ 7,440**

#4	**FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)**	**$ 10,495**
#5	**SIMPLE PAYBACK IN YEARS (1G/#4)**	**17.4**
#6	**TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)**	**$ 183,294**
#7	**SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]**	**1.00**

LOCATION:		Biak Training Center -	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:		Renewable Energy - Biomass Boiler			FISCAL YEAR:	2014
ANALYSIS DATE:		11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
					CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:						
A.	CONSTRUCTION COST					$ 350,000
B.	SIOH				3.0%	$ 10,500
C.	CONTINGENCIES				5.0%	$ 17,500
C.	DESIGN				6.0%	$ 21,000
C.	COMMISSIONING				0.6%	$ 2,100
D.	TOTAL COST (1A+1B+1C)					$ 401,100
E.	SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F.	PUBLIC UTILITY COMPANY REBATE					$ 218,314
G.	TOTAL INVESTMENT (1D-1E-1F)					$ 182,786
2. ENERGY SAVINGS (+)/COST (-):						
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS					09/01/11	Commercial
ENERGY		COST	SAVINGS	ANNUAL$	DISCOUNT	DISCOUNTED
SOURCE		$/MMBTU(1)	MMBTU/YR(2)	SAVINGS(3)	FACTOR(4)	SAVINGS(5)
A.	ELECTRIC	$ -	0.0	$ -	14.11	$ -
B.	DISTILLATE	$ -	0.0	$ -	15.74	$ -
C.	RESIDUAL	$ -	0.0	$ -	21.74	$ -
D.	NAT. GAS	$ -	0.0	$ -	15.64	$ -
E.	PROPANE/LPG	$ 20.329	677.7	$ 13,777	17.05	$ 234,897
F.	BIOMASS PELLETS	$ 9.302	(406.6)	$ (3,782)	15.61	$ (59,043)
		$/k-gal	k-gal			
G.	WATER	$ -	0.0	$ -	16.65	$ -
		$/kW/YR	kW			
H.	DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I.	TOTAL		271.1	$ 9,995		$ 175,854
3. NON-ENERGY SAVINGS (+) OR COST (-):						
A. ANNUAL RECURRING (+/-)				$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)				14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)						$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)						
		SAVINGS(+)	YEAR OF	DISCOUNT	DISCOUNTED SAV-	
ITEM		COST (-)(1)	OCCUR (2)	FACTOR(3)	INGS/COST (+/-)(4)	
a.		$ -		1.000	$ -	
b.				1.000	$ -	
c.				1.000	$ -	
d.	TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)						$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):						$ 10,495
5. SIMPLE PAYBACK (1G/4)						17.4
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):						$ 183,294
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:						1.00

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	7,391.30	=	677.71	Enter Cost / Gal------------->	$ 1.8639	=	$ 20.329
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Biomass Wood Pellet	17,200,000	BTU / ton	Enter Units----------->	(23.64)	=	(406.61)	Enter Cost / Unit----------->	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:

- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!

- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234

- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix F: Umatilla Sim Center Building #30 Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION:	**Umatilla - Simulation Center**	**REGION NO:**	**4**	**PROJECT NO.:**	**411300**
PROJECT TITLE:	**Renewable Energy - Biomass Heating System**			**FY:**	**2014**
ANALYSIS DATE:	**11/29/12**	**ECONOMIC LIFE:**	**20 YEARS**		
PREPARED BY:	**Craig Volz**	**CHECKED BY:**	**Larry Hamburg**		

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 410,000		
B. SIOH	$ 35,260		*(Supervision + Inspection + Overhead)*
C. DESIGN COST	$ 24,600		
D. TOTAL COST (1A+1B+1C)		$ 469,860	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -	
F. PUBLIC UTILITY COMPANY REBATE		$ 198,038	
G. TOTAL INVESTMENT (1D-1E-1F)		$ 271,822	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: **09/01/11** REGION # **4**

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 20.83	1,225.2	$ 25,521	17.05	$ 435,140
F. BIOMASS	$ 9.30	(735.1)	$ (6,838)	15.61	$ (106,747)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		490.0	$ 18,683		$ 328,393

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 500		
1 DOE UPV DISCOUNT FACTOR		14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			$ 7,440

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4)	$ 7,440
#4 FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)	$ 19,183
#5 SIMPLE PAYBACK IN YEARS (1G/#4)	14.2
#6 TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)	$ 335,833
#7 SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]	1.24

LOCATION:		Umatilla - Simulation (	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:		Renewable Energy - Biomass Heating System			FISCAL YEAR:	2014
ANALYSIS DATE:		11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
					CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:						
A.	CONSTRUCTION COST					$ 410,000
B.	SIOH				3.0%	$ 12,300
C.	CONTINGENCIES				5.0%	$ 20,500
C.	DESIGN				6.0%	$ 24,600
C.	COMMISSIONING				0.6%	$ 2,460
D.	TOTAL COST (1A+1B+1C)					$ 469,860
E.	SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F.	PUBLIC UTILITY COMPANY REBATE					$ 198,038
G.	TOTAL INVESTMENT (1D-1E-1F)					$ 271,822
2. ENERGY SAVINGS (+)/COST (-):						
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS					09/01/11	Commercial
ENERGY		COST	SAVINGS	ANNUAL$	DISCOUNT	DISCOUNTED
SOURCE		$/MMBTU(1)	MMBTU/YR(2)	SAVINGS(3)	FACTOR(4)	SAVINGS(5)
A.	ELECTRIC	$ -	0.0	$ -	14.11	$ -
B.	DISTILLATE	$ -	0.0	$ -	15.74	$ -
C.	RESIDUAL	$ -	0.0	$ -	21.74	$ -
D.	NAT. GAS	$ -	0.0	$ -	15.64	$ -
E.	PROPANE/LPG	$ 20.831	1,225.2	$ 25,521	17.05	$ 435,140
F.	BIOMASS PELLETS	$ 9.302	(735.1)	$ (6,838)	15.61	$ (106,747)
		$/k-gal	k-gal			
G.	WATER	$ -	0.0	$ -	16.65	$ -
		$/kW/YR	kW			
H.	DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I.	TOTAL		490.0	$ 18,683		$ 328,393
3. NON-ENERGY SAVINGS (+) OR COST (-):						
A. ANNUAL RECURRING (+/-)				$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)				14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)						$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)						
		SAVINGS(+)	YEAR OF	DISCOUNT	DISCOUNTED SAV-	
ITEM		COST (-)(1)	OCCUR (2)	FACTOR(3)	INGS/COST (+/-)(4)	
a.		$ -		1.000	$ -	
b.				1.000	$ -	
c.				1.000	$ -	
d.	TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)						$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):						$ 19,183
5. SIMPLE PAYBACK (1G/4)						14.2
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):						$ 335,833
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:						1.24

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs			Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->		$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->		$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->		$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->		$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->		$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	13,362.00	=	1,225.16	Enter Cost / Gal------------->		$ 1.9100	=	$ 20.831
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->		$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->		$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->		$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->		$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->		$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(42.74)	=	(735.13)	Enter Cost / Unit----------->		$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:

- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!

- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234

- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix G: Umatilla Dining Hall Building #36 Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION: Umatilla - Dining Bldg 36 **REGION NO:** 4 **PROJECT NO.:** 411300
PROJECT TITLE: Renewable Energy - Biomass Heating System **FY:** 2014
ANALYSIS DATE: 11/29/12 **ECONOMIC LIFE:** 20 YEARS
PREPARED BY: Craig Volz **CHECKED BY:** Larry Hamburg

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 570,000		
B. SIOH	$ 49,020		*(Supervision + Inspection + Overhead)*
C. DESIGN COST	$ 34,200		
D. TOTAL COST (1A+1B+1C)		$ 653,220	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -	
F. PUBLIC UTILITY COMPANY REBATE		$ 273,518	
G. TOTAL INVESTMENT (1D-1E-1F)		$ 379,702	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 09/01/11 REGION # 4

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 20.83	2,448.8	$ 51,010	17.05	$ 869,727
F. BIOMASS	$ 9.30	(1,469.2)	$ (13,667)	15.61	$ (213,345)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		979.5	$ 37,343		$ 656,382

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 500		
1 DOE UPV DISCOUNT FACTOR		14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			$ 7,440

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4)	$ 7,440
#4 FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)	$ 37,843
#5 SIMPLE PAYBACK IN YEARS (1G/#4)	10.0
#6 TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)	$ 663,822
#7 SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]	1.75

LOCATION:	Umatilla - Dining Bldg	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:	Renewable Energy - Biomass Heating System			FISCAL YEAR:	2014
ANALYSIS DATE:	11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
				CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:					
A. CONSTRUCTION COST					$ 570,000
B. SIOH				3.0%	$ 17,100
C. CONTINGENCIES				5.0%	$ 28,500
C. DESIGN				6.0%	$ 34,200
C. COMMISSIONING				0.6%	$ 3,420
D. TOTAL COST (1A+1B+1C)					$ 653,220
E. SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F. PUBLIC UTILITY COMPANY REBATE					$ 273,518
G. TOTAL INVESTMENT (1D-1E-1F)					$ 379,702
2. ENERGY SAVINGS (+)/COST (-):					
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS				09/01/11	Commercial
ENERGY SOURCE	COST $/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECTRIC	$ -	0.0	$ -	14.11	$ -
B. DISTILLATE	$ -	0.0	$ -	15.74	$ -
C. RESIDUAL	$ -	0.0	$ -	21.74	$ -
D. NAT. GAS	$ -	0.0	$ -	15.64	$ -
E. PROPANE/LPG	$ 20.831	2,448.8	$ 51,010	17.05	$ 869,727
F. BIOMASS PELLETS	$ 9.302	(1,469.2)	$ (13,667)	15.61	$ (213,345)
	$/k-gal	k-gal			
G. WATER	$ -	0.0	$ -	16.65	$ -
	$/kW/YR	kW			
H. DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I. TOTAL		979.5	$ 37,343		$ 656,382
3. NON-ENERGY SAVINGS (+) OR COST (-):					
A. ANNUAL RECURRING (+/-)			$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)			14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)					$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)					
ITEM	SAVINGS(+) COST (-)(1)	YEAR OF OCCUR (2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS/COST (+/-)(4)	
a.	$ -		1.000	$ -	
b.			1.000	$ -	
c.			1.000	$ -	
d. TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)					$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):					$ 37,843
5. SIMPLE PAYBACK (1G/4)					10.0
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):					$ 663,822
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:					1.75

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	26,707.00	=	2,448.76	Enter Cost / Gal------------->	$ 1.9100	=	$ 20.831
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(85.42)	=	(1,469.22)	Enter Cost / Unit------------>	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:
- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!
- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234
- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix H: Umatilla Barracks Building #53 Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION: Umatilla - Billeting Bldg # 53 **REGION NO:** 4 **PROJECT NO.:** 411300
PROJECT TITLE: Renewable Energy - Biomass Heating System **FY:** 2014
ANALYSIS DATE: 11/29/12 **ECONOMIC LIFE:** 20 YEARS
PREPARED BY: Craig Volz **CHECKED BY:** Larry Hamburg

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 240,000	
B. SIOH	$ 20,640	*(Supervision + Inspection + Overhead)*
C. DESIGN COST	$ 14,400	
D. TOTAL COST (1A+1B+1C)		$ 275,040
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -
F. PUBLIC UTILITY COMPANY REBATE		$ 123,470
G. TOTAL INVESTMENT (1D-1E-1F)		$ 151,570

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 09/01/11 REGION # 4

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 20.83	576.2	$ 12,002	17.05	$ 204,642
F. BIOMASS	$ 9.30	(345.7)	$ (3,216)	15.61	$ (50,202)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		230.5	$ 8,786		$ 154,440

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 500		
1 DOE UPV DISCOUNT FACTOR		14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			$ 7,440

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4)	$ 7,440
#4 FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)	$ 9,286
#5 SIMPLE PAYBACK IN YEARS (1G/#4)	16.3
#6 TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)	$ 161,880
#7 SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]	1.07

LOCATION:		Umatilla - Billeting Bld	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:		Renewable Energy - Biomass Heating System			FISCAL YEAR:	2014
ANALYSIS DATE:		11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
					CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:						
A.	CONSTRUCTION COST					$ 240,000
B.	SIOH				3.0%	$ 7,200
C.	CONTINGENCIES				5.0%	$ 12,000
C.	DESIGN				6.0%	$ 14,400
C.	COMMISSIONING				0.6%	$ 1,440
D.	TOTAL COST (1A+1B+1C)					$ 275,040
E.	SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F.	PUBLIC UTILITY COMPANY REBATE					$ 123,470
G.	TOTAL INVESTMENT (1D-1E-1F)					$ 151,570
2. ENERGY SAVINGS (+)/COST (-):						
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS					09/01/11	Commercial
ENERGY SOURCE		COST $/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A.	ELECTRIC	$ -	0.0	$ -	14.11	$ -
B.	DISTILLATE	$ -	0.0	$ -	15.74	$ -
C.	RESIDUAL	$ -	0.0	$ -	21.74	$ -
D.	NAT. GAS	$ -	0.0	$ -	15.64	$ -
E.	PROPANE/LPG	$ 20.831	576.2	$ 12,002	17.05	$ 204,642
F.	BIOMASS PELLETS	$ 9.302	(345.7)	$ (3,216)	15.61	$ (50,202)
		$/k-gal	k-gal			
G.	WATER	$ -	0.0	$ -	16.65	$ -
		$/kW/YR	kW			
H.	DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I.	TOTAL		230.5	$ 8,786		$ 154,440
3. NON-ENERGY SAVINGS (+) OR COST (-):						
A. ANNUAL RECURRING (+/-)				$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)				14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)						$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)						
ITEM		SAVINGS(+) COST (-)(1)	YEAR OF OCCUR (2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS/COST (+/-)(4)	
a.		$ -		1.000	$ -	
b.				1.000	$ -	
c.				1.000	$ -	
d.	TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)						$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):						$ 9,286
5. SIMPLE PAYBACK (1G/4)						16.3
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):						$ 161,880
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:						1.07

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	6,284.00	=	576.18	Enter Cost / Gal------------->	$ 1.9100	=	$ 20.831
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(20.10)	=	(345.72)	Enter Cost / Unit------------>	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:
- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!
- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234
- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix I: Youth Challenge Facility Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION:	**FORT OREGON**	**REGION NO:**	**4**	**PROJECT NO.:**	**411300**
PROJECT TITLE:	**Renewable Energy - Biomass Heating Systems**			**FY:**	**2014**
ANALYSIS DATE:	**11/29/12**	**ECONOMIC LIFE:**	**20 YEARS**		
PREPARED BY:	**Craig Volz**	**CHECKED BY:**	**Larry Hamburg**		

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	**$ 655,000**		
B. SIOH	**$ 56,330**	*(Supervision + Inspection + Overhead)*	
C. DESIGN COST	**$ 39,300**		
D. TOTAL COST (1A+1B+1C)		**$ 750,630**	
E. SALVAGE VALUE OF EXISTING EQUIPMENT		**$ -**	
F. PUBLIC UTILITY COMPANY REBATE		**$ 463,646**	
G. TOTAL INVESTMENT (1D-1E-1F)		**$ 286,984**	

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: **09/01/11** REGION # **4**

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	**COST $/MMBTU (#1)**	**SAVINGS MMBTU/YR (#2)**	**ANNUAL $ SAVINGS (#3) (#1 X #2)**	**FEMP UPV DISCOUNT FACTOR (#4)**	**PRESENT VALUE SAVINGS (#5) (#3 X #4)**
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	**$ 19.25**	**2,577.6**	**$ 49,617**	**17.05**	**$ 845,969**
F. BIOMASS	**$ 9.30**	**(1,546.5)**	**$ (14,386)**	**15.61**	**$ (224,559)**
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		**1,031.1**	**$ 35,231**		**$ 621,410**

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	**$ 500**		
1 DOE UPV DISCOUNT FACTOR		**14.88**	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)			**$ 7,440**

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4)	**$ 7,440**
#4 FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)	**$ 35,731**
#5 SIMPLE PAYBACK IN YEARS (1G/#4)	**8.0**
#6 TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)	**$ 628,850**
#7 SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]	**2.19**

LOCATION:	FORT OREGON	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:	Renewable Energy - Biomass Heating Systems			FISCAL YEAR:	2014
ANALYSIS DATE:	11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
				CHECKED BY:	Larry Hamburg

1. INVESTMENT COSTS:

A.	CONSTRUCTION COST		$ 655,000
B.	SIOH	3.0%	$ 19,650
C.	CONTINGENCIES	5.0%	$ 32,750
C.	DESIGN	6.0%	$ 39,300
C.	COMMISSIONING	0.6%	$ 3,930
D.	TOTAL COST (1A+1B+1C)		$ 750,630
E.	SALVAGE VALUE OF EXISTING EQUIPMENT		$ -
F.	PUBLIC UTILITY COMPANY REBATE		$ 463,646
G.	TOTAL INVESTMENT (1D-1E-1F)		$ 286,984

2. ENERGY SAVINGS (+)/COST (-):

DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS 09/01/11 Commercial

ENERGY SOURCE	COST $/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECTRIC	$ -	0.0	$ -	14.11	$ -
B. DISTILLATE	$ -	0.0	$ -	15.74	$ -
C. RESIDUAL	$ -	0.0	$ -	21.74	$ -
D. NAT. GAS	$ -	0.0	$ -	15.64	$ -
E. PROPANE/LPG	$ 19.250	2,577.6	$ 49,617	17.05	$ 845,969
F. BIOMASS PELLETS	$ 9.302	(1,546.5)	$ (14,386)	15.61	$ (224,559)
	$/k-gal	k-gal			
G. WATER	$ -	0.0	$ -	16.65	$ -
	$/kW/YR	kW			
H. DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I. TOTAL		1,031.1	$ 35,231		$ 621,410

3. NON-ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING (+/-)	$ 500	
(1) DISCOUNT FACTOR (TABLE A-2)	14.88	
(2) DISCOUNTED SAVINGS (3A X 3A1)		$ 7,440

B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)

ITEM	SAVINGS(+) COST (-)(1)	YEAR OF OCCUR (2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV-INGS/COST (+/-)(4)
a.	$ -		1.000	$ -
b.			1.000	$ -
c.			1.000	$ -
d. TOTAL	$ -			$ -

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)	$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):	$ 35,731
5. SIMPLE PAYBACK (1G/4)	8.0
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):	$ 628,850
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:	2.19

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	28,111.60	=	2,577.55	Enter Cost / Gal------------->	$ 1.7650	=	$ 19.250
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(89.91)	=	(1,546.45)	Enter Cost / Unit------------>	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:
- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!
- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234
 - Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year

Appendix J: Burns Armory Life-Cycle Cost Analysis

ARNG LIFE CYCLE COST ANALYSIS (LCCA) SUMMARY

LOCATION: Burns Armory **REGION NO:** 4 **PROJECT NO.:** 411300
PROJECT TITLE: Renewable Energy - Biomass Heating System **FY:** 2014
ANALYSIS DATE: 11/29/12 **ECONOMIC LIFE:** 20 YEARS
PREPARED BY: Craig Volz **CHECKED BY:** Larry Hamburg

#1 INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$ 320,000	
B. SIOH	$ 27,520	*(Supervision + Inspection + Overhead)*
C. DESIGN COST	$ 19,200	
D. TOTAL COST (1A+1B+1C)		$ 366,720
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ -
F. PUBLIC UTILITY COMPANY REBATE		$ 204,143
G. TOTAL INVESTMENT (1D-1E-1F)		$ 162,577

#2 ENERGY & DEMAND SAVINGS (+) / COSTS (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: 09/01/11 REGION # 4

NOTE: IN THIS ANALYSIS, MM = 1,000,000

ENERGY SOURCE	COST $/MMBTU (#1)	SAVINGS MMBTU/YR (#2)	ANNUAL $ SAVINGS (#3) (#1 X #2)	FEMP UPV DISCOUNT FACTOR (#4)	PRESENT VALUE SAVINGS (#5) (#3 X #4)
A. ELEC. (Site)					
B. DIST. OIL					
C. RESID. OIL					
D. NAT. GAS					
E. PPG/LPG	$ 19.22	715.8	$ 13,758	17.05	$ 234,579
F. BIOMASS	$ 9.30	(429.5)	$ (3,995)	15.61	$ (62,365)
G. WATER					
H. DEMAND SAVINGS					
I. TOTAL		286.3	$ 9,763		$ 172,214

#3 NON-ENERGY SAVINGS (+) / COSTS (-)

A. ANNUAL RECURRING OM & R (+/-)	$ 500	
1 DOE UPV DISCOUNT FACTOR	14.88	
2 DISCOUNTED SAVINGS/COST (3A X 3A1)		$ 7,440

B. NON-RECURRING SAVINGS (+) OR COSTS (-)

ITEM	SVGS (+) COST (-) (#1)	YEAR OF OCCUR. (#2)	DOE SPV FACTOR (#3)	DISCOUNTED SAVINGS/COSTS [+ / -] (#4)
a.				
b.				
c.				
d. **TOTAL**				

C. TOTAL NON-ENERGY DISCOUNTED SAVINGS (3A2 + 3Bd4) $ 7,440

#4	**FIRST YEAR DOLLAR SAVINGS (2I3 + 3A + 3Bd1/YRS ECON LIFE)**	$ 10,263
#5	**SIMPLE PAYBACK IN YEARS (1G/#4)**	15.8
#6	**TOTAL NET DISCOUNTED SAVINGS (2I5 + 3C)**	$ 179,654
#7	**SAVINGS TO INVESTMENT RATIO (SIR) # 6/(1G)]**	1.11

LOCATION:		Burns Armory	REGION:	4	PROJECT NO:	411300
PROJECT TITLE:		Renewable Energy - Biomass Heating System			FISCAL YEAR:	2014
ANALYSIS DATE:		11/29/12	ECON LIFE:	20	PREPARER:	Craig Volz
					CHECKED BY:	Larry Hamburg
1. INVESTMENT COSTS:						
A.	CONSTRUCTION COST					$ 320,000
B.	SIOH				3.0%	$ 9,600
C.	CONTINGENCIES				5.0%	$ 16,000
C.	DESIGN				6.0%	$ 19,200
C.	COMMISSIONING				0.6%	$ 1,920
D.	TOTAL COST (1A+1B+1C)					$ 366,720
E.	SALVAGE VALUE OF EXISTING EQUIPMENT					$ -
F.	PUBLIC UTILITY COMPANY REBATE					$ 204,143
G.	TOTAL INVESTMENT (1D-1E-1F)					$ 162,577
2. ENERGY SAVINGS (+)/COST (-):						
DATE OF NISTR 85-3273-X USED FOR DISCOUNT FACTORS					09/01/11	Commercial
ENERGY		COST	SAVINGS	ANNUAL$	DISCOUNT	DISCOUNTED
SOURCE		$/MMBTU(1)	MMBTU/YR(2)	SAVINGS(3)	FACTOR(4)	SAVINGS(5)
A.	ELECTRIC	$ -	0.0	$ -	14.11	$ -
B.	DISTILLATE	$ -	0.0	$ -	15.74	$ -
C.	RESIDUAL	$ -	0.0	$ -	21.74	$ -
D.	NAT. GAS	$ -	0.0	$ -	15.64	$ -
E.	PROPANE/LPG	$ 19.220	715.8	$ 13,758	17.05	$ 234,579
F.	BIOMASS PELLETS	$ 9.302	(429.5)	$ (3,995)	15.61	$ (62,365)
		$/k-gal	k-gal			
G.	WATER	$ -	0.0	$ -	16.65	$ -
		$/kW/YR	kW			
H.	DEMAND SAVINGS	$ -	0.0	$ -	14.11	$ -
I.	TOTAL		286.3	$ 9,763		$ 172,214
3. NON-ENERGY SAVINGS (+) OR COST (-):						
A. ANNUAL RECURRING (+/-)				$ 500		
(1) DISCOUNT FACTOR (TABLE A-2)				14.88		
(2) DISCOUNTED SAVINGS (3A X 3A1)						$ 7,440
B. NON-RECURRING SAVINGS (+) OR COST (-) (TABLE A-1)						
		SAVINGS(+)	YEAR OF	DISCOUNT	DISCOUNTED SAV-	
ITEM		COST (-)(1)	OCCUR (2)	FACTOR(3)	INGS/COST (+/-)(4)	
a.		$ -		1.000	$ -	
b.				1.000	$ -	
c.				1.000	$ -	
d.	TOTAL	$ -			$ -	
C. TOTAL NON-ENERGY DISCOUNTED SAVINGS/COST (3A2 + 3B4d)						$ 7,440
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+3Bd1/YRS ECON LIFE):						$ 10,263
5. SIMPLE PAYBACK (1G/4)						15.8
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):						$ 179,654
7. SAVINGS TO INVESTMENT RATIO (SIR) 6/1G:						1.11

Project Energy Savings Summary

Category	Constant	Units		Input		MMTBUs		Input		$/MMTBU
Purchased Electric	3,412	BTU / kWh	Enter kWh----------->	0	=	0.0	Enter Cost / kWh----------->	$ 0.0680	=	$ 19.930
Purchased Steam	1,000	BTU / lb	Enter Pounds------->	0.00	=	0.00	Enter Cost / lb---------------->	$ 0.0556	=	$ 55.550
Distillate Fuel Oil	138,700	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 18.421
Natural Gas	1,031	BTU / CuFt	Enter Cubic Feet-->	0.00	=	0.00	Enter Cost / CuFt----------->	$ 0.0056	=	$ 5.388
Natural Gas	100,000	BTU / Therm	Enter Therms------->	0.00	=	0.00	Enter Cost / Therm--------->	$ 0.5555	=	$ 5.555
LPG, Propane	91,690	BTU / gal	Enter Gallons------->	7,807.00	=	715.82	Enter Cost / Gal------------->	$ 1.7623	=	$ 19.220
Butane	102,032	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 2.5550	=	$ 25.041
Bituminous Coal	24,580,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 240.5500	=	$ 9.786
Anthracite Coal	25,400,000	BTU / short Ton	Enter Tons----------->	0.00	=	0.00	Enter Cost / Ton------------->	$ 241.6000	=	$ 9.512
Residual #1 Fuel Oil	140,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 39.679
#2 Fuel Oil	138,000	BTU / gal	Enter Gallons------->	0.00	=	0.00	Enter Cost / Gal------------->	$ 5.5550	=	$ 40.254
Other (Define)	17,200,000	BTU / ton	Enter Units----------->	(24.97)	=	(429.48)	Enter Cost / Unit------------>	$ 160.0000	=	$ 9.302

Water (per 1000 gallons or other unit)	Enter 1000 Gallons>	0.00	Enter Cost / K-Gal------------	$1.5666
Demand Savings	Enter kW------------->	0	Enter Cost / kW / Year--->	$0.00

* Conversions from USACE DD1391 Validation Program Checklist, Feb 2011

Calculator: Unit Conversions for Reference

1.000	MWh ----------->	1,000.000	kWh
1.000	English Ton	2,000.000	lbs
1.000	Metric Ton	2,204.623	lbs
1.000	Kilogram	2.205	lbs
1.000	CCF (natural gas)	100.000	cubic feet
1.000	MCF (natural gas)	1,000.000	cubic feet
1.000	MMCF (nat gas)	1,000,000.000	cubic feet
1.000	Therm	96.993	cubic feet
1.000	MMBTU (natural gas)	969.932	cubic feet
1.000	MMBTU (natural gas)	10.000	therms
1.000	MMBTU (electric)	293.083	kWh
1.000	Acre	43,560.000	square feet

Tips and Guidance:
- Type your Project's Energy Savings in Column F
- Type your Location's Cost per Unit of Energy in Column L

You're done here! Go to the Project Tab!
- Only write in light yellow cells. The light gray cells are auto-calculated.
- Input 4 significant digits in cost so the $/MMBTU calculations are accurate

All of the following examples are 4 significant digits: $12.34, $1.234, $0.1234
- Multiply $ / kW / Month (from bill) x 12 to get to $ / kW / Year

Guidance: Input 75% or less of Load Differential as kW savings calculation.
If higher, you need to justify why you will save more.
e.g. Current Lighting Peak Wattage: 120 kW, New Lighting 60 kW
Reasonable Demand Charge Savings Estimate (60 x 0.75 = 45 kW)

Financial Conversions for Reference

$1.000	MCF -------------------->	$0.00000100	per cubic foot
$1.000	CCF -------------------->	$0.01000000	per cubic foot
$1.000	MMBTU (gas) ------->	$0.10000000	per therm
$1.000	MWh-------------------->	$0.00100000	per kWh
$1.000	$$ / kW / month------>	$12.00000000	per kW / Year