From Behavior Change to Environmental Outcomes In the Grocery Sector

May 2015

Northeast Waste Management Officials' Association (NEWMOA)

Connecticut • Maine • Massachusetts • New Hampshire • New Jersey • New York • Rhode Island • Vermont

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Introduction

In 2012, the Northeast Waste Management Officials' Association (NEWMOA) launched a Regional Sustainable Grocers Initiative to promote more sustainable practices at grocery stores and recognize the efforts already underway at many stores and chains. The goals of the Regional Initiative are to:

- Increase adoption of sustainable practices to address environmental problems in grocery stores
- Recognize the achievements of those within the sector
- Measure the environmental benefits of the initiative

Over the last couple of years, NEWMOA, with input from its Sustainable Grocers Workgroup, researched and developed the following methods and tools to estimate the outcomes from sustainable practices in this sector. This initiative supports government programs that conduct outreach and assistance to grocers and designate sustainable recognition. The intent is to improve their ability and those of their clients to calculate the environmental impacts of their sustainability efforts, and thereby strengthen the programs and expand adoption of sustainable practices. This initiative helps participants to communicate the impacts of their work to policy makers, customers, and other stakeholders.

This project is funded by EPA Regions 1 and 2 and the participating state programs.

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Metrics Category #1
Waste Reduction Measures – Corresponds with Section B in Workbook

Section 1A: (B8) Implementing a Recycling Program in Grocery Stores

Variables:
Number of employees = direct measure from the facility
Total recyclable waste per employee = 10,606.6 lbs. [1]

Formulas:
(Total recyclable waste per employee) x (number of employee) =
Amount of recyclable waste captured per year when implementing a recycling program in grocery stores

Example – A Store with 100 Employees:
(10606.6 lbs. / 1 employee / 1 year) x (100 employees) = *1,060,660 pounds per year* (approx. 530 tons per year)

Section 1B: (B11) Implementing a Food Composting Program

Variables:
Number of employees = direct measure from the facility
Amount of food waste per employee per year = 4,625 lbs. [2]
Percentage of food waste that is non-meat = 70% [3]

Formulas:
[(Number of employees) x (Amount of food Waste per employee per year)] x (1-30%) =
Amount of food waste (non-meat) captured per year when implementing a composting program

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Section 1C: (B28) Offering Incentives to Customers Using Reusable Bags

Variables:

Number of employees = direct measure from the facility

Average number of customers per employee per year =15,444 customers [4]

Environmental impacts in table noted below = [5]

Impact Category	Unit	Plastic bag	Reusable Bag
Global Warming	Kilograms (kg) CO_2	7.35	6.47
Water Use	Kiloliters (kl) H_2O	0.053	0.038
Solid Waste	kg	3.307	0.806
Fossil Fuels	Mega joules (MJ) surplus	19.067	6.463

Formulas:

(Number of employees) x (number of customers per employee per year) x (kg of CO2 from plastic bags per year per customer - kg of CO2 from reusable bags per year per customer) =
Kg of CO2 reduced when switching from plastic bags to reusable bags

(Number of employees) x (number of customers per employee per year) x (kl of H2O from plastic bags per year per customer- kl of H2O from reusable bags per year per customer) =
Kl of water saved when switching from plastic bags to reusable bags

(Number of employees) x (number of customers per employee per year) x (kg of solid waste from plastic bags per year per customer- kg of solid waste from reusable bags per year per customer) =
Kg of solid waste reduced when switching from plastic bags to reusable bags

(Number of employees) x (number of customers per employee per year) x (MJ surplus of fossil fuels from plastic bags per year per customer- MJ surplus of fossil fuels from reusable bags per year per customer) =
MJ surplus of fossil fuels saved when switching from plastic bags to reusable bags

Metrics Category #2
Reductions in Energy Use – Corresponds with Section C in Workbook

Section 2A: (C32) Replacing CFLs with LEDs for Interior Lighting

Variables:
Number of CFLs replaced with LEDs = direct measure from the facility
Number of hours used per day= direct measure from the facility
Difference in electricity consumption per LED vs. CFL (watts) = 5 watts [6]

Formulas:
(Number of CFLs replaced with LEDs) x (number of watts saved per LED) / 1,000 x (number of hours used per day) = **Total kWh saved per day by switching to LEDs**

Section 2B: (C33) Replacing CFLs with LEDs for Refrigerated Display Lighting

Variables:
Number of CFLs replaced with LEDs = direct measure from the facility
Number of hours used per day = direct measure from the facility
Difference in electricity consumption per LED vs. CFL (watts) = 211 watts [7]

Formulas:
(Number of CFLs replaced with LEDs) x (number of watts saved per LED) / 1,000 x (number of hours used per day) = **Total kWh saved per day by switching to LEDs**

Section 2C: (C13) Replacing Illuminated Exit Signs with LED Exit Signs

Variables:
Number of incandescent exit signs replaced with LEDs = direct measure from the facility
Difference in electricity consumption between incandescent and LED signs (kwh/sign/year) =306kwh [8]

Formulas:
(Number of exit signs replaced with LEDs) x (difference in kWh per year) =
Total kWh saved per year by switching to LED exit signs

Example – Store Replaced 10 Exit Signs:
(10 exit signs) x (306 kWh per year) = *3,060 kWh saved per year*

Section 2D: (C34) Upgrading to LED Lighting for Parking Lot

Variables:
Number of total lights replaced with LEDs = direct measure from the facility
Number of hours used per day = direct measure from the facility
Difference in electricity consumption per LED vs Incandescent (watts) = 124 watts [9]
Difference in electricity consumption per LED vs. Halogen Quartz (watts) = 119 watts [10]
Difference in electricity consumption per LED vs. Fluorescent (watts) = 8 watts [11]
Difference in electricity consumption per LED vs. Mercury Vapor (watts) = 146 watts [12]
Difference in electricity consumption per LED vs. Metal Halide (watts) =131 watts [13]
Difference in electricity consumption per LED vs. High Pressure Sodium (watts) = 7 watts [14]
Average breakdown of the types of lights used = see list below [15]

- High pressure sodium = 39%
- Metal halides = 27%
- Mercury vapor = 13%
- Halogen quartz = 8%
- Fluorescent = 6%
- Incandescent = 2%

Formulas:
[(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to Incandescent) / 1,000 x (number of hours used per day) x 2%] + [(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to Halogen Quartz) / 1,000 x (number of hours used per day) x 8%] + [(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to Fluorescent) / 1,000 x (number of hours used per day) x 6%] + [(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to Mercury Vapor) / 1,000 x (number of hours used per day) x 13%] + [(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to Metal Halide) / 1,000 x (number of hours used per day) x 27%] + [(Number of total lights replaced with LEDs) x (number of watts saved per LED compared to High Pressure Sodium) / 1,000 x (number of hours used per day) x 39%] =
Total kWh saved per day by switching all types of lights to LEDs

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Section 2E: (C25) Installing Strip Curtains on Walk-in Refrigeration Units

Variables:
Number of strip curtains = direct measure from the facility
Energy savings for a strip curtain = 3,730 kwh/year [16]

Formulas:
(Energy savings for a strip curtain) x (Number of strip curtains) =
Total kWh saved per year by installing strip curtains

Example – Store with 10 Strip Curtains:
(10 curtains) x (3,730 kWh per year) = *37,300 kWh saved per year*

Metrics Category #3
Water Conservation Measures – Corresponds with Section D in Workbook

Section 3A: (D5) Switching to Low-flow Toilets (≤ 1.6 gal)

Variables:
Number of employees = direct measure from the facility
Difference in flush volume per flush = 1.9 gallons [17]
Average number of flushes per day per employee = 2.6 [18]
Average number of flushes per day per customer = 0.13 [19]
Number of days open per year = 362 [20]
Average number of customers per employee per year = 15,444 customers [21]

Formulas:
[(Average number of customers per employee per year) x (number of employees) x (362 day) x (Difference in flush volume per flush) x (Average number of flushes per day per customer)] + [(number of employees) x (Difference in flush volume per flush) x (Average number of flushes per day per employee) x (362 day)] =
Gallons of water saved per year when switching from standard to low flow toilets

Example – A Store with 100 Employees:
[(15,444 customers / 1 employee / 1 year) x (100 employees) x (362 days) x (1.9 gal / 1 flush) x (0.13 flush / 1 customer / 1 day)] + [(100 employees) x (1.9 gal / 1 flush) x (2.6 flush / 1 employee / 1 day) x (362 day)] =
X gallons of water saved per year

Section 3B: (D11) and (D12) Switching to High-efficiency or Dual-flush Toilets (≤ 1.28 gal)

Variables:
Number of employees = direct measure from the facility
Difference in flush volume per flush = 2.2 gallons [22]
Average number of flushes per day per employee = 2.6 [23]
Average number of flushes per day per customer = 0.13 [24]
Number of days open per year = 362 [25]
Average number of customers per employee per year = 15,444 customers [26]

Formulas:
[(Average number of customers per employee per year) x (number of employees) x (362 day) x (Difference in flush volume per flush) x (Average number of flushes per day per customer)] + [(number of employees) x (Difference in flush volume per flush) x (Average number of flushes per day per employee) x (362 day)] =
Gallons of water saved per year when switching from standard to high efficiency toilets

Example – A Store with 100 Employees:
[(15,444 customers / 1 employee / 1 year) x (100 employees) x (362 days) x (2.2 gal / 1 flush) x (0.13 flush / 1 customer / 1 day)] + [(100 employees) x (2.2 gal / 1 flush) x (2.6 flush / 1 employee / 1 day) x (362 day)] =
X gallons of water saved per year

Section 3C: (D13) Switching to Waterless or High-efficiency Urinals

Variables:
Number of employees = direct measure from the facility
Difference in flush volume per flush = 1.1 gallons [27]
Average number of flushes per day per employee = 1.3 [28]
Average number of flushes per day per customer = 0.07 [29]
Number of days open per year = 362 [30]
Average number of customers per employee per year =15,444 customers [31]

Formulas:
[(Average number of customers per employee per year) x (number of employee) x (362 day) x (Difference in flush volume per flush) x (Average number of flushes per day per customer)] + [(number of employee) x (Difference in flush volume per flush) x (Average number of flushes per day per employee) x (362 days)] =
Gallons of water saved per year when switching from standard to high-efficiency urinals

Example – A Store with 100 Employees:
[(15,444 customers / 1 employee / 1 year) x (100 employees) x (362 days) x (1.1 gal / 1 flush) x (0.07 flushes / 1 day / 1 customer)] + [(100 employees) x (1.1 gal / 1 flush) x (1.3 flushes / 1 day / 1 employee) x (362 days)] =
X gallons of water saved per year

Section 3D: (D4) Switching to Low-flow Faucets in Hand-washing Sinks (≤ 1.5 gal)

Variables:
Number of employees = direct measure from the facility
Difference in flow rate from non-conserving faucets to conserving faucets = 0.7 gpm [32]
Average number of minutes a faucet is run by employee per day = 0.43 [33]
Average number of minutes a faucet is run by customer per day = 0.02 [34]
Number of days open per year = 362 [35]
Average number of customers per employee per year =15,444 customers [36]

Formulas:
[(Number of employees) x (Difference in flow rate, gallons per minute) x (Average number of minutes a faucet is run by employees per day) x (362 day)] + [(Average number of customers per employee per year) x (number of employees) x (362 day) x (Difference in flow rate, gallons per minute) x (Average number of minutes a faucet is run by customer per day)] =
Gallons of water saved per year when switching from standard to low-flow faucets

Example – A Store with 100 Employees:
[(100 employees) x (0.7 gpm) x (0.43 min / 1 employee/ 1 day) x (362 days)] + [(15,444 customers / 1 employee / 1 year) x (100 employees) x (362 days) x (0.7 gpm) x (0.02 min / 1 customer / 1 day)] =
X gallons of water saved per year

Section 3E: (D10) Switching to Utlra Low-flow Faucets in Hand-washing Sinks (≤ 0.5 gal)

Variables:

Number of employees = direct measure from the facility
Difference in flow rate from non-conserving faucets to conserving faucets = 1.7 gpm [37]
Average number of minutes a faucet is run by employee per day = 0.43 [38]
Average number of minutes a faucet is run by customer per day = 0.02 [39]
Number of days open per year = 362 [40]
Average number of customers per employee per year =15,444 customers [41]

Formulas:

[(Number of employees) x (Difference in flow rate, gallons per minute) x (Average number of minutes a faucet is run by employees per day) x (362 day)] + [(Average number of customers per employee per year) x (number of employees) x (362 day) x (Difference in flow rate, gallons per minute) x (Average number of minutes a faucet is run by customer per day)] =
Gallons of water saved per year when switching from standard to low-flow faucets

Example – A Store with 100 Employees:

[(100 employees) x (0.7 gpm) x (0.43 min / 1 employee/ 1 day) x (362 days)] + [(15,444 customers / 1 employee / 1 year) x (100 employees) x (362 days) x (0.7 gpm) x (0.02 min / 1 customer / 1 day)] =
X gallons of water saved per year

Metrics Category #4
Reductions in Greenhouse Gas (GHG) Emissions

Section 4A: GHG Reductions Resulting from Water Conservation Practices

Note: Some facilities may only implement one or two of the water conservation programs listed below; for those facilities, the gallons of water saved would be zero.

Variables:
Water saved by Switching to Low-flow Toilets (gallon) = *calculated in Section 3A*
Water saved by Switching to High Efficiency Toilets (gallon) = *calculated in Section 3B*
Water saved by Switching to Low-flow Urinals (gallon) = *calculated in Section 3C*
Water saved by Switching to Low-flow Faucets (gallon) = *calculated in Section 3D*
Water saved by Switching to Ultra- Low-flow Faucets (gallon) = *calculated in Section 3E*
GHG emission of the whole water cycle: 19.24 ton/million gallon [42]
Unit conversion = 1 ton is equivalent to 2,000 pounds

Formulas:
(GHG emission of the whole water cycle, ton/million gallon) x [(gallons of water saved per year by switching to low-flow toilets) + (gallons of water saved per year by switching to low-flow urinals) + (gallons of water saved per year by switching to low-flow faucets)] x 10^6 x (1 ton/2000 pounds) = **GHG emission reduced when implementing water conservation measures**

Section 4B: GHG Reductions Resulting from Energy Efficiency Practices

Note: Some facilities may only implement one or two of the energy efficient programs listed below; for those facilities, the kWh saved would be zero.

Variables:

Total kWh saved per day by switching to LEDs for recessed downlights = *calculated in Section 2A*
Total kWh saved per day by switching to LEDs for refrigerated display lighting= *calculated in Section 2B*
Total kWh saved per day by switching to LEDs for exit signs= *calculated in Section 2C*
Total kWh saved per day by switching to LEDs for parking lot= *calculated in Section 2D*
Total kWh saved per year by installing strip curtains= *calculated in Section 2E*
CO_2 emission (metric tons / kWh) = 6.89551×10^{-4} [43]
Unit conversion = 1 metric ton is equivalent to 2,205 pounds

Formulas:

[(Total kWh saved per day by switching to LEDs for recessed downlights) + (Total kWh saved per day by switching to LEDs for refrigerated display lighting) + (Total kWh saved per day by switching to LEDs for exit signs) + (Total kWh saved per day by switching to LEDs for parking lot) + (Total kWh saved per day by installing strip curtains)] x (CO_2 emission, metric tons / kWh) x (1 metric ton/ 2205 pounds) = **GHG emissions reduced by implementing energy practices**

Section 4C: GHG Reductions Resulting from Recycling Programs

Variables:

Amount of recyclable waste captured per year when implementing a recycling program in grocery stores = *calculated in Section 1A*

Formulas:

(Pounds of waste recycled) x (0.0005 tons/pound) = *Tons of waste recycled per year*

Tons of waste recycled plugged into the following EPA calculator:
www.epa.gov/climatechange/wycd/waste/calculators/Warm_Form.html =
Reduced GHG emissions from alternative waste scenarios

Note: When using WARM model, the baseline scenario could assume an equal amount of waste landfilled and combusted. However, the individual amounts of waste landfilled and composted may be changed depending on the state and/or individual facility, as long as the total amount of waste equals tons of waste recycled per year.

Section 4D: GHG Reductions Resulting from Food Composting Programs

Variables:
Amount of food waste captured per year when implementing a composting program = *calculated in Section 1B*

Formulas:
(Pounds of food waste (no meat) composted) x (0.0005 tons/ 1 pound) = *Tons of food waste (no meat) composted per year*

Tons of food waste (no meat) composted plugged into the following EPA calculator:
www.epa.gov/climatechange/wycd/waste/calculators/Warm_Form.html =
Reduced GHG emissions from alternative waste scenarios

Metrics Category #5
Associated Financial Savings

Section 5A: Installing Low-Flow and/or High Efficiency Water Devices

Note: Some facilities may only implement one or two of the water conservation programs listed below; for those facilities, the gallons of water saved would be zero.

Variables:

Water saved by Switching to Low-flow Toilets (gallon) = *calculated in Section 3A*
Water saved by Switching to High Efficiency Toilets (gallon) = *calculated in Section 3B*
Water saved by Switching to Low-flow Urinals (gallon) = *calculated in Section 3C*
Water saved by Switching to Low-flow Faucets (gallon) = *calculated in Section 3D*
Water saved by Switching to Ultra- Low-flow Faucets (gallon) = *calculated in Section 3E*
Cost of water ($/gallon) = $0.002 per gallon [44]

Formulas:

[(Water saved from low-flow toilets) + (Water saved from high-efficiency toilets) + (Water saved from waterless urinals) + (Water saved from low-flow faucets) + (Water saved from ultra-low-flow faucets)] x (cost of water per gallon) = **Total savings in water costs**

Section 5B: Installing Energy-Efficient Lighting Applications

Note: Some facilities may only implement one or two of the energy efficient programs listed below; for those facilities, the kWh saved would be zero.

Variables:

Total kWh saved per day by switching to LEDs for recessed downlights = *calculated in Section 2A*
Total kWh saved per day by switching to LEDs for refrigerated display lighting= *calculated in Section 2B*
Total kWh saved per day by switching to LEDs for exit signs= *calculated in Section 2C*
Total kWh saved per day by switching to LEDs for parking lot= *calculated in Section 2D*
Cost of electricity ($/kWh) = $0.10[45]

Formulas:

[(kWh saved from LEDs in recessed downlights) + (kWh saved from LEDs in refrigeration displays) + (kWh saved from LEDs in exit signs) + (kWh saved from LEDs in parking lots)] x (cost of electricity per kWh) = **Total savings in lighting energy costs**

References for Variables Used

[1] Recyclable waste includes cardboard, paper, recyclable glass, recyclable metal, and recyclable plastic. The data were from direct measure from the study. 34 food stores were recruited in the heavily urbanized areas of Los Angeles, Sacramento, San Diego, and San Francisco. This group includes retail stores primarily engaged in selling food for home preparation and consumption. Food stores that have approximately 15 fulltime employees or more are eligible to participate. In general, data was gathered from each participating site to confirm numbers of employees, to quantify and characterize the materials that are diverted, and to quantify and characterize the materials that are disposed. Cascadia Consulting Group. "Targeted Statewide Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry Groups". June 2006. http://www.calrecycle.ca.gov/publications/Documents/Disposal%5C34106006.pdf.

[2] The data were from direct measure from the study. 34 food stores were recruited in the heavily urbanized areas of Los Angeles, Sacramento, San Diego, and San Francisco. This group includes retail stores primarily engaged in selling food for home preparation and consumption. Food stores that have approximately 15 fulltime employees or more are eligible to participate. In general, data was gathered from each participating site to confirm numbers of employees, to quantify and characterize the materials that are diverted, and to quantify and characterize the materials that are disposed. Cascadia Consulting Group. "Targeted Statewide Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry Groups". June 2006. http://www.calrecycle.ca.gov/publications/Documents/Disposal%5C34106006.pdf.

[3] NEWMOA estimates 70% of food waste in grocery store is non-meat according to "The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States": The top three food groups in terms of share of total value of food loss are meat, poultry, and fish (30 percent); vegetables (19 percent); and dairy products (17 percent). http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib121.aspx?mkt_tok=3RkMMJWWfF9wsRonuKjOZKXonjHpfsX56%2B4qWKWzlMI%2F0ER3fOvrPUfGjI4ATsthI%2BSLDwEYGJlv6SgFT7DGMaNny7gNUxI%3D#.UwubD-NdWOl.

[4] Results came from direct measurement field studies and end use modeling components of the research projects. Dziegielewski, B., Kiefer, J., Opitz, E., Porter, G., Lantz, G., DeOreo, W., Mayer, P., and Nelson, J. (2000). Commercial and Institutional End Uses of Water, AWWARF, Denver. http://ufdc.ufl.edu/WC13511002/00001/1x

[5] Environmental impacts of shopping bags. Assumptions: The plastic bag material is high density polyethylene (HDPE) with 15% recycled material. The reusable bag material is reusable polyethylene terephthalate (PET) bag with recycled material. The values in the table are based on a common "functional unit", defined as the number of shopping bags consumed by a household to carry 70-grocery items home from the supermarket each week for 52 weeks. The number of plastic bags used per year is 520 and the number of reusable bag used per year is 4.1. The Sustainable Packaging Alliance Limited. 30 April 2009. http://mams.rmit.edu.au/r97dgq3iero9.pdf.

[6] The U.S. Department of Energy Report, "Energy Savings of Light Emitting Diodes in Niche Lighting Applications," estimates that the average wattage for CFL used in commercial facilities is 16 watts. The equivalent LED wattage would be 11 watts, for an energy difference of 5 watts per bulb. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[7] The U.S. Department of Energy Report, "Energy Savings of Light Emitting Diodes in Niche Lighting Applications," estimates that the average wattage for fluorescent used for refrigerated display case lighting systems is 482 watts. The equivalent LED wattage would be 271 watts, for an energy difference of 221 watts per bulb. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[8] Old incandescent exit signs consume up to 40 watts of electricity and use 350 kWh per year. Energy Star-qualified LED exit signs consume less than 5 watts of electricity and use approximately 44 kWh per year, for an annual savings of 306 kWh per year. www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf .

Note: This default value uses the assumption that the current illuminated exit signs use incandescent bulbs. However, fluorescent bulbs and CFLs may also be used in exit signs. These signs consume up to 16 watts of electricity and use up to 140 kWh per year. Therefore, when replacing these signs with LEDs, the annual savings is 96 kWh per year. Individual facilities may want to override this default value with a value that is specific to the type of exit sign they are replacing (i.e., incandescent versus fluorescent).

[9] The U.S. Department of Energy Report, "Energy Savings of Light Emitting Diodes in Niche Lighting Applications," estimates that the average wattage for Incandescent used in street and area lighting is 150 watts. The equivalent LED wattage would be 26 watts, for an energy difference of 124 watts per bulb. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[10] The U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” estimates that the average wattage for Halogen Quartz used in street and area lighting is 150 watts. The equivalent LED wattage would be 31 watts, for an energy difference of 119 watts per bulb.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[11] The U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” estimates that the average wattage for Fluorescent used in street and area lighting is 159 watts. The equivalent LED wattage would be 151 watts, for an energy difference of 8 watts per bulb.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[12] The U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” estimates that the average wattage for Mercury Vapor used in street and area lighting is 254 watts. The equivalent LED wattage would be 108 watts, for an energy difference of 146 watts per bulb.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[13] The U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” estimates that the average wattage for Metal Halide used in street and area lighting is 458 watts. The equivalent LED wattage would be 327 watts, for an energy difference of 131 watts per bulb.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[14] The U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” estimates that the average wattage for High Pressure Sodium used in street and area lighting is 283 watts. The equivalent LED wattage would be 276 watts, for an energy difference of 7 watts per bulb.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[15] According to the U.S. Department of Energy Report, “Energy Savings of Light Emitting Diodes in Niche Lighting Applications,” 27% of street and area lighting are metal halides and 39% are high pressure sodium. While incandescent, halogen quartz, fluorescent and mercury vapor take up 2%, 8%, 6% and 13% respectively.
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

[16] The data is based on a 180 square foot door area. Analysis of Standards Options for Walk-in Coolers (Refrigerators) and Freezers. 2004. http://www.energy.ca.gov/appliances/2004rulemaking/documents/case_studies/CASE_Walk-In_Cooler.pdf.

[17] EPA notes that, toilets made from the early 1980s to 1992 typically used 3.5 gallons per flush or more. Toilets made prior to 1980 typically used 5.0 to 7.0 or high gallons per flush. The oldest toilets can use more than 8 gallons per flush. Since 1992 the “standard” flush toilets have been no more than 1.6 gallons per flush. However, for this purposes of this metric to be consistent with the specifications in the Workbook, NEWMOA considers “low-flow” toilets using 1.6 gallons and “standard” toilets as using 3.5 gallons per flush. Therefore the difference in flush volume is 1.9 gallons of water saved per flush. http://www.home-water-works.org/indoor-use/toilets.

[18] This average was pre-calculated based on three studies of office buildings in which the numbers varied from 2.0 to 3.45 toilet flushes per employee per day (Darell Rogers cited in Schultz Communications (1999); Konen cited in A and N Technical Services, Inc. (1994); and Eva Opitz cited in PMCL (1996). http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/appendix_d3.pdf

[19] A case study of Walmart indicates that 20 percent of visitors use the restroom (Eastern Municipal Water District 1995). We assumed that 66 percent of these visitors used toilets and 33 percent used urinals (Vickers 2001). http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/appendix_d3.pdf

[20] NEWMOA assumes that stores are open every day except for Thanksgiving, Christmas, and New Year's Day.

[21] See reference #3.

[22] The EPA Water Sense Program states that a conservative estimate of standard flush volume is 1.6 gallons; flush volume for high-efficiency toilets is no more than 1.28 gallons. However, for this purposes of this metric to be consistent with the specifications in the Workbook, NEWMOA considers “low-flow” toilets using 1.6 gallons and “standard” toilets as using 3.5 gallons per flush as cited in reference #16. Therefore the difference in flush volume when compared to “standard” toilets is 2.22 gallons of water saved per flush.
http://www.epa.gov/watersense/docs/spec_het508.pdf

Note: This default value uses the assumption that the current toilets are the old models that use 3.5 gallons per flush; however, since the 1990s the standard water consumption values have changed to the approximate 1.6 gallons per flush. Therefore, when replacing *these toilets with high-efficient models, the savings is only 1.9 gallons. Individual facilities may want to override this default value with a value that is specific to the type of toilet they are replacing (if known).*

[23] See reference #17.

[24] See reference #18.

[25] See reference #19.

[26] See reference #3.

[27] NEWMOA estimates a water savings of 1.1 gallons per flush using an average flow rate for low-flow urinals of 0.5 gallons of water per flush compared to an average flow rate for standard toilets of 1.6 gallons per flush, based on the following references:

- Using data collected in detailed regional audits performed by the East Bay Municipal Utilities District (EBMUD), the amount of water an average flush is based on the mix of urinal in each water district's service area.
- According to WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities, by EPA, the average flow rate of high efficient urinals is 0.5 gpf or less. http://www.epa.gov/watersense/commercial/docs/watersense_at_work/#/1/zoomed

Formula: 1.6-0.5 = 1.1 gallons of water per flush saved

[28] The number of times that employees use urinals daily is the average of the number of times the toilets are used daily in office buildings divided by two (because only men, presumably 50 percent of the employees, use urinals) (Darell Rogers cited in Schultz Communications 1999 and Konen cited in A and N Technical Services, Inc. 1994).

Formula: 2.6 / 2 = 1.3 urinal flushes per day per employee

[29] The number of times visitors use urinals was calculated from the assumption that they use urinals once for every two times they use the toilet (Vickers 2001). As the average number of flushes per day per customer is 0.13 cited above. NEWMOA estimates the average number of flushes per day per customer is 0.07 (rounded up).

Formula: 0.13 / 2 = 0.065 number of flushes per day per customer

[30] See reference #19.

[31] See reference #3.

[32] The EPA Water Sense program cites the standard faucet flow rate as 2.2 gallons per minute (gpm); low-flow faucets use between 0.8 to 1.5 gpm (for this metric, NEWMOA uses the more conservative value of 1.5 gpm). Therefore the difference in flow rate is 0.7 gpm. www.epa.gov/watersense/docs/faucet_spec508.pdf

[33] NEWMOA estimates 0.43 minutes a faucet is run by employee per day under the assumption that total water use from restroom faucets is related to the number of toilet and urinal flushes. Average number of minutes the faucet run per flush is 0.11 minutes, based on Gleick, et al. "Waste Not, Want Not: The Potential for Urban Water Conservation in California" Pacific Institute: California Nov. 2003. http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/waste_not_want_not_full_report3.pdf . Average number of flushes of toilet per day per employee is 2.6. Average number of flushes of urinal per day per employee is 1.3. While restroom faucets are not used only after toilet or urinal use, insufficient data prevented us from estimating additional uses.

Formula: 0.11 mpf x (2.6 + 1.3) per flush = 0.43 mins

[34] NEWMOA estimates 0.02 minutes a faucet is run by a customer per day under the assumption that total water use from restroom faucets is related to the number of toilet and urinal flushes. Average number of minutes the faucet run per flush is 0.11 minutes, based on Gleick, et al. "Waste Not, Want Not: The Potential for Urban Water Conservation in California" Pacific Institute: California Nov. 2003. (http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/waste_not_want_not_full_report3.pdf). Average number of flushes of toilet per day per customer is 0.13. Average number of flushes of urinal per day per customer is 0.07. While restroom faucets are not used only after toilet or urinal use, insufficient data prevented us from estimating additional uses.

Formula: 0.11 mpf x (0.13 + 0.07) flush = 0.02

[35] See reference #19.

[36] See reference #3.

[37] The EPA Water Sense program cites the standard faucet flow rate as 2.2 gallons per minute (gpm); low-flow faucets use between 0.8 to 1.5 gpm (for this metric, NEWMOA uses the ultimate low value of 0.5 gpm). Therefore the difference in flow rate is 1.7 gpm. www.epa.gov/watersense/docs/faucet_spec508.pdf

[38] See reference #32.

[39] See reference #33.

[40] See reference #19.

[41] See reference #3.

[42] Greenhouse Gas Emissions Related to Water and Wastewater Services: Baseline, Reduction Strategies, and Recommendations. June 2008. http://www.coolplan.org/ccap-report/source-material/4%20Wastewater.pdf . GHG emission of the whole water cycle = GHG emission associated with water supply + GHG emission associated with end use + GHG emission associated with wastewater. The data is based on emissions from each element of the Santa Rosa municipal water cycle.

- GHG emission associated with water supply: 0.37 ton/million gallon;
- GHG emission associated with end use: 17.4 ton/million gallon;
- GHG emission associated with wastewater: 1.47 ton/million gallon.

[43] eGRID, U.S. annual non-baseload CO2 output emission rate, year 2010 data. U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/cleanenergy/energy-resources/refs.html .

[44] The EPA document, "Water on Tap: What You Need to Know" (December 2009) cites the national average cost of water at $2.00 per 1,000 gallons, or approximately $0.002 per gallon. www.epa.gov/safewater/wot/pdfs/book_waterontap_full.pdf

[45] NEWMOA assumes an average of 10¢ per kWh based on the following references. The U.S. Department of Energy estimates that the average retail price of electricity for the commercial sector is $0.1017 per kWh based on August 2010 data estimated over a 12-month period. www.eia.doe.gov/cneaf/electricity/epm/table5_3.html