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Clark Recycled and Composted Materials in Equivalent Energy Savings and Greenhouse Gas Emissions for 2011

Clark University began a student run on campus single stream recycling program in 1990 and the program has always been student led and operated. Today, the program is thriving and has evolved and expanded from the original model, adding a staff member and moving to a more functional building. Working on the recycling crew over the last semester has shown me that while the actual function of the recycling program is clear, the general student body has very little knowledge of the program. Most students just assume that the recycling disappears along with the garbage and give the matter no more thought. Students are often surprised to see their peers handling the recycling. I thought that it would be useful to translate the work of the recycling center and the results of campus composting into terms of energy savings and greenhouse gas (GHG) emissions mitigation. That data can then be converted into forms of energy that the average student uses in their everyday life, such as gallons of gasoline. Phrasing the result of the student run recycling program in these terms will place the program into context for non-involved students, and hopefully increase awareness. The converted data will also be useful as a check up for the program and the methods used to report the product of the commodity streams.

I used the 2009 version of the Environmental Benefits Calculator developed and maintained by the Northeast Recycling Council, Inc. (NERC). The NERC calculator allows users to input data into a spreadsheet containing categories for a wide range of the materials and commodities that can be recycled. The calculator also has sections for data on the amount of materials the reporting institution is reducing or reusing, though for the purpose of this study those numbers were not reported. The reported tonnage of recycled materials is converted into energy and emissions equivalents, which are determined using conversion factors worked into the calculator. The conversion factors incorporate the average emissions from life cycle analysis studies and operations data from many institutions and studies which are cited in the calculator, as well as data from the Environmental Protection Agency WARM calculator (NERC 2009). This calculator was recommended to me by the Clark Sustainability Advisor, Jenny Isler. The data I entered into the calculator was also passed on to me by Jenny Isler, along with some advice for estimating or extrapolating figures. My own experience in the recycling center helped me to interpret the data and accurately define each stream for the calculator.

The Clark recycling stream begins with single stream bins placed in each of the buildings and residences. There are also containers with separate compartments for each stream in some of the largest buildings and the material in these bins is collected in bags by the custodial staff and left for the recycling crew. Once a week or on a call in basis the bins and bags of recyclables are collected by the student crew and replaced with empty bins. The crew takes the unsorted single stream recyclables back to the center and hand sorts everything into separate streams. The streams that are ideally sorted isolate cardboard, high grade paper, bulky metal, electronic waste and universal waste. The redeemable glass, aluminum and plastic bottles or cans are sorted out and taken to a redemption center, and the remainder of the single stream is placed in a co-mingle recycling dumpster for commercial sorting and processing. Not all of the streams are sorted all of the time, such as during the summer when the crew is greatly reduced. At those times, all unsorted single stream goes into the co-mingle dumpster after the cardboard has been removed.

E-waste includes all electronics, which at Clark most often means computer parts and appliances. The universal waste stream includes batteries, fluorescent lightbulbs and any other potentially hazardous waste. Compost and shredded paper are the only recycling streams I entered into the calculator that do not come through the recycling center. Shredded paper is handled by an outside company but is recycled at their facility (Cintas 2011). All of the food waste from dining services is composted, which was accounted for separately from the very generalized estimate of yard waste. The yard waste data was not reported alongside the rest of the recycling data I received from Jenny Isler, but was reported in the most recent Clark Climate Impacts calculator. The figure of 35 tons of yard waste has been constant for as long as it has been reported and is likely not precise. Yard waste collected by physical plant is composted at the Clark Hadwen Arboretum, which the calculator considers the impacts of as an alternative to incinerators (NERC 2009).

I interpreted the recycling data I accumulated into inputs for twelve of the calculator categories (Figure 1). The figures for recycled glass, PET plastic and aluminum cans were estimated from the data provided by Jenny Isler for the redeemed bottles and cans for two months this year. I calculated the tonnage by multiplying the number of boxes or bags collected in a month by the expected weight of each box or bag. I assumed that redeemable cans and bottles had been sorted for ten months of the year (Figure 2). Corrugated cardboard, bulky metal and sorted office paper all had correlating categories in the calculator. The data for shredded paper was entered as mixed paper, electronic waste was entered as whole computers, and universal waste was added to the miscellaneous data and entered as other recyclables. The estimation for yard waste compost was entered as leaf trimmings, and the food compost was entered as mixed organics. All of the co-mingled recycling was entered as mixed recyclables.

The total tonnage of non-recycled waste was entered as tons sent to incinerators, as Clark's waste is handled by a waste to energy incinerator. I report the outputs for energy and emissions savings due to recycling alone, not as a net effect compared to disposal as the incineration of waste reports as a negative number in the calculator because of the waste-to-energy assumptions.

By recycling and composting 443.54 tons of material in 2011, Clark saved a total of 5,553.12 Million BTUs. This energy savings is equivalent to 651.66 barrels of oil, 30,422.43 gallons of gasoline, or 55 average cars off the road for a year (Figure 1)(EPA 2005). The greenhouse gas emissions that were prevented by recycling all of this material is equal to 200 Metric Tons of Carbon Equivalent (Figure 1). Glass and steel recycling saved 2.01 tons of limestone, 31.95 tons of iron ore, and 17.89 tons of coal (Figure 3). The 76.45 tons of recycled paper is equivalent to the amount of carbon sequestered in 5,963 tree seedlings grown for ten years. The largest proportion by weight of recycled material at Clark is the composted organic materials, and 48% of the overall waste produced at Clark is diverted from disposal (Figure 4&5). The calculator made it very clear that the environmental impact of recycling is greatly influenced by the type of material that is recycled. Metals and mixed recyclables represent less than a quarter of the weight of recycled materials, but together they account for almost three quarters of the energy savings, and more than half of the negative GHG emissions (Figures 6&7). Composted material can actually have a positive energy use and negative fuel savings values, which could possibly be accounted for by the calculator assumption that organic material would produce more useful energy if it was sent to the waste-to-energy incinerator (NERC 2009) (Figures 1, 6&7). The calculator returned no values for the miscellaneous data.

The Clark recycling program does mitigate a significant amount of GHG equivalent by providing recycling receptacles and hand sorting the product. It would be interesting to include source reduction data from sources other than the recycling center, such as the Clark thrift store and the library book sales. In my use of the calculator, I entered no data for source reductions or reuse, which might be difficult to accurately measure but is still worth considering in future studies. This study also does not address the actual effectiveness of a student run recycling crew compared to a commercial recycling plant such as the one our co-mingled stream is sent to. This analysis shows that it would be most effective to increase the recycling rates of metals and paper products, as these streams have high returns of saved electricity and GHG emissions. The Clark recycling program has a measurable benefit to the university community and to the environment. Increasing awareness about the program and the way the recyclables are handled could help to increase the flow of useful materials into the center and raise energy savings and GHG emissions prevention. Using the NERC Environmental Benefits Calculator to frame the results of the program will hopefully make the information more accessible to the general student body and help the program gain both support and more material to sort.

Figures

Figure 1. NERC Calculator Inputs and Outputs

Material	Tons Recycled	Electricity Use if Recycled (Million BTUs)	Oil Barrels Saved	Gallons of Gas saved	Greenhouse Gas Emissions (MTCE)
Aluminum Cans	0.6	-123.85	21.422	1000.13	-2.24
Glass	2.5	-5.33	1.16	54.13	-0.19
PET Plastic	0.41	-21.66	2.99	139.79	-0.17
Corrugated Cardboard	49.44	-762.36	67.34	3143.77	-41.95
Office Paper	27.01	-272.26	13.18	615.26	-21.00
Whole Computers	1.96	-85.14	12.7	593.03	-1.21
Yard Trimmings	35.0	20.30	-20.46	-955.02	-1.89
Mixed Paper	8.23	-188.8	21.84	1019.49	-7.94
Mixed Metals	36.00	-2911.32	505.49	23598.56	-51.62
Mixed Recyclables	78.72	-1311.48	123.64	5772.3	-61.89
Mixed Organics	187.55	108.78	-97.66	4559.0	-10.13
Other Recyclables	16.12	NA	NA	NA	NA
Total	443.54	-5553.12	651.66	30,422.43	-200.23

Figure 2. Redeemable Bottle and Can Conversions

Redeemable	Boxes/Bags per Month	Weight per Box/Bag (lb.)	Total for Ten Months (Tons)
Plastic (PET)	25	3.25	0.41
Glass Bottles	20	12.5	2.5
Aluminum Cans	25	5.3	0.6

Figure 3. Resource Conservation From Steel and Glass

	Tons Recycled	Limestone Saved (Tons)	Iron Ore Saved (Tons)	Sand Saved (Tons)	Coal Saved (Tons)
Ferrous Steel	25.56	1.53	31.95	NA	17.86
Glass	2.5	0.48	NA	1.63	NA
Total	28.06	2.01	31.95	1.63	17.86

Figure 4.

Figure 4 represents the proportion by weight of each recycling stream compared to the total waste sent to the waste-to-energy incinerator from Clark University in 2011.

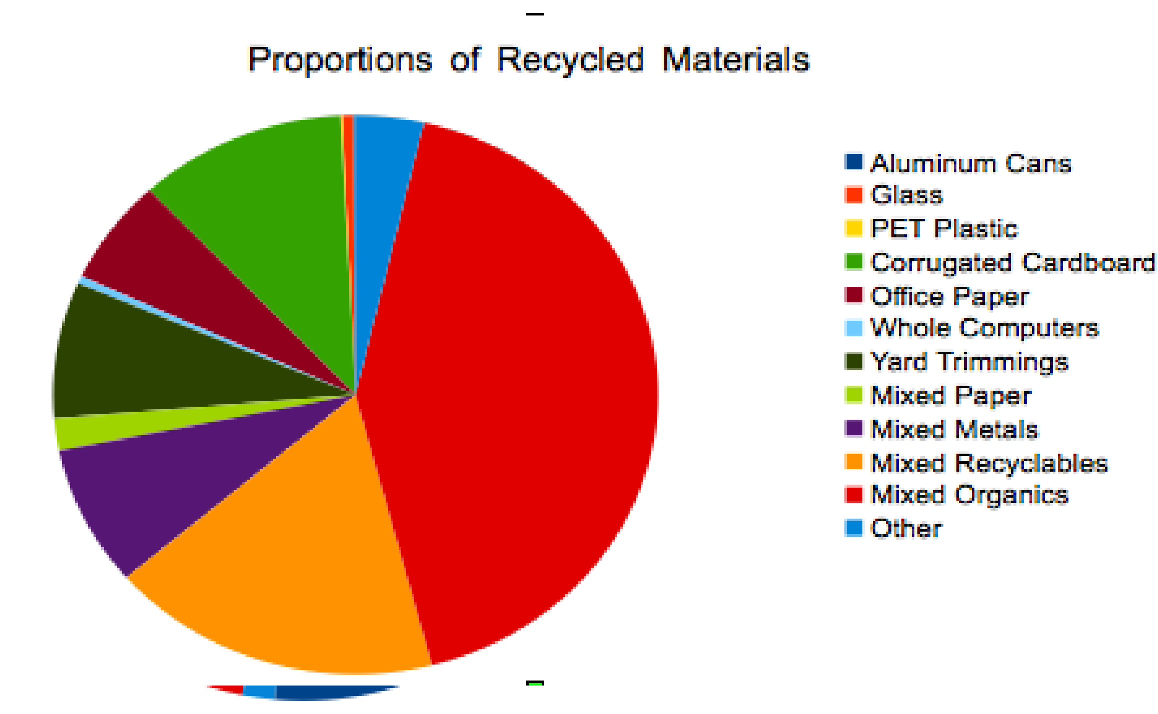

Figure 5.

Figure 5 represents the proportions of the different recycling streams by weight.

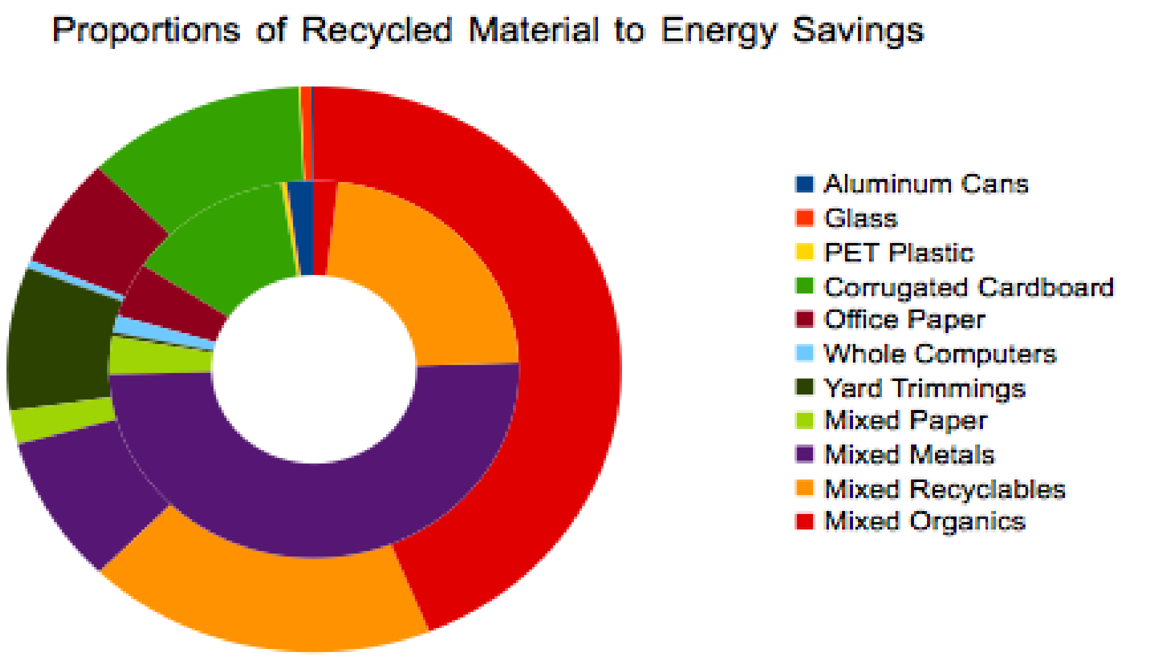

Figure 6.

Figure 6 represents the proportions of the recycled materials by weight and the corresponding proportions of energy savings from each stream. The outermost ring is the weight of each stream, and the inner ring is the energy savings from each stream. Obvious disproportionate energy savings can be seen for organic materials, mixed metals, corrugated cardboard, aluminum cans and yard trimmings.

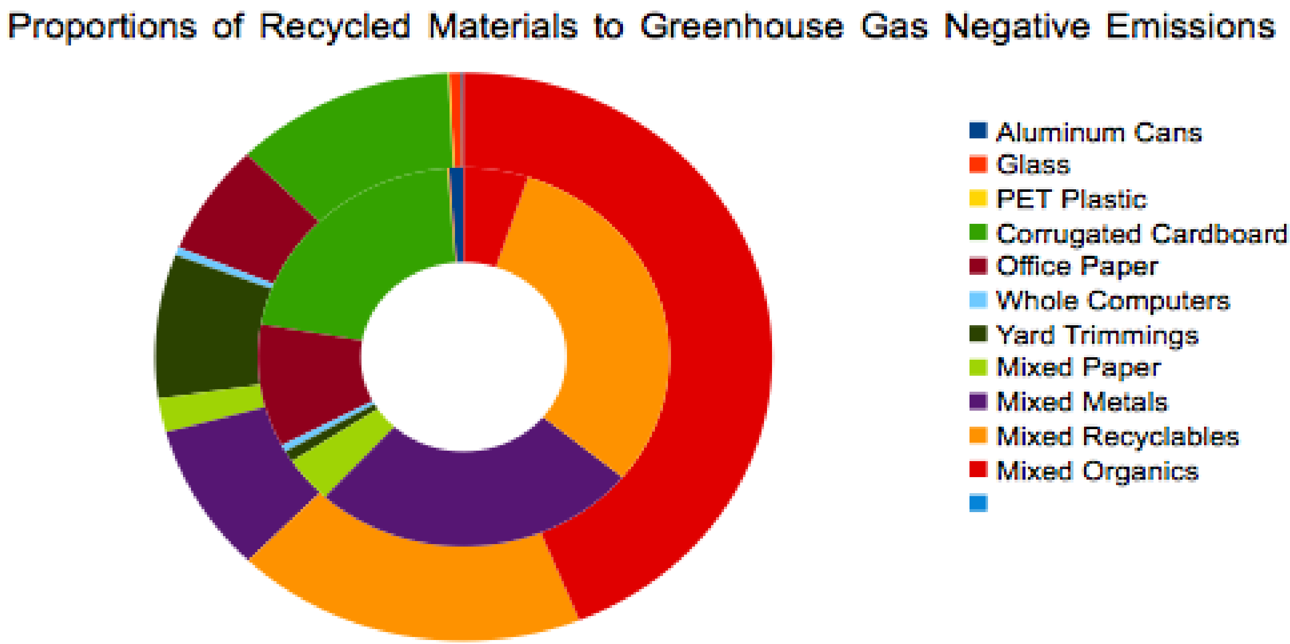

Figure 7.

Figure 7 represents the proportions of recycled materials by weight and the corresponding negative GHG emissions. The outermost ring is the weight of each stream, and the inner ring is the negative emissions resulting from each stream. Obvious disproportionate GHG emissions prevention can be seen from mixed organics, mixed metals, corrugated cardboard, aluminum cans and yard trimmings.

Sources

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