GREENHOUSE GASES SAVINGS AT HARVARD UNVERSITYAFTER REPLACING OLDER WASHERS WITH NEW ENERGY EFFICIENT WASHERS

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Final Graduate Paper
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May 2004

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EXECUTIVE SUMMARY

This paper has determine the efforts made by Harvard University at reducing the air pollution by replacing older, less efficient washers used in the Harvard University dormitories by energy efficient washers. Some of the assumptions made for the purposes of calculations in this exercise have been discussed and are presented as follows:

- Specifications used for the Maytag Washer MAH21PD
- 30% of all the loads washed are hot, 40% are warm and 30% are coldwater washes.
- This is an assumption that all the loads washed will be dried using dryers that are currently in use at the Harvard University dormitories.
- This is also an assumption that water used will be released 100% in the sewer system. Technically this is not true because some of the water is retained in the laundry.
- Electricity is used for drying laundry in dryers.
- For this paper EPA Model is used to calculate the $$ savings. Although several more complicated models that take into account specific assumptions are available through EPRI, Clean Air Cool Planet, World Resources Institute and World Environmental Center.
- It is found that the actual rates are significantly higher than the rates used by Mac-Gray Laundry for the calculations to show the savings. When actual rates are used the savings can be significantly higher than what is presented in this paper.

Following questions needed to be answered in an effort to calculate the greenhouse gases savings.

- Number of energy efficient washers slated for replacement and the washers actually replaced.
- Water savings per load.
- Number of loads per washer per year.
- Dryers replaced if any.
- Who trades the GHG?
- When are they traded?
- What is its current market value?

Total savings in Water utility are **$118,454.22** and **8607 HCF**.
Total savings in Electric utility are **$28,576.53** and **332,285 KWH**.
The savings in Natural Gas utility bills is **$28,462.63**. Natural gas use is reduced by **29,961 SCFH**.

I. BACKGROUND

As apart of graduate research paper, Dr. Spengler listed some of the projects that the class could participate in. One of the projects was to determine how Harvard University has benefited by replacing older top loading washers in the residential halls with the new energy efficient frontloading Maytag MAH21PD. The washers have allowed Harvard University to save over 50% in the utilities cost related to the washers and dryers. I chose to conduct the research and calculate the savings in greenhouse gases, savings in dollar amounts, its value on the current market, and whether these savings are tradable. Harvard plans to replace 508 washers. These calculations are based on 502 washers. At the time of the study the project was not completed.

II. AVAILABLE INFORMATION

1. Washer Specifications

MAH21PD is a frontloading washer. It is designed to wash 14 lb laundry vs. 10 lb. This allows the Maytag to wash larger loads. It uses fifteen (15) gallons of water vs. thirty-one (31) gallons used by the top-loading washer. This gives water savings of sixteen (16) gallons. This allows the water savings and sewer savings for the same amount. The Maytag has a variable speed motor design that uses higher, 0.37 kW for extraction and 0.19 kW for washing. Thus using less energy to run the washer. The washer also uses variable rpm of 618 for washing and 1000 for extraction. It is acknowledged that the washer runs 2-3 min longer than the top loading washer. This has been compensated in the energy use calculations.[1]

2. Harvard University Information

Harvard University is planning to replace the top-loading washers to frontloading, energy efficient Maytag MAH21PD washers. There are 508 washers currently in the residence Halls. Out of the 508 washers, at the time of this paper, 502 washers were replaced. Harvard University uses these washers on an average for 3.2 loads per day per washer. This has been calculated from the coin recovery for the whole year and back calculated for the average from number of washers and number of days the washer is available (365).

3. Specific Water Use Data for the Washer

Top-load washer uses 6.5 gallons of hot water for the hot water cycle while the frontload uses 5.5 gallons for the hot water cycle and 2 gallons

[1] http://www.maytagcommerciallaundry.com/cmths/products/productDetail/productDetailMain.jsp?cs=0&BV_UseBVCookie=Yes&category=Products&domain=WASHER&model=MAH21PDAWW&familyName=Neptune

for warm cycle. No data is available for warm cycle for top-load washer. Natural gas is used to heat the water. This is the case at Harvard.

4. Dryer Information

Dryer in the Residence Halls are electric and all the dryers use electricity. ***No dryers are replaced under this project.*** The table includes savings from electricity use, as there is less moisture to evaporate from the clothes.

III. ASSUMPTIONS FOR CALCULATIONS

For the purposes of this paper, the assumptions made by Maytag are used to show the financial savings realized by Harvard University. There are limitations to the calculations and these are discussed as what are national average rates and individual cities and towns may be paying for utility. The average rates used by Maytag may be used by the industry in various calculations.

1. Washing Pattern Calculations

It is assumed that the Residence Hall will have similar pattern of use. It is calculated that 10 lb loads for 3.2 loads a washer and used for 365 days for the top-loading washers. This will translate into 2.29 loads a washer for 365 days for the frontload washer. It is assumed that normal wash cycles will be used. Normally 30% of the washes are hot wash cycles, 40% are warm wash cycles and 30% are cold wash cycles. These are assumed to be national averages.

2. Drying Pattern

It is assumed that all the washed loads will be dried in the dryer. Each load will be dried as a single load. What this means is that one would not wash two loads and dry the two loads as one. Due to design changes, the washer extracts more water from the wash. This requires less time to dry the load and less electricity is used.

3. Water Use and Sewer Discharge

Total water use is based on the 2.29 loads/day/washer assumption and not 3.2 loads/day/washer. It is also assumed that all the water used by the washer is discharged into the sewer system. Although it is clear that some water is retained in the load of laundry. This directly affects the sewer charges and reflects falsely high sewer bill while actually it is lower and translates into greater savings.

4. Utility Rates Used in the Calculations Compared to Actual Rates

- Water Rates — Water rate used for the calculations is 0.0315/cu. ft. The MWRA rates for Cambridge, MA are:

0-40HCF	$2.66/HCF
41-400HCF	$2.87/HCF

401-2,000 HCF	$3.03/HCF
2001-10,000HCF	$3.23/HCF
Over 10,000 HCF	$3.49/HCF

- Sewer Rates —

0-41HCF	$4.99/HCF
41-401HCF	$5.29/HCF
401-2,000 HCF	$5.68/HCF
2001-10,000HCF	$6.12/HCF
Over 10,000 HCF	$6.50/HCF

  Cambridge charges the same rate for residential and commercial clients. Cambridge has an escalating rate for the water and sewer. It depends on the water usage. Normally sewer charges are higher than the water charges. Also some communities buy water from MWRA while some communities use their own reservoirs. It appears that the charges are comparable to charges used in the calculations. It is not quite clear if the calculations take into account the total water consumption and model it so that the billing cycle (quarterly or semiannually) has been incorporated. This can be explained by an example. Suppose the total water and sewer usage is 10,000 HCF and the escalating rates are applied as is the case in Cambridge, and the billing cycle is quarterly as is the case in Cambridge, the water usage will be 2,500 HCF per quarter. This will have significant difference in total charges for quarterly billing cycle vs. total charges for 10,00 HCF.
- Electric Rates — Electric rate used in the calculations is 0.0860/kWH. This rate is significantly lower than the Cambridge rate. The residential rate for electricity calculates to be $0.13228/kWH.
- Natural Gas Rates — Gas rates used in the calculations is 0.95/SCFH. Gas rates in Cambridge are calculated to be $1.69/SCFH (therm). These rates are also significantly higher than assumed for calculations.

After further research it is evident that the rates used for electricity may be the generation cost of electricity. The distribution and transmission cost and other charges may not be included in the rate. Natural gas price is also higher. This will drive the actual savings for Harvard utility bills higher and will look substantially attractive for implementing other energy efficiency programs.[2]

[2] http://www.cambridgema.gov/departments.cfm

IV. REALIZED SAVINGS

1. Water Utility

Harvard has saved considerably in utility bills. The savings in water bill by reducing the number of gallons used per load and the load size is **$45,503.75**. This directly translates into considerable reduction in sewer charges. As discussed earlier, sewer charges are higher than the water charges and leads to greater savings. The savings in sewer charges are **$72,950.47**.

Total savings are $118,454.22 and 8607 HCF.

2. Electric Utility

Electric utility savings are derived from two different uses in energy consumption in laundry. Electricity is used in running the washing machine cycle. Electricity is also used in drying the laundry. The total savings from these two functions is **$28,576.53**

Energy savings are calculated to be **68,434** KWH from the power needed to run the washing machine and **263,851** KWH is saved from the electric dryer for not needing as much to dry the same load.

Total Savings $28,576.53 and 332,285 KWH

3. Natural Gas

Natural gas is used to heat the water that is used in the washing machine and is dependent on the choices an individual makes while selecting various cycles, hot, warm or cold. The natural gas utility savings are derived from the savings in reduced need to heat the water.

The savings in utility bills is $ 28,462.63. Natural gas use is reduced by 29,961 SCFH.

4. Total Savings

Total saving in utility bills is $175,493.38

V. GREENHOUSE GAS REDUCTION

1. NO_x Reduction

There are various models used by various energy institutes like World Resources Institute (WRI) and companies that are practicing in this field.[3]

[3] http://www.ghgprotocol.org/standard/Current_Tools_10_2_03/StationaryCombustion.v2.0.xls

EPA also provides a model to calculate greenhouse gases (GHG) calculations. This model includes regional information of the sources used for electricity production. This allows individuals to track their own progress in an effort to reduce the GHG by taking into account individual actions. EPA model is much simpler and easy to use. For the purposes of this paper EPA model is used.[4]

There are three processes that use electricity, powering the washing machine, powering the dryer and using electricity to dry the wash. The individual breakdown of the NO_x is as follows:

112 lb of NO_x is saved from washing machine.
432 lb of NO_x is saved from dryer.

Total of 544 lb (0.28 tons) of NO_x per year is reduced from entering the environment

2. SO_x Reduction

The same calculator calculates the reduction in SO_x. The individual breakdown of SO_x is as follows:

282 lb of SO_x is saved from washing machine.
1087 lb of SO_x is saved from dryer.

Total of 1369 lb (0.59 tons) of SO_x per year is reduced from entering the environment

3. CO_2 Reduction

Carbon dioxide is generated during electricity production as well as during the natural gas burning. Natural gas does not generate any NO_x or SO_x. Individual breakdown from each activity is as follows:

66920 lb of CO_2 is saved from washing machine.
258011 lb of CO_2 is saved from dryer.
359528 lb of CO_2 is saved from natural gas use for hot water.

Total of 684459 lb (343 tons) of CO_2 is reduced from entering the environment.

[4] http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html

VI. MARKET VALUE

All the market trading is conducted on per ton basis. Each ton is an allowance. Anyone can trade by registering with EPA. EPA does not actually trade the allowances. There are organizations that trade NO_x, SO_x or CO_2. The organizations are listed below:

Clean Air Conservancy
Clean Air Conservancy trades only NO_x. The organization will purchase the allowance and retire these allowances. It also provides a certificate so that these allowances cannot be traded again. EPA has provided a website for Clean Air Conservancy. This site for some reason is not active. The contact information is listed here.

Clean Air Conservancy Kevin Snape 216-621-2008
CLEAN AIR CONSERVANCY
3130 MAYFIELD RD, CLEVELAND, OH 44118
http://www.cleanairconservancy.org/

An effort was made to get in touch with Clean Air Conservancy several times but was unable to reach the organization.

Acid Rain Retirement Fund
The Acid Rain Retirement Fund accepts donations and educates kids about acid rain. The organization is located in Maine. The contact information to retire SO_x is listed here. The membership fees are $10. All of their funds raised through donations are used to purchase allowances for retirement

Michael S. Hamilton 207-780-4190
Acid Rain Retirement Fund
P.O. Box 10272
Portland, ME 04104
http://www.usm.maine.edu/%7Epos/arrf.htm

The Acid Rain Retirement Fund could buy only seven (7) allowances at a cost of $300 per allowance for total of $2100. The organization had to bid higher to confirm the buying price so that they may not loose their bid. Their highest contributor was a 6th Grade class that was doing a project on greenhouse gases and SO_x related project and raised $300 through Bake Sale.

Clean Air - Cool Planet
Clean Air-Cool Planet creates partnerships in the Northeast to implement solutions to climate change and build constituencies for effective climate policies and actions. [5]

[5] http://www.cleanair-coolplanet.org/about

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Clean Air-Cool Planet
100 Market Street, Suite 204
Portsmouth, NH 03801
603-422-6464 x 100
nraynolds@cleanair-coolplanet.org

Chicago Climate Exchange (CCE)
Chicago climate Exchange will be trading CO_2 in a few months. They have just opened offices and are getting ready to trade. At the beginning of April on 4/1/2004, their trade value for one allowance for CO_2 was trading at $1. EU CO_2 market trading is mature and on 4/1/04 CO_2 was trading at $10. CCE converts all the air pollution into CO_2 allowances and trade the air pollution as CO_2.

Phone: +01 (312) 554-3350
Fax: +01 (312) 554-3373
Chicago Climate Exchange
111 W. Jackson, 14th Floor
Chicago, Illinois 60604 USA

Auction
At the end of March 2004, EPA auctioned the available allowances. There were 125,011allowances available for this auction period. American Utility purchased most of the allowances. Current market trading value for allowances that were available on the market were valued at $260. A seven year advance bids were at $129.11 and $128. Each allowance is traded yearly.

VII. SAVINGS AT A GLANCE

Table-1

Harvard University GHG Savings						
	lbs. Saved by Energy Efficient Washer	**lbs. Saved by Less Drying Needs from EE Washer**	**lbs. Saved by the Use of Natural Gas**	**Total lbs. of GHG Savings**	**Total tons of GHG Savings**	**Market Value as of April 2004**
NO_x Reduction	112	432	-	544	0.27	81.60
SO_x Reduction	282	1087	-	1369	0.68	205.35
CO_2 Reduction	66,920	258,011	359,528	684459	342	342.23
Total Cost to Retire GHG Saved by Harvard University						**629.18**

Table-2

Total Savings and Positive Environmental Impact Achieved by Harvard University		
	$$$ Saved by Energy Efficient Washer	**Natural Resources Savings**
Water	45,503.75	8,607.11 HCF
Sewer	72,950.47	> 8,607.11 HCF
Electricity	28,576.53	332,285 kWH
Natural Gas	28,462.63	29,961 SCFH

IX. RECOMMENDATIONS

Following recommendations are made to Harvard University:

- Evaluate if there are any other laundry services besides the dormitory that can utilize these savings from utility cost and indirectly have the advantage of reducing the GHG and reduction in resources use.
- Retire the current savings in GHG achieved by energy efficient washers.
- Figure out a way to retire two savings per year by each Environmental Management Class.

X. LIMITATIONS

The calculations have limitations due to the nature of charges. Some charges are per unit energy and some include mandatory and basic service charges. Average charges used to show savings to Harvard University by Mac-Gray Laundry are used for calculations. There are discrepancies in charges used by Mac-Gray Laundry and actual rates charged to Harvard in all areas e.g. water and sewer, electricity, and natural gas. An effort has been made to calculate and show average utility charges that are more composite of all the charges that a customer may be required to pay.

XI. ACKNOWLEDGEMENT

A direct help from Mr. John Sellier and Mr. Bob Looney of Mac-Gray Laundry is sincerely appreciated. Mr. Ned Raynolds of Clean Air – Cool Planet granted the permission to evaluate their model for GHG calculations.

XII. CONCLUDING QUESTIONS

The central question is if a 6^{th} grade class is baking to buy one allowance, how can we help to accelerate the process of moving toward cleaner environment for the next generation?

What options does Harvard University have?
Harvard University can buy these allowances and retire them for a total of about $650. These allowances will never be used to trade pollution again. Harvard University can also use these allowances in the future for other expansion projects where these savings can keep the overall GHG low.

How Can the Environmental Management II Class help retire at least one allowance in the short run?

Can future Environmental Management Class I & II help buy two allowances per year (one per semester)?

APPENDIX-1

Product Specification Obtained from Maytag Online Brochures

APPENDIX-2

Calculations Provided By Mr. Bob Looney

APPENDIX-3

PowerPoint Presentation