International Sustainability Institute

Comparative Analysis of Waste Management Practices

City of Seattle - Copenhagen

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Executive Summary

Seattle is considered to have a top recycling program when compared to other cities in the United States. Move the benchmark to worldwide best practices and compare Seattle to Copenhagen – a city similar in population size – and it becomes clear that Seattle's management of municipal solid waste is focused on a very small portion of the picture and, as a result, misses an enormous opportunity.

Seattle residents export almost 440,000 tons of waste every year to landfills in Oregon. The waste export process consumes significant energy in order to transport the waste 300 miles, 300 days a year. Copenhagen, on the other hand, landfills one twentieth of this amount within a seven mile radius from its city center, after converting almost all of what it does not recycle into energy – enough energy to offset what they use, and have a surplus to heat and power 70,000 homes.

A brief quantitative analysis of the latest comparable data, which is from 2004 to 2006, will compare the municipal waste streams by the numbers, and then will highlight the main differences in the processes. A qualitative analysis will draw lessons from these numbers and process descriptions to compare the cities' practices from a sustainability perspective.

Quantitative analysis

Waste Generated

Waste per capita/per employee

- Residential waste per inhabitant was 10% higher in Seattle than in Copenhagen. (0.567 Tons per Inhabitant vs. 0.519 Tons)[1].
- Commercial waste generated per employee was 5% less in Seattle than in Copenhagen. (0.857 Tons per employee vs. 0.897 Tons)[2].

Construction and Demolition Waste[3]

- Seattle generated 373,000 Tons; Copenhagen generated close to 430,000 Tons.
- Seattle reused, recycled, converted to energy, or diverted from the landfill 42%. Copenhagen reused or recycled 90%, and converted another 8% into energy.
- Seattle exported to the landfill 216,000 tons of Construction and Demolition Waste while Copenhagen only landfilled 8,600 tons.

Recycling Rates without Construction and Demolition Tonnage

- Seattle recycling rate for residential is 56% and for commercial is 55%[4]
- Copenhagen's recycling rate is 26% for residential and 32% for commercial.[5]

Process highlights

Recycling Considerations

- Recycling Rate" for MSW is defined as Recycled Tons / (Recycled + Disposed). Copenhagen includes Construction and Demolition waste in its MSW category while Seattle doesn't. Copenhagen's official recycling figure for MSW is 55%. For the purposes of this study, the C+D content was isolated from the overall tonnage and is compared as a category of its own.

- Through a taxation scheme, the producers of packaged goods in Denmark are encouraged to use packaging that can be recycled or incinerated rather than landfilled; therefore from the beginning packaging is designed to fit into one of these categories.[6]. At the very moment of disposing the waste, the end user must follow the path chosen by the producer of the packaging. While Copenhagen focuses their efforts in reducing packaging as a whole, Seattle is mainly focusing their effort in increasing recycled content in the total waste amounts (recycling rates). The larger the packages in the trash bins the better the recycling rates will appear.

- Because turning waste-to-energy is Copenhagen's preferred option, the city does not facilitate recycling as much as Seattle does. It places the burden of the cleaning and transportation of recyclable containers on the end user in a process focused on "separation at source." Homeowners for example are required to take recyclables to a community deposit center. Seattle, on the other hand, picks up recyclable materials at the curbside of the homeowners.

- Copenhagen's bottom line for waste management analysis is based on the energy outcome and the landfill footprint. Seattle's bottom line instead appears focused on increasing the proportion of recyclable vs. disposable waste. The embedded energy in recycling is not taken into account in this approach.

Land-filling vs. Treatment

Once recyclable materials are culled from the waste stream, the remainder is considered "landfill material" in Seattle, and "materials due for treatment" in Copenhagen; landfilling is nothing but the last available option. In 2006, Seattle buried 438,000 tons of garbage, while Copenhagen buried only 22,000 tons. 70% of all Residential and Commercial waste in Copenhagen ended up in a Waste to Energy Treatment facility.

As long as the landfill is the end of the line for waste – the place where, by default, all garbage is disposed of, landfills will continue to grow. Seattle already has filled 14 landfill sites.[7] These mountains of waste require monitoring for years to come and risk leakage. Two of Seattle's sites are now Federal Superfund sites, costing more than $110 million for mitigation.[8] King County regulations stopped Seattle from overflowing the Cedar Hills

landfill facility in the late 80s, and furthermore forbade the construction of another landfill in the county. Waste export is the only possibility for Seattle since.

In Copenhagen, the Amagerforbraending treatment facility received two thirds of the total 400,000 tons suitable for incineration in 2006. The Vestforbrænding treatment facility received the other third, as well as the waste of 20 other municipalities.[9] Together they produced enough energy to provide heat and power to 70,000 households. (Copenhagen's district energy system is critical to deliver the heat.)

Even the by-product of the waste incineration is useful. Eighty percent of it is recycled as fly-ash for low-energy concrete production.[10] If it were to be tabulated as recycled content, it would increase their MSW recycling figures by 8%.

<u>Energy Considerations</u>

Seattle's residential waste is carted from the home to a transfer station, from a transfer station to the rail yard and finally from the rail yard to a landfill in Oregon. We calculated the energy required to transport all this waste to its final resting place to be 44 billion BTUs – almost all of it generated from fossil fuels. Using carbon emission figures we calculated that merely *transporting* Seattle's waste from where it is disposed to where it arrives at landfill released almost 7.2 million pounds of CO2 to the atmosphere in 2006.[11]

Copenhagen's residential density allows it to shorten the path of its garbage. One company, a non-profit concession that collects waste since 1898, delivers it directly to one of two waste-to-energy plants, at a maximum trip distance of seven miles. Transporting Copenhagen's 553,000 tons of residential and commercial waste consumed approximately 6.8 billion BTUs of energy – approximately 15 percent of the Seattle total. [12]

Denmark's state of the art facilities can turn three tons of garbage into the same amount of energy that burning one ton of oil produces. Copenhagen's two facilities turn waste into an approximate total of 4.2 million GJ, or 3.9 trillion BTUs per year. Approximately 3.1 trillion BTUs are distributed as heat to its citizens, and the rest is distributed as electricity. The total is enough to cover the power and heating needs of about 70,000 households. Co2 emissions from W2E plants have been calculated as 20% of those that a coal burning plant would generate to produce the same amount of energy. [13]

Conclusions

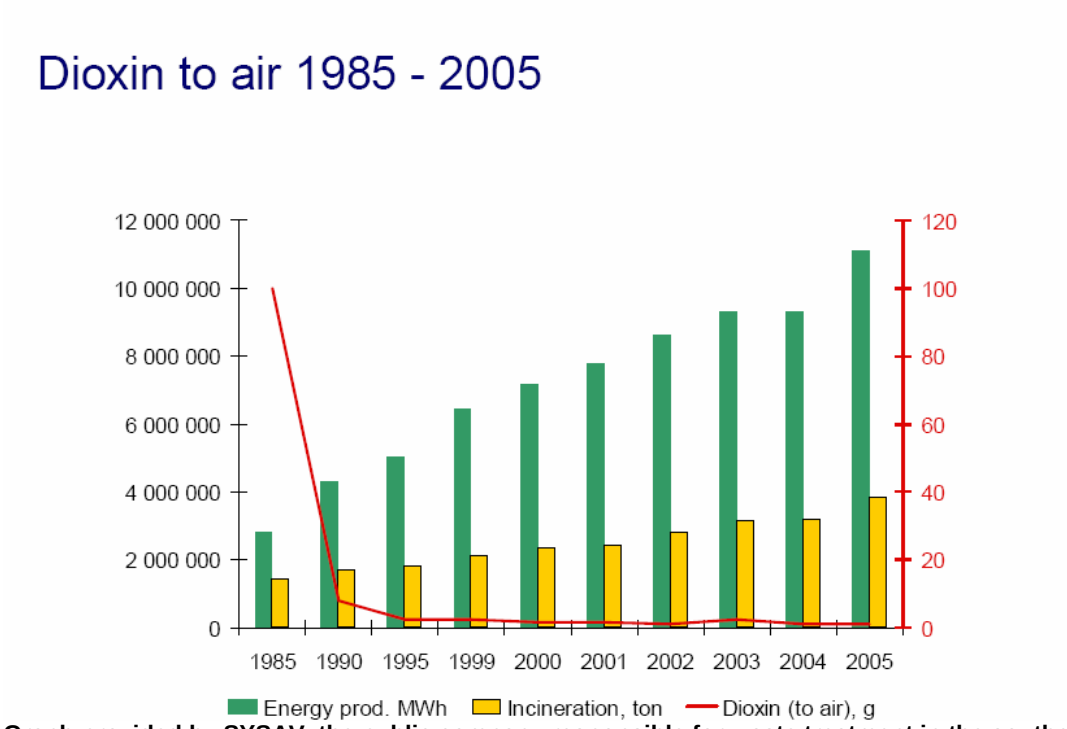
Under the existing system, Seattle ignores the externalities of recycling, transport and landfilling processes. Seattle offsets its waste problem in space and in time. The landfill destination is the endpoint of a typical linear process while Copenhagen's energy recovery enables a circular one. If Seattle wants to be truly sustainable it must move unto circular models. There is an axiom that, *"You cannot run a linear system on a finite planet indefinitely".* [14] By moving toward a closed waste system Seattle would be able to minimize its landfill footprint and produce enough energy to offset the entire amount spent and have a considerable surplus.

When seeking comparisons to worldwide best practices, Copenhagen is a good benchmark for Seattle. Copenhagen, which has roughly the same population as Seattle, has a waste footprint one-twentieth the size of Seattle's. [15] The energy surplus of Copenhagen's waste management system is enough to power and heat 70,000 households, while the deficit of Seattle's system requires a considerable linear demand for fossil fuel energy.

Recommendations

- Seattle must evolve to analyze its overall waste management system from three related perspectives: energy, carbon emissions and landfill footprint. Measuring the success of the system by mere recycled content is inaccurate. The energy embedded in recycling processes, as well as collection and transport of waste is never taken into account. The opportunity of recovering the energy of this inert material is being missed, as well as that of minimizing the impact to neighboring regions.

- Seattle must embrace waste-to-energy as a way to transform a land-fill liability into clean energy. City leaders have the responsibility to educate the public on the efficiency and safety of sophisticated waste-to-energy facilities. The city's current website still quotes facts from 1987 as reasons why Seattle rejected the possibility of "incineration". Even present viral marketing efforts from progressive non-profit foundations[16] name Dioxins as the main reason to reject this practice. The graph on the next page illustrates the evolution of the Waste to Energy technology since 1985. The success of Waste-to-Energy plants has made them proliferate in Europe: Denmark has 31 plants, Germany 58, and France 123.[17]



Graph provided by SYSAV, the public company responsible for waste treatment in the southern Scania region.

- Seattle must improve the way it handles the Construction and Demolition Waste process. The fact that it does not make part of Seattle's definition of MSW has left it outside the picture for policy makers, yet it's a big contributor to the landfills. (An additional 50% more tonnage to the already bulky 440,000 Tons). The current law that obliges any load with 10% of contaminants to be considered "Waste" is not an adequate measure. Further exploration of the Copenhagen Recycling Center -a site destined to be a landfill that now recycles 90% of the C+D material- would be of positive impact for the city.

[1] Seattle's 586k inhabitants produced 332,000 Tons of waste. Copenhagen's 503k inhabitants produced 261,000. Calculations and figures in pgs 10-20 of the addendum.
[2] 490,700 Seattle employees generated 420,360 Tons. 325,978 Copenhagen employees generated 292,244 Tons. Calculations and figures in pg 21-22 of the Addendum.
[3] Seattle figures come from Seattle Public Utilities, Construction and Demolition Waste in the City of Seattle (2006) 1. Figures for Copenhagen were given by Jens Nejrup, director of Copenhagen Recycling Center (2007). The Constructions and Demolition category in Copenhagen is called CDL, as it includes "Landclearing" waste. A portion of the 432k come would be considered compost Waste.
[4] ISI, Comparative Study of Seattle's and Copenhagen's Waste Management Practices Between the Years of 2004-2006 PowerPoint (2008) 69,43.
[5] Jens Nejrup, Copenhagen Waste Management PowerPoint (2007) 4-5. Calculation done by dividing both residential and commercial waste tonnage by the total waste tonnage
[6] Jens Nejrup, Copenhagen Waste Management PowerPoint (2007) 18.
[7] On the Path to Sustainability 2004 Plan Amendment (2004) 60. This document put out by Seattle Public Utilities outlines the cost of each of the two-superfund sites cleanup as well as containing a map of all closed Seattle Landfills. On the Path to Sustainability 2004, 14. Seattle Public Utilities refers to continual management of past landfills as a cost for the future.
[8] King County Department of Natural Resources and Parks, Proposed Recommendations: Solid Waste Transfer and Waste System Plan (2006) 33. Quote: "The Cedar Hills landfill is the only active landfill remaining in King County. County policy DSW-2 (Ordinance 14236) states that "the county should not seek to site a replacement landfill for the Cedar Hills regional landfill in King County." The disposal policies direct the county to contract for long-term disposal at an out-of-county landfill." King County Department of Natural Resources and Parks, Proposed Recommendations: Solid Waste Transfer and Waste System Plan (2006). Once it had been decided that another landfill was no longer an option based on the ordinances this report was made in order to formulate a plan for waste export.
[9] Jens Nejrup, Copenhagen Waste Management PowerPoint (2007), 15. ISI, Comparative Study of Seattle's and Copenhagen's Waste Management Practices Between the Years of 2004-2006 PowerPoint (2008) 75-6 and 15. Calculated based on the assumption that 2/3 of the potential yearly energy comes from Amagerforbraending and 1/3 comes from Vestforbrænding.
[10] Jens Nejrup, Copenhagen Waste Management PowerPoint (2007) 15-16.
Graph produced by SYSAV in 2002. Can be found at www….xxx
[11] Conversions from BTUs to CO2 are based on the individual fuel types and the miles in which each one was type is used in the transport. See excel worksheet on page 90 of the PowerPoint presentation. All calculations and figures are explained and/or hyper linked. A very commonly used energy figure in the freight industry is the BTU per ton/mile, or the amount of Energy in BTUs required for moving one ton of material for one mile. The most efficient W2E system in Europe: Waste to Energy in Denmark; copyright RenoSam and Ramboll. Pg. 8. available at
http://www.renosam.dk/media/filebank/org/RenosamhvidbogGB.pdf
[12] ISI, Comparative Study of Seattle's and Copenhagen's Waste Management Practices Between the Years of 2004-2006 PowerPoint (2008) 78. Calculation can also be referenced in the excel worksheet on page 90 of the PowerPoint presentation
[13] Waste-to-Energy in Denmark. The most efficient waste management system in Europe. RenoSam and Ramboll 2006. Set by Hoiland Design Aps. PE Offset printers . Translated by Susanne Nilsson
[14] "The Story of Stuff" by Annie Leotard. Available at www.storyofstuff.com
[15] Copenhagen considers more than 95% of its remaining waste "suitable for incineration." Jens Nejrup, Copenhagen Waste Management PowerPoint (2007) 6; ISI, Comparative Study of Seattle's and Copenhagen's Waste Management Practices Between the Years of 2004-2006 PowerPoint (2008) 29.
[16] "The Story of Stuff" by Annie Leotard. Chapter 5. Available at www.storyofstuff.com
[17] ISI, Comparative Study of Seattle's and Copenhagen's Waste Management Practices Between the Years of 2004-2006 PowerPoint (2008) 99.