Recommendation

Replace the two 2.45 MMBtu Laars boilers with two 70 hp special alternate dual fuel boilers, that use solvent waste as their primary fuel. This will reduce annual natural gas consumption by 86.3%, and eliminate all solvent waste disposal expenses.

Annual Savings Summary

Source	*Quantity*	*Units*	*Cost Savings*
Waste Disposal	134,400	Gallons	$302,400
Natural Gas	11,061	MMBtu	$73,321
Total	**11,061**	**MMBtu**	**$375,721**

Implementation Cost Summary

Description	*Cost*	*Payback (yrs)*
Before Incentives	$379,891	1.0
After Incentives	$189,945	0.5

Facility Background

The facility uses solvents, primarily acetone, in the manufacturing of pharmaceutical products. Solvents are mixed with polymers and other active pharmaceutical ingredients (API) to ensure an even mixture of compounds. The mixture is then sent to spray dryers to separate the solvent from solution.

The facility currently uses approximately 1,500 gallons of acetone per month at their R&D and Manufacturing buildings. Facility personnel project that they will be purchasing 14,000 gallons of acetone per month, from which 80% will be recovered and sent to waste management companies for disposal.

The facility currently pays $2.25 per gallon of solvent disposed, with a fixed volume of 2,500 gallons for every truckload, forecasting an annual cost of $302,400 in waste management. Acetone cannot be sold after processing due to potential intellectual property protection needs, nor can it be reused due to potential cross contamination.

Technology Background

Most conventional boilers use commercially available fuels such as natural gas, light oil or heavy oil. However, some boilers can be adapted to burn alternative fuels, or a combination of alternative and commercial fuels. These dual-fuel burners may have more than one fuel nozzle, with a single combustion air feed system.

Some alternative fuels that can be used with commercially available dual boilers are digester gas, landfill gas, solvents, waste oils, or biogas. The feasibility of using solvent as fuel depends on the water content and contaminant composition. Vendors require a fuel analysis to analyze the feasibility of implementation.

Waste repurpose programs can potentially present challenges, such as a need for a constant waste fuel supply. Special attention must be given to systems designed to run off of "hot" fuels (energy values below 25,600 kJ/kg) and the contaminants that alternative fuels may produce.

Proposal

Replace the two 2.45 MMBtu Laars boilers with two 70 hp special alternate dual fuel boilers, that use the facility's solvent waste as their primary fuel. This will reduce annual natural gas consumption by 86.3%, generating annual savings of $73,321 and reducing solvent waste management expenses by $302,400 per year. Total annual savings will be $375,721 after an implementation cost of $379,891, resulting in a simple payback of 1 year before incentives, and 0.5 years after incentives.

Notes

This recommendation would require combining the hot water grid from the new mezzanine and the boilers. An alternative would be to replace the two Laars boilers with the alternate dual fuel boilers, and only replace the natural gas demand of those two boilers (estimated at 30% of the total natural gas consumption by facility personnel) by their calorific equivalent in solvent.

Doing so will generate $130,656 in annual savings with a payback of 2.9 years after an implementation cost of $379,891 before incentives, and 2.2 payback period after an implementaion cost of $290,119 after incentives.

A local representative indicated that boilers in operation at the facility are not able to be adapted for solvent fuels, however they do offer an alternative that could potentially use solvents, subjected to a fuel quality analysis.

Operational Data

Utility Data

Annual Natural Gas Consumption	(E_C)	*12,822*	MMBtu	**(Rf. 1)**
Incremental Gas Cost	(IC_G)	*$6.63*	/MMBtu	**(Rf. 1)**

Data Collected

Waste Data

Estimated Solvent Inflow	(m_W)	*14,000*	gal/month	**(Rf. 2)**
Solvent Recuperated as Waste	(SW)	*80%*		**(Rf. 2)**
Current Waste Handling Cost	(C_U)	*$2.25*	/gal	**(Rf. 2)**
Waste Generation	(V_w)	*134,400*	gal/yr	**(Eq. 1)**
Waste Handling Cost	(C_C)	*$302,400*	/yr	**(Eq. 2)**

Energy Analysis

Alternative Fuel Analysis

Gross Calorific Value (acetone)	(GCV)	*29,000*	kJ/kg	**(Rf. 3)**
Conversion Factor 1	(CF_1)	*3.78541*	L/gal	**(Rf. 4)**
Conversion Factor 2	(CF_2)	*0.001*	m^3/L	**(Rf. 4)**
Conversion Factor 3	(CF_3)	*0.94782*	Btu/kJ	**(Rf. 4)**
Acetone Density	(r)	*791*	kg/m^3	**(Rf. 4)**
Waste Energy Content	(E_w)	*11,061*	MMBtu/yr	**(Eq. 3)**

Implementation Cost Analysis

Dual Fuel Boiler	(C_B)	*$180,000*	/unit	**(Rf. 5, N. 1)**
Replacement Boilers	(n)	*2*	units	**(Rf. 2)**
Labor Cost	(C_L)	*$4,033*	/unit	**(Rf. 6)**
Piping and Pumping installed Cost	(C_{PP})	*$11,825*		**(Rf. 7, N. 2)**

Economic Results

Savings	(S)	*$375,721*	/yr	**(Eq. 4)**
Implementation Cost	(C_M)	*$379,891*	/yr	**(Eq. 5, Rf. 3)**
Simple Payback	(t_{PB})	*1.0*	yrs	**(Eq. 6)**

Notes

N. 1) The feasibility of the recommendation will depend on the waste composition. High water content in solvents or fuels containing harmful substances may not be usable as boiler fuel.

N. 2) Cost considers 2 industrial 3 hp pumps and 700 ft of service piping. Costs considered include overhead and profit. This is the cost associated with extending the piping from the new boilers to the new mezzanine. Hoewever the details of the connection were not covered in this recommendation.

Equations

Eq. 1) Annual Waste generation (C_C)

$$SW \times m_w \times \frac{12\ month}{year}$$

Eq. 2) Annual Waste Handling Cost (C_C)

$$V_W \times C_U$$

Eq. 3) Waste Energy Content (E_w)

$$CF_1 \times CF_2 \times CF_3 \times \rho \times GCV \times V_W \times \frac{MMBtu}{10^6\ Btu}$$

Eq. 4) Savings (S)

$$C_C + E_W \times IC_G$$

Eq. 5) Implementation Cost (C_M)

$$n \times \left(C_B + C_L\right)$$

Eq. 6) Simple Payback (t_{PB})

$$\frac{C_M}{S}$$

References

Rf. 1) Developed in the Utility Analysis located in the Site Data section of this report. Incremental cost represents the weighted average of the two natural gas meters.

Rf. 2) Information provided by the Environmental, Health, and Safety Specialist during the assessment.

Rf. 3) Retrieved from http://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html

Rf. 4) Retrieved from http://www.metric-conversions.org/

Rf. 5) Quote provided by vendor for a 70 HP special alternate dual fuel boiler. This quote represents a conservative estimate of the equipment cost.

Rf. 6) Retrieved from RSMeans Building Construction Data, 2012. B-10Y crew.

Rf. 7) Industrial Miscellaneous Costs, retrieved from www.michigan.gov

3 - AR No. 2 - Incentives

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Recommendation Details

Implementation Cost	*$379,891*	
Annual Cost Savings	*$375,721*	/year
Simple Payback	*1.0*	years

Incentive Analysis Summary

Description	*Incentive*	*After Incentive*	*Payback*	*Notes*
			(yrs)	
ETO	*$189,945*	*$189,945*	*0.5*	*$2.00/therm ·yr, up to 50% cost of project*

ETO

Companies paying a public purpose charge may qualify for Energy Trust of Oregon cash incentives. Incentives are calculated on a case-by-case basis and are based on the results of a technical analysis study. Trimming natural gas costs projects may qualify for an incentive of $2.00 per annual therm saved, up to 50% of the project cost.