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Project name:
Perdue PA Soy Crush GHG Emissions Comparison

Project ref:
60522641

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Date:
January 13, 2017

Memo

AECOM Technical Services, Inc. (AECOM) was commissioned to calculate the anticipated reduction in greenhouse gas (GHG) emissions associated with the operation of Perdue's proposed soybean crush plant in Pennsylvania (PA), when compared to current practices at other similar operations located out of state. This memo presents AECOM's assessment of:

- The anticipated annual operational GHG emissions associated with the proposed PA soybean crush plant;
- The existing (i.e., baseline) annual GHG emissions associated with the current scenario of transporting and processing the same volume of soybeans grown in PA out of state, due to the lack of sufficient crush facilities in PA , i.e., the 'no action' scenario; and
- A comparison of the two.

1. Introduction

AECOM understands that Perdue is currently designing and constructing a greenfield soybean crush plant in Marietta, Pennsylvania, which is expected to become operational in 2017. When compared to current practices, the operation of the plant is anticipated to result in a reduction of GHG emissions, primarily associated with eliminating the need to transport large volumes of soybeans grown within Pennsylvania out of state for processing into animal feed and then transporting the resulting soy feed, back to Pennsylvania for sale to local dairy and livestock farmers.

In addition, the proposed PA soybean crush plant will be located adjacent to the Lancaster County Solid Waste Management Authority's waste-to-energy facility, which will supply 'waste' steam to the proposed plant; 'waste' steam will serve as the primary heat source for the plant's soybean dryers, eliminating the need to generate steam onsite using fossil fuel fired boilers.

2. Methodology

Background

Gases that trap heat in the atmosphere are called greenhouse gases (GHGs). The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases.

- Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- Methane is emitted during the production and transport of energy sources such as coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- Fluorinated gases are manmade, powerful greenhouse gases that are emitted from a variety of industrial processes.

Each gas' effect on climate change depends on three main factors: how much of these gases are in the atmosphere, how long they stay in the atmosphere, and how strongly they retain heat, thereby potentially impacting global temperatures.

Methodology

The annual GHG emissions associated with the operation of Perdue's proposed soybean crush plant in PA, GHG emissions associated with current practices at similar operations located out of state, and the anticipated reductions offered by the new PA operation have been calculated in general accordance with the following recognized GHG accounting guidance documents developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD):

- *The GHG Protocol: A Corporate Accounting and Reporting Standard*, 2004 (and amended 2013) (the GHG Protocol)[1]
- *GHG Protocol Scope 2 Guidance: An Amendment to the GHG Protocol Corporate Standard* (2015)[2]
- *The GHG Protocol: The GHG Protocol for Project Accounting*, 2004 (the GHG Project Protocol)[3]
- *The GHG Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard*, 2011[4]

In particular, the GHG Protocol provides standards and guidance for companies and corporations preparing a GHG emissions inventory and is the basis for nearly every other GHG standard and program in the world including the International Standards Organization (ISO) and The Climate Registry. It covers the accounting and reporting of the six GHGs covered by the Kyoto Protocol — carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The GHG Protocol Corporate Standard was amended in 2013 to include a seventh GHG - nitrogen trifluoride (NF_3). The GHG Project Protocol provides specific principles, concepts, and methods for quantifying and reporting GHG reductions, i.e., the decreases in GHG emissions, or increases in removals and/or storage, from specific climate change mitigation projects intended to reduce GHG emissions.

Greenhouse Gas Emission 'Scopes'

The first step in developing a GHG assessment is to define the boundary, i.e., the gases and emission sources covered by the assessment. The GHG Protocol defines different sources of GHG emissions into a series of categories or 'scopes'.

[1] http://www.ghgprotocol.org/standards/corporate-standard
[2] http://www.ghgprotocol.org/scope_2_guidance
[3] http://www.ghgprotocol.org/standards/project-protocol
[4] http://www.ghgprotocol.org/files/ghgp/public/Corporate-Value-Chain-Accounting-Reporing-Standard_041613.pdf

These definitions have been used to determine the boundary and sources of emissions to be considered in the GHG assessment, and are displayed in Figure 1:

- **Scope 1: Direct GHG emissions** from within the physical boundary of the project from sources that are owned or controlled by the company, for example, emissions from combustion in company-owned or operated boilers, vehicles and process emissions.
- **Scope 2: Electricity/Steam indirect GHG emissions** associated with the project's use of purchased electricity, steam and heating/cooling generated outside the project boundary (i.e., GHG emissions from the offsite generation of electrical power, delivered via the power grid and used by a facility). Scope 2 emissions physically occur at the facility where electricity is generated.
- **Scope 3: Other indirect GHG emissions**. Scope 3 is an optional reporting category that allows for quantification of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the project, but occur from sources not owned or controlled by the project e.g., production of raw materials, and transport of finished product by a third party.

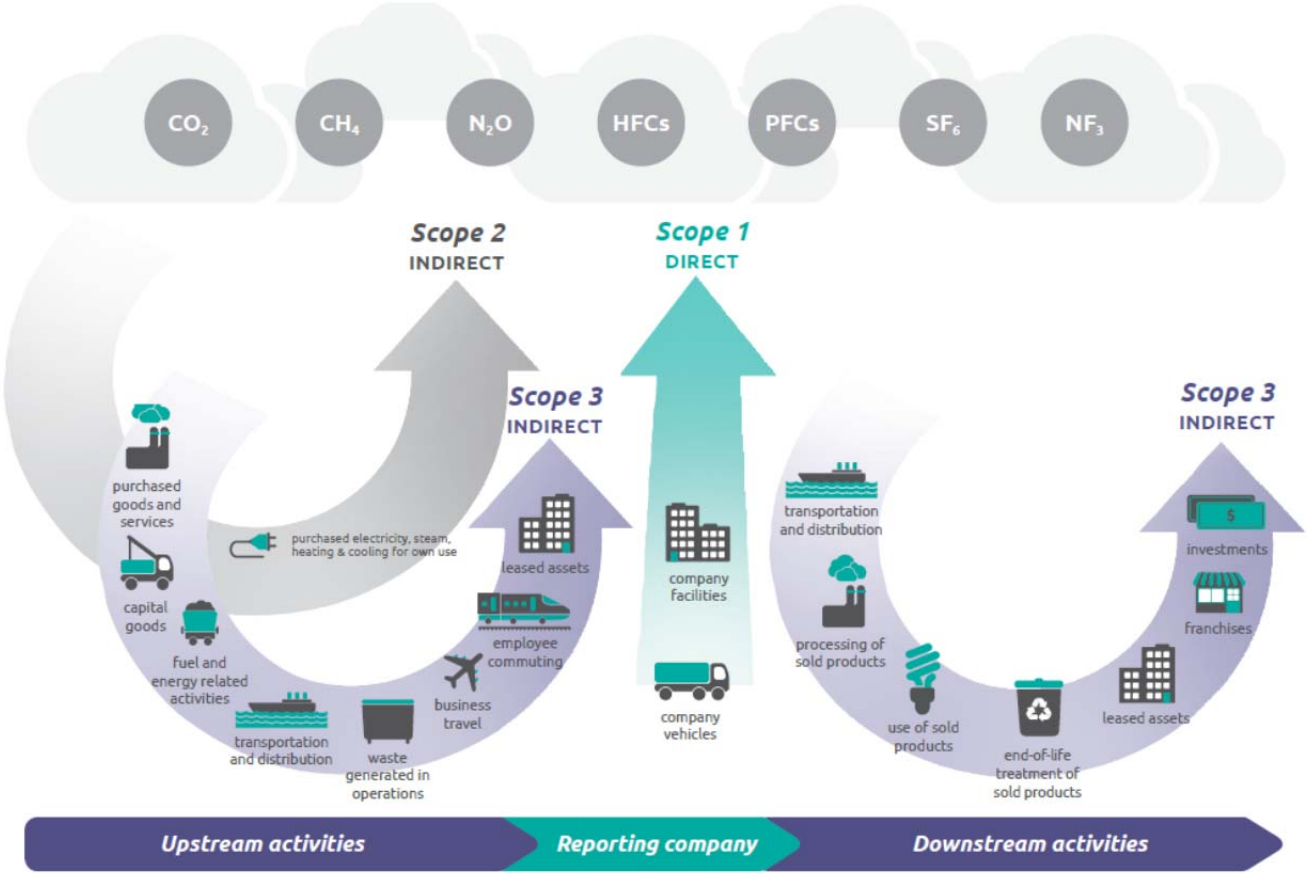

Figure 1: Overview of GHG Protocol Scopes and emissions[5]

For the purpose of this assessment, Scope 3 emissions focus on those elements over which Perdue has significant control and influence and also those that are anticipated to significantly differ from the current 'no action' scenario, i.e., transport of soybean and finished product, steam generation, water supply and wastewater treatment by a third party. All transport is assumed to be undertaken by a third party (i.e., Scope 3 activity) and not in vehicles which are owned/operated by Perdue (i.e., Scope 1 activity). Process emissions from wastewater treatment are excluded from the assessment on the basis of materiality.

[5] Source *The GHG Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard*, 2011

A simplified breakdown of the emission sources included in the scope of the GHG emissions assessment is displayed in **Figure 2**.

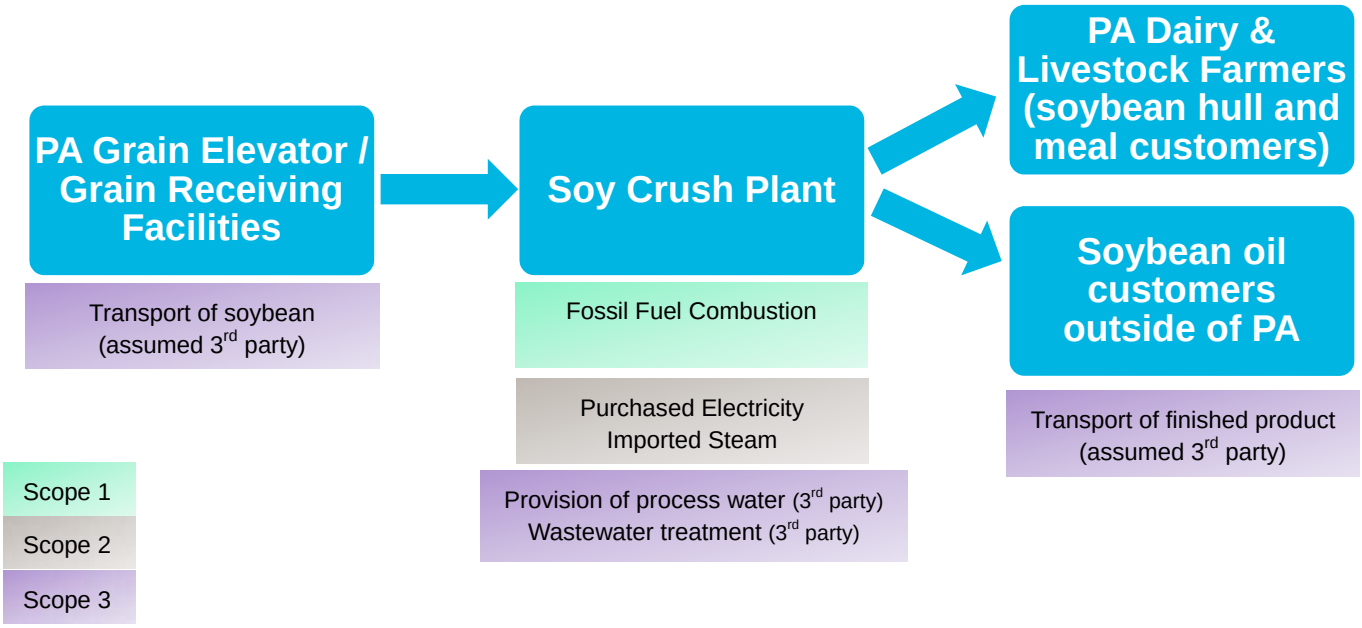

Figure 2: Breakdown of emission scope included in the GHG Assessment

GHG Calculation Methodology

Activity data provided by Perdue were converted into GHG emission estimates using relevant published emissions factors. Emission factors relate the amount of GHGs emitted by an action to a set amount of activity under that action, i.e.:

Annual GHG Emissions (metric tons CO_2e)

=

Activity (e.g., annual standard cubic feet [scf] of natural gas consumption) × Emission Factor (e.g., kg CO_2e per scf)

In line with current best practice, emission factors were obtained from the following publicly available sources:

- U.S. Environmental Protection Agency (EPA)'s Center for Corporate Climate Leadership, *Emission Factors for Greenhouse Gas Inventories,* November 2015[6]; and
- U.S. Environmental Protection Agency (EPA)'s Emissions & Generation Resource Integrated Database (eGRID), eGRID2012, released 10/08/15[7].

The convention for reporting GHG emissions in terms of metric ton of CO_2 equivalents (CO_2e) is calculated by multiplying the mass of each GHG by the appropriate Global Warming Potential (GWP). GWPs were developed by the Intergovernmental Panel on Climate Change (IPCC) and describe how much heat a GHG can trap in the atmosphere compared to carbon dioxide, which has a GWP of 1 (because it is the gas being used as the reference). For example, methane has a GWP of 25, which means that 1 metric ton of methane will trap 25 times more heat than 1 metric ton of carbon dioxide, making methane a more potent GHG.

[6] https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub
[7] https://www.epa.gov/energy/egrid

In line with EPA GHG reporting requirements[8], the GWPs applied to the calculations to estimate GHG emissions on a CO_2e basis are sourced from the Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), over a 100-year time period[9].

3. PA Soybean Crush Plant GHG Emissions

Data and Assumptions

Where possible, design data for the proposed PA soybean crush plant have been used in the GHG emissions calculations. However, some assumptions have been made where exact values are not known at this stage. The assumptions made are set out in this assessment including a justification for their selection. Where available, peak annual operation data has been presented to represent a worst case scenario. This approach is intentionally conservative (i.e., likely to overestimate GHG emissions from this source).

In this assessment it is assumed that the proposed PA soybean crush plant will operate for 24 hours per day and 365 days per year and will process a maximum of 638,750 short tons of soybeans per year. All other data, assumptions and emission factors used in the GHG emissions calculations are described in detail in Table 1 below.

Table 1: Proposed PA Soybean Crush Plant - Data and Assumptions

Scope	Emission Source	Annual Activity	Source of Emission Factors
Scope 1	Use of fossil fuel to generate steam	• 0 (no steam generated on site)	N/A
Scope 2	Use of purchased/grid supplied electricity	• 103,641 BTU/short ton soybean (assumed average of the BTU/ton for Perdue's Salisbury and Chesapeake crush plants) • 19,402 MWh/year	EPA eGRID2012 Electricity Emission Factors for RFCE sub-region (lbs/MWh)
	Use of purchased steam (Steam used for drying will be sourced from the adjacent third party waste-to-energy [WTE] facility, where steam is generated from the combustion of Municipal Solid Water [MSW])	• 600 lbs/short ton soybean (worse case) • 371,891 MMBtu/year • Assume 80% thermal efficiency of steam production (as per the GHG Protocol CHP Tool[10]) • Assume 58% biogenic CO_2 in MSW (as per the site's 2015 GHG report to EPA[11])	EPA Stationary Combustion Emission Factors for Municipal Solid Waste (kg/MMBtu)
Scope 3	Energy associated with supplying process water (Process water will be sourced from the adjacent WTE facility)	• Water use = 328,000 gallons/day • 177 MWh/year (electricity use determined from publicly available data regarding average energy intensity of municipal water supply [1.5kWh/1000 gallons]) – see Appendix A	EPA eGRID2012 emissions rates specific to the electricity output generated at the adjacent WTE facility (plant name Lancaster County Resource Recovery) (lbs/MWh)
	Energy associated with treatment of wastewater (process water and steam condensate) (Wastewater will be returned to the adjacent WTE facility where 90% will be treated/reused at the WTE facility and 10% will be sent to the municipal wastewater treatment works [WWTW] [Elizabethtown] for treatment)	• Assume volume of wastewater generated is equal to volume of water used • 237 MWh /year (electricity use determined from publically available data regarding average energy intensity of municipal WWTWs [2kWh/1000 gallons]) – See Appendix A	EPA eGRID2012 Electricity Emission Factors for RFCE sub-region (lbs/MWh) for wastewater treated at municipal WWTW

[8] 40 CFR Part 98 Mandatory Reporting of Greenhouse Gases
[9] https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html
[10] *Allocation of GHG emissions from a Combined Heat and Power (CHP) Plant* (V1 September 2006) http://www.ghgprotocol.org/calculation-tools/all-tools
[11] https://ghgdata.epa.gov/ghgp/service/html/2015?id=1007677&et=undefined

Scope	Emission Source	Annual Activity	Source of Emission Factors
Scope 3	Transport of soybeans grown in PA from various grain elevator / grain receiving facilities across PA to the proposed PA soybean crush plant	• Tonnage = 638,750 short tons • Distance goods are transported = Assumed 50 miles • Mode = 100% road	EPA Product Transport Emission Factors for Medium and Heavy Duty Truck (kg/ton-mile)
	Transport of finished products (meal and hulls) from proposed soybean crush plant to farmers in PA	• Tonnage = 81% of input (517,388 short tons) • Distance goods are transported = 84 miles (mean transport distance from proposed plant to Perdue's meal and hull customers in PA) • Mode = 100% road	
	Transport of finished product (oil) from proposed PA soybean crush plant to oil customers (outside of PA)	• Tonnage = 19% of input (121,363 short tons) • Distance goods are transported = 244 miles (mean transport distance from proposed plant to Perdue's oil customers) • Mode = 100% road	

Provision of Steam from adjacent WTE Facility

As previously discussed, the proposed PA soybean crush plant will be located adjacent to a waste-to-energy (WTE) facility which is owned and operated by Lancaster County's Solid Waste Management Authority (LCSWMA). The WTE facility generates electricity from the combustion of non-hazardous municipal solid waste (MSW), whereby high pressure steam generated during the combustion process drives a turbine which creates electricity. A small portion of the electricity generated is used to power the day-to-day operations of the WTE facility (e.g., for water and wastewater treatment); however, the majority is sold to the local utility grid. Once the proposed PA soybean crush plant is operational it will purchase 'waste' low pressure steam and process water directly for the WTE facility. Used process water and steam condensate will also be returned to the WTE facility where it will be treated and recycled back into the WTE system.

For the purposes of Pennsylvania's Renewable Portfolio Standard[12] (the Alternative Energy Portfolio Standards Act) energy generated by WTE facilities has been defined as 'renewable' energy. However, the recent GHG Protocol Scope 2 guidance states that "*Emissions from steam, heat, or cooling that is received via direct line as "waste" from an industrial process should still be reported based on the underlying emissions from the original generation process. Some companies may wish to account for these as zero emissions because the steam/heat/cooling would have been vented instantaneously if not used. However, accurate emissions accounting requires the actual emissions associated with the production of this waste to be reported. An emission factor for such systems should characterize the average GHG intensity of the fuels used to generate the heat/steam/cooling, as well as the efficiency of that generation An emission factor per unit energy for purchased steam or heat is equal to the emission factor per unit energy of the fuel used divided by the thermal efficiency of the generation.*"[13]

Therefore, in accordance with the guidance, and in line with the GHG Protocol principle of conservativeness, worse–case emissions associated with the generation of steam have been calculated using the EPA's emission factors for Municipal Solid Waste combustion and a standard assumed thermal efficiency of 80%. In addition, as per the requirements of the GHG Protocol, the direct biogenic CO_2 emissions from the combustion of the biomass fraction of the MSW (such as wood, paper products and food waste) are excluded from the scope categories (1, 2 and 3) because biomass is considered to absorb an equivalent amount of CO_2 during the growth phase through the process of photosynthesis as the CO_2 that is released during combustion, creating a net '0' CO_2 release. Publicly available data included in the facility's GHG report to EPA indicate that the MSW combusted at the LCSWMA's WTE facility contains 58% biomass material.

[12] Renewable portfolio standards (RPS) are policies designed to increase generation of electricity from renewable resources. These policies require or encourage electricity producers within a given jurisdiction to supply a certain minimum share of their electricity from designated renewable resources. Generally, these resources include wind, solar, geothermal, biomass, and some types of hydroelectricity, but may include other resources such as landfill gas, municipal solid waste, and tidal energy.
[13] http://www.ghgprotocol.org/scope_2_guidance

Emissions associated with the WTE facility's use of on-site generated electricity for the provision and treatment of water / wastewater have been calculated using facility-specific emission factors sourced from the EPA's eGRID database.

Results

The annual anticipated GHG emissions from the operation of the proposed soybean crush plant in PA have been calculated. A breakdown of the results is presented in Table 2 below.

Table 2: Proposed PA Soybean Crush Plant - GHG Emission Results

Scope	Emission Source	Annual GHG Emissions / Metric Tons CO_2e
Scope 1	Use of fossil fuel (natural gas) to generate steam	0
	Total Scope 1	**0**
Scope 2	Use of purchased/grid supplied electricity	7,592
Scope 2	Use of purchased steam	18,662
	Total Scope 2	**26,254**
Scope 3	Energy associated with supply of process water	282
Scope 3	Energy associated with treatment of wastewater (process water and steam condensate)	350
	Total Scope 3 (Water/Wastewater)	**632**
Scope 3	Transport of soybeans grown in PA from various grain elevator / grain receiving facilities across PA to the proposed PA soybean crush plant	4,677
Scope 3	Transport of finished products (meal and hulls) from proposed PA soybean crush plant to farmers in PA	10,702
Scope 3	Transport of finished product (oil) from proposed PA soybean crush plant to oil customers (outside of PA)	
	Total Scope 3 (Transport)	**15,379**
	Total Scope 3	**16,011**
	Total CO_2e Emissions (MT)	**42,265**

The available information indicates estimated annual worse-case GHG emissions associated with the operation of the proposed soybean crush plant to be approximately 42,300 MT CO_2e per year. The principal sources of GHG emissions are MSW combustion to generate steam (44%), transport emissions (36%) and use of electricity imported from the grid (18%). As the proposed plant is anticipated to process up to 638,750 short tons of soy per year, annual emissions are therefore equivalent to 0.07 MT CO_2e per ton of soybean processed.

However, as discussed, the emissions associated with the provision of steam to the proposed PA soybean crush plant presented in Table 2 above are worse-case and include the underlying emissions from the MSW combustion responsible for generating the required amount of steam (~18,700 MT CO_2e). In reality, the WTE facility produces both electricity and 'waste' steam from a single combustion process, with the primary purpose of the MSW combustion being to generate electricity for export to the local utility grid. The plant is not formally designated as a Combined Heat and Power (CHP) facility by the EPA, thus all CO_2e emissions generated by the WTE facility and reported in EPA's eGRID database are allocated to the plant's electrical output and incorporated into EPA's regional electricity emission factors. The proposed soybean crush plant will purchase some of the low pressure 'waste' steam generated by the WTE plant, which is currently vented to the air as no other local user exists for this heat source. As no additional emissions will be created by Perdue's use of the 'waste' steam (i.e., additional to those already allocated to the site's electrical output) there is a strong argument that to include the underlying steam emissions would be 'double counting,' and therefore many companies present these emission as zero. In addition the GHG Protocol CHP Guidance[14] also recommends that to avoid double counting of

[14] *Allocation of GHG Emissions from a Combined Heat and Power (CHP) Plant: Guide to Calculation Worksheets* (September 2006) v1.0 http://www.ghgprotocol.org/calculation-tools/all-tools

emissions both the producer/seller and consumer/purchaser of the electricity and steam should use the same method to allocate emissions between the electricity and steam output.

Therefore, when assuming zero emissions associated with provision of 'waste' steam (and allocating all emissions from MSW combustion at the WTE facility to the provision of electricity), annual GHG emissions associated with the operation of the proposed soybean crush plant are approximately 23,600 MT CO_2e, equivalent to 0.04 MT CO_2e per ton soybean processed.

4. Comparison of PA Soybean Crush Plant GHG Emissions

To quantify the anticipated reduction in GHG emissions associated with the operation of Perdue's proposed PA soybean crush plant, they must be compared to a reference / baseline level of GHG emissions. For the purposes of this assessment the reduction is calculated as a difference between the anticipated emissions of the PA soybean crush plant and the hypothetical emissions that would happen in the absence of the PA soybean crush plant, should the current transport and processing activities of the soybeans grown in PA be continued (i.e., the "no action" baseline). The assessment is also focused on GHG emissions from activities that differ from (or are additional to) between the baseline and the proposed plant.

4.1 Reduced Transport Emissions

The state of PA produces approximately 29.6 million bushels of soybeans and consumes more than 44 million bushels of soybean meal[15]. However, it is understood that currently only 10-12 million bushels of soybeans are processed within the state, with the remaining soybeans transported out of state to New Jersey, Ohio, Maryland and Virginia for processing, before transporting the resulting soybean meal and hulls back to PA where they are sold to the state's diary and livestock farmers.

With a capacity to process up to a maximum of 638,750 tons soybean (~21 million bushels[16]) per year, Perdue's proposed soybean crush plant will eliminate the need to transport the majority of soybeans harvested throughout PA out of state for processing and in turn reduce GHG emissions associated with the transportation of both soybeans and finished product. The emissions associated with current transportation practices are shown below.

Data and assumptions

Table 3: Current / No Action – Transport Data and Assumptions

Scope	Emission Source	Annual Activity	Source of Emission Factors
Scope 3	Transport of soybeans grown in PA from various grain elevator / grain receiving facilities across PA to soybean crush plants in the following locations: • Perdue Salisbury and Curtis Bay, MD (15%) • Perdue Chesapeake, VA (15%) • Perdue Cofield and Cargill-Fayetteville, NC (3%) • Port of Newark, NJ (35%) • East Liverpool and Bellevue, OH (29%) • Indiana, PA (2%)	• Tonnage = 638,750 short tons • Distance goods are transported = 238 miles by road and 217 miles by rail (weighted average transport distance based on 2015 data from Perdue regarding volume and destination of Soybeans transported out of PA) • Mode = 87% road and 13% rail (based on 2015 data from Perdue regarding volume and mode of Soybeans transported out of PA)	EPA Product Transport Emission Factors for Medium and Heavy Duty Truck and Rail (kg/ton-mile)
Scope 3	Transport of finished products (meal and hulls) from existing soybean crush plants to farmers in	• Tonnage = 81% of input (517,388 short tons) • Distance goods are transported = 274 miles	EPA Product Transport Emission Factors for Medium and Heavy Duty

[15] 2014 data http://www.perdueagribusinesspa.com/about
[16] According to U.S. Soybean Export Council 1 short ton soybeans = 33.33 bushels http://ussec.org/resources/conversion-table/

Scope	Emission Source	Annual Activity	Source of Emission Factors
	PA	(average of median transport distances from Perdue's plants in Salisbury, MD and Chesapeake, VA to Perdue's meal and hull customers in PA) • Mode = 100% road	Truck (kg/ton-mile)
Scope 3	Transport of finished product (oil) from existing soybean crush plants to oil customers (outside of PA)	• Tonnage = 19% of input (121,363 short tons) • Distance goods are transported = 56 miles (Salisbury only ships soybean oil to the Salisbury oil refinery therefore distance is 0 and median transport distance from Chesapeake to Perdue's oil customers is 112 miles) • Mode = 100% road	

Results

The current annual GHG emissions from the transport of 638,750 tons soybean gown within PA to typical locations out of state to be processed, and also transporting the resulting finished product to customer, have been calculated. A breakdown is shown in Table 4 below.

Table 4: Current / No Action – Transport GHG Emission Results

Scope	Emission Source	Annual GHG Emissions / Metric Tons CO_2e
Scope 3	Transport of soybeans grown in PA from various grain elevator / grain receiving facilities across PA to soybean crush plants located out of state	19,773
Scope 3	Transport of finished products (meal and hulls) from existing soybean crush plants to farmers in PA	21,719
Scope 3	Transport of finished product (oil) from existing soybean crush plants to oil customers (outside of PA)	
	Total Scope 3 (Transport)	**41,493**

*Due to rounding numbers do not add up precisely

Current annual GHG emissions associated with the transport of soybean and finished product are approximately 41,500 MT CO_2e per year. As shown in Table 2 above, equivalent transport emissions from the proposed PA soybean crush plant are anticipated to be only 15,400 $MTCO_2e$ per year, **representing a reduction of approximately 26,100 $MTCO_2e$ per year compared to the current transport practices**.

4.2 Effects from Use of Steam from Adjacent WTE Facility

As discussed above, Perdue's proposed plant will purchase 'waste' steam directly from an adjacent WTE facility operated by Lancaster County's Solid Waste Management Authority. The purchased steam will be used as the heat source for the soybean dryer, eliminating the need to use fossil fuel fired steam boilers at the soybean crush plant (e.g., Perdue's other soy crush facilities use natural gas fired boilers). In addition, the WTE will also provide the proposed PA soy crush plant with process water, and used process water and steam condensate will be returned to the WTE Facility, where it will be treated and recycled back into the WTE system for reuse.

For comparison, emissions associated with steam, electricity and water provision and wastewater treatment at typical current soybean crush plants have been calculated, using representative data from the Perdue's soy crush plants in Salisbury, MD, and Chesapeake, VA, and are presented below.

Data and assumptions

Table 5: Current / No Action – Steam and Water Data and Assumptions

Scope	Emission Source	Annual Activity		Source of Emission Factors
		Salisbury, MD	Chesapeake, VA	
Scope 1	Use of fossil fuel (natural gas) to generate steam	• 1,071,396 BTU/short ton soybean • 667,012,020 scf/year	• 926,432 BTU/short ton soybean • 576,762,891 scf/year	EPA Stationary Combustion Emission Factors for Natural Gas (kg/scf)
Scope 2	Use of purchased/grid supplied electricity	• 87,943 BTU/ton soybean • 16,463 MWh/year	• 119,339 BTU/ton soybean • 22,340 MWh/year	EPA eGRID 2012 Electricity Emission Factors for RFCE sub-region (Salisbury) and SRVC sub-region (Chesapeake) (lbs/MWh)
Scope 2	Use of purchased steam	• 0 (both Salisbury and Chesapeake generate steam on site from natural gas – see Scope 1)		N/A
Scope 3	Energy associated with supply of process water	• Water use = 105 gallons/short ton soybean • At Salisbury process water is sourced from on-site wells therefore electricity consumed to supply water is included in site electricity use – see Scope 2.	• Water use = 95 gallons/short ton soybean • 90 MWh/year (electricity use determined from publically available data regarding average energy intensity of municipal water supply (1.5kWh/1000 gallons))	EPA eGRID 2012 Electricity Emission Factors for SRVC sub-region (Chesapeake) (lbs/MWh)
Scope 3	Energy associated with treatment of wastewater (process water and steam condensate)	• Wastewater = 100 gallon/short ton soybean • At Salisbury wastewater is treated on site therefore electricity consumed to treat wastewater is included in site electricity use – see Scope 2.	• Wastewater = 70 gallons/short ton soybean • A Chesapeake wastewater is treated by municipal WWTW - Hampton Roads Sanitation District (HRSD))	2014 Carbon Footprint published by HRSD (CO_2e metric tons per million gallons wastewater treated[17])

Results

The current annual GHG emissions associated with the generation of steam, supply of water and wastewater treatment required to process 638,750 tons soybean have been calculated. A breakdown of emissions is shown in Table 6 below.

Table 6: Current / No Action – Steam and Water GHG Emission Results

Scope	Emission Source	Annual GHG Emissions / Metric Tons CO_2e
Scope 1	Use of fossil fuel (natural gas) to generate steam	33,890
	Total Scope 1	**33,890**
Scope 2	Use of purchased/grid supplied electricity	7,972
Scope 2	Use of purchased steam	0
	Total Scope 2	**7,972**
Scope 3	Energy associated with supply of process water	19
Scope 3	Energy associated with treatment of wastewater (process water and steam condensate)	33
	Total Scope 3 (Water/Wastewater)	**52**

Current annual Scope 1 GHG emissions associated with the use of fossil fuel to generate steam are approximately 33,900 MT CO_2e per year and current annual Scope 2 GHG emissions associated with the use of purchased electricity and steam

[17] http://www.hrsd.com/pdf/SAG/SAG_NewsletterSummer2015.pdf

are approximately 8,000 MT CO_2e per year. As per Table 2 above Scope 1 emissions from the proposed PA soybean crush plant are anticipated to be zero whereas worse case Scope 2 emissions are anticipated to be 26,300 MT CO_2e. The decrease in Scope 1 emissions of 33,900 MT and increase in Scope 2 emission of 18,300 MT at the proposed PA soybean crush plant compared to current equivalent emissions is due to a) emissions from purchased steam (Scope 2) replacing the use of natural gas to generate steam (Scope 1), and b) the lower carbon intensity of combusting MSW (with a biogenic fraction of 58%) to generate steam as compared to natural gas.

Alternatively, when assuming zero emissions associated with the provision of 'waste' steam to Perdue's plant (as discussed in Section 3 above), Scope 2 emissions from the proposed PA soybean crush plant are anticipated to be only 7,600 MT CO_2e representing a small reduction in equivalent Scope 2 emissions (~ 400 MT CO2e) per year compared to current practices.

Current annual Scope 3 GHG emissions associated with the supply of water and treatment of wastewater are approximately 50 MT CO_2e. This is lower than the anticipated emissions from comparable activities at the proposed PA soybean crush plant (600 MT CO_2e), and is due to the higher carbon intensity of the electricity generated from MSW combustion compared to the regional grid average[18]. In addition, at the Salisbury plant process water is sourced from on-site wells and process water is treated on site. Therefore, current emissions from electricity consumed to supply and treat water are included in the site's Scope 2 emissions, as opposed to the Scope 3 classification for those activities at the proposed PA soybean crush plant. Emissions from the provision of water and wastewater treatment represent less than 1% of total emissions.

Ultimately, siting the proposed PA soybean crush plant adjacent to the existing WTE facility results in net a reduction of approximately 15,000 MT CO_2e per year (when emissions from 'waste' steam provision are included) or 33,700 MTCO_2e (when emissions from 'waste' steam provision are excluded) compared to current practices.

4.3 Other Effects on GHG Emissions

In accordance with the GHG Project Protocol, the potential for other significant ongoing secondary effects (i.e., an unintended change in GHG emissions caused as a result of the operation of the proposed PA soybean crush plant[19]) have also been considered. The purpose of considering secondary negative effects is to identify those that would negate the activity's primary effect, and/or consider secondary positive effects that provide further reportable benefits.

It is understood that the soybeans grown within PA and that are currently transferred out of state will be used to supply the ~638,750 short tons per year of soybeans needed by the proposed plant. Therefore, the following potential effects on GHG emissions due to the response of existing users of the PA soybeans have been considered:

1. Could the out-of-state plants that currently process the soybeans grown in PA be required to source soybeans from a location further away than PA, once the PA soybean crush plant becomes operational and begins using their current supply?
2. Similarly for finished product, could the out-of-state plants that currently process the soybean grown in PA need to transport finished product further, once the market in PA is served by the new PA soybean crush plant?

The changes in supply and demand caused by the proposed PA soybean crush plant are not considered to be significant relative to the overall size of the market, i.e., for Perdue's Salisbury and Chesapeake plants, only 15% and 10% respectively of total soybean is sourced from PA, and the addition of the soybean crush plant in PA is therefore not considered to cause a material increase in GHG emissions at the current soybean crush plants.

[18] The 2012 fuel mix used to generate electricity for the RFCE sub-region (Salisbury) is 41% nuclear, 31% natural gas, 24% coal, 3% renewable and 1% other fossil and for the SRVC sub-region (Chesapeake) is 41% nuclear, 35% coal, 20% natural gas and 3% renewable

[19] A secondary effect is an unintended change in GHG emissions, removal or storage caused by a project activity. Secondary effects are typically small relative to a project activity's primary effect. In some cases secondary effects will also result in GHG emission reductions but in other cases they may be negative undermine or negate the primary effect (e.g., switching from coal to less carbon intensive biomass as a fuel may reduce combustion emissions but in turn increase emissions associated with transporting the fuel to site or changing the type of material in a product to a less energy intensive material may in turn reduce emissions associated with the product's use or disposal).

5. Summary and Conclusions

While it is recognized that the total worse case GHG emissions from the proposed PA soybean crush plant are estimated to be 42,300 MT CO_2e per year, when compared to current practices, by increasing the capacity to process soybeans within PA, the operation of the proposed PA soybean crush plant will significantly reduce emissions associated with the transport of soybeans and finished product. The plant also provides an additional opportunity to recover and use an existing steam resource generated by the adjacent WTE facility, which is currently being wasted as there is no other local user for this 'waste' steam, thus avoiding the GHG emissions associated with using an alternative fossil fuel to generate steam on site.

Current annual GHG emissions associated with the transport of soybean and finished product are approximately 41,500 MT CO_2e per year and equivalent transport emissions from the proposed PA soybean crush plant are anticipated to be only 15,400 MTCO_2e per year, representing a reduction of approximately 26,100 MTCO_2e per year compared to the current transport practices. Siting the proposed PA soybean crush plant adjacent to the existing WTE facility also results in a net reduction of approximately 15,000 MT CO_2e per year (when worse case emissions from the provision of 'waste' steam are included) compared to current practices, due to the use of 'waste' steam generated from the combustion of MSW (with a biomass content of approximately 58%) which has a lower carbon intensity compared to that of natural gas. However, when emissions associated with provision of 'waste' steam to Perdue are assumed to be zero (and all emissions from MSW combustion at the WTE facility are allocated to the facilities' provision of electricity to the local grid), the net reduction increases to 33,700 MT CO_2e per year.

Therefore, compared to current practices the project will result in a 'worse case' net decrease of approximately 41,100 metric tons CO_2e per year, which is a 49% decrease in total emissions. For comparison, 41,100 MT CO_2e is equivalent to the GHG emissions from the energy used by 4,340 homes in one year, or the same as the GHG emissions generated by driving an average passenger car 98.5 million miles[20]. **When assuming zero emissions associated with the provision of 'waste' steam however, the project will result in a net decrease of approximately 59,800 metric tons of CO_2e per year, which is a 72% decrease in total emissions.**

The proposed PA soy crush plant is anticipated to process up to 638,750 short tons of soy per year; therefore, annual emissions are equivalent to 0.07 (including emissions for 'waste' steam provision) and 0.04 (excluding emissions for 'waste' steam provision) MT CO_2e per ton of soy, compared to 0.13 MT CO_2e per ton of soy currently. This is equivalent to a **reduction of 60 kg and 90 kg CO_2e per short ton of soybean processed, respectively.**

Table 7 below compares total GHG emissions from the proposed PA soybean crush facility with an average of current comparable soybean crush facilities, including estimated reductions. Figures 3 and 4 provide a graphical presentation of these results.

[20] Sourced from https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Table 7: Total GHG Emission Results

Scope	Emission Source	Annual GHG Emissions / Metric Tons CO_2e				
		Current, Average[21]	Proposed, PA (Including Steam Emissions)	Reduction (Including Steam Emissions)	Proposed, PA (Excluding Steam Emissions)	Reduction (Excluding Steam Emissions)
Scope 1	Use of fossil fuel (natural gas) to generate steam	33,890	0	*-33,890*	0	*-33,890*
	Total Scope 1	**33,890**	**0**	***-33,890***	**0**	***-33,890***
Scope 2	Use of purchased/grid supplied electricity	7,972	7,592	*-381*	7,592	*-381*
Scope 2	Use of purchased steam	0	18,662	*18,662*	0	*0*
	Total Scope 2	**7,972**	**26,254**	***18,281***	**7,592**	***-381***
Scope 3	Energy associated with supply of process water	19	282	*263*	282	*263*
Scope 3	Energy associated treatment of wastewater (process water and steam condensate)	33	350	*317*	350	*317*
	Total Scope 3 (Water / Wastewater)	***52***	***632***	***580***	***632***	***580***
Scope 3	Transport of soybeans grown in PA from various grain elevator / grain receiving facilities across PA to the soybean crush plant	19,733	4,677	*-15,096*	4,677	*-15,096*
Scope 3	Transport of finished products (meal and hulls) from soybean crush plant to farmers in PA	21,719	10,702	*-11,018*	10,702	*-11,018*
Scope 3	Transport of finished product (oil) from soybean crush plant to snack food customers (outside PA)					
	Total Scope 3 (Transport)	***41,493***	***15,379***	***-26,113***	***15,379***	***-26,113***
	Total Scope 3	**41,545**	**16,011**	***-25,534***	**16,011**	***-25,534***
	Total CO_2e Emissions (MT)	**83,407**	**42,265**	***-41,142***	**23,603**	***-59,804***
	Total CO_2e Emissions (MT) per ton soy processed	**0.13**	**0.07**	***-0.06***	**0.04**	***-0.09***
	% change	**N/A**	**N/A**	***-49%***	**N/A**	***-72%***

[21] Current is an average of Perdue's Chesapeake, MD, and Salisbury, VA, soybean crush facility activities and associated emissions associated with fossil fuel use, steam, electricity and water provision and wastewater treatment

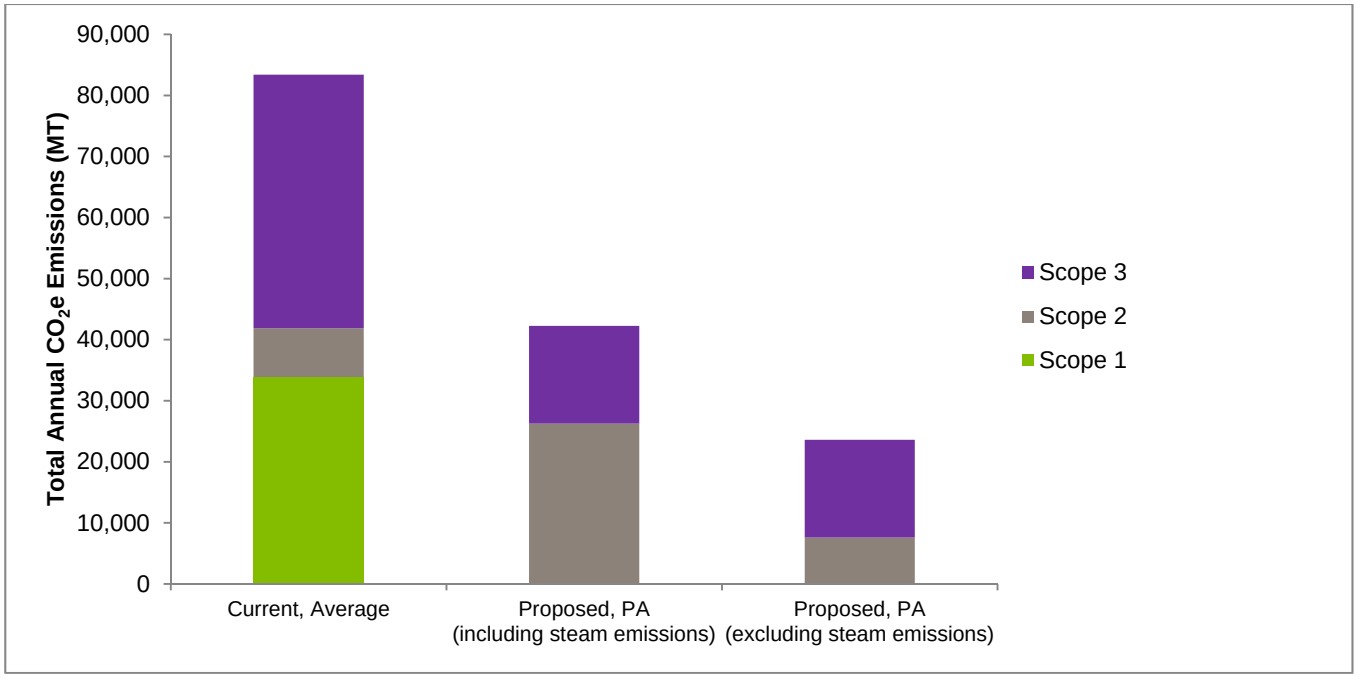

Figure 3: Annual GHG Emissions from the Proposed PA Soybean Crush Facility and the Average of Current Comparable Facilities presented on a Scope Basis

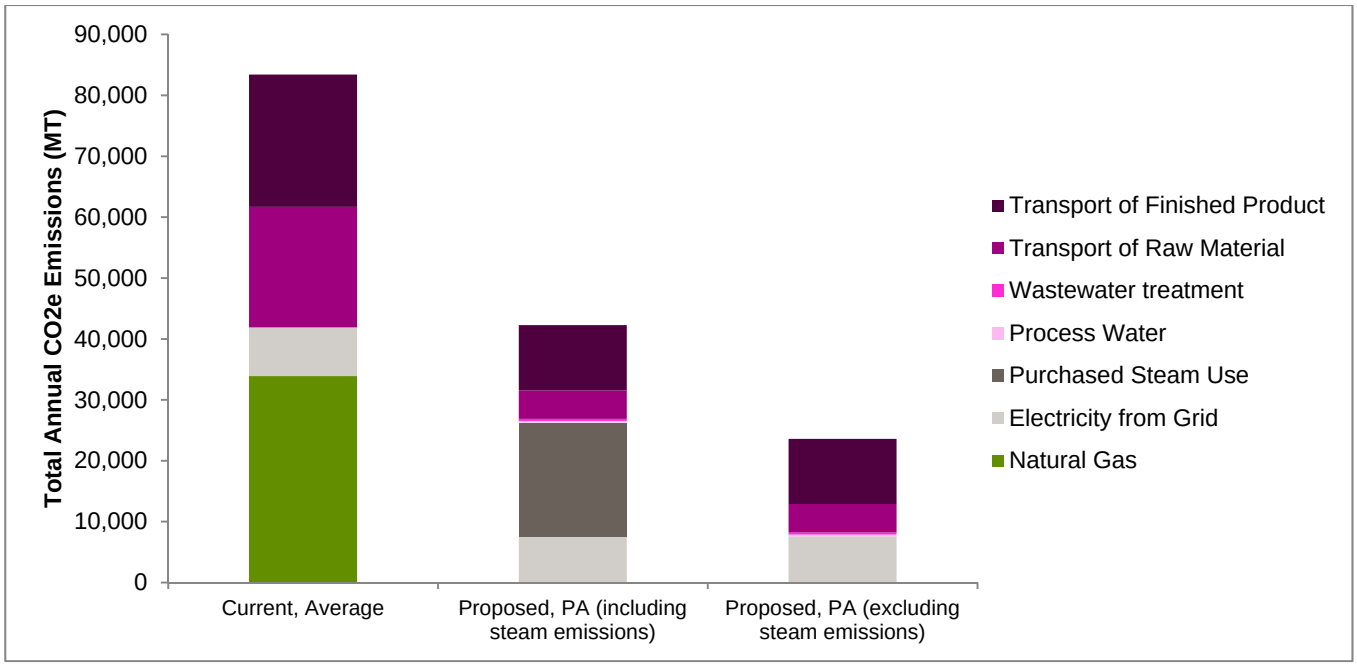

Figure 4: Annual GHG Emissions from the Proposed PA Soybean Crush Facility and the Average of Current Comparable Facilities presented on an Activity Basis

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Appendix A – Water / Wastewater Data Sources

Water Supply average energy cost (kWh/1000 gallons)	Data Source
1.1	For projects located outside Massachusetts Water Resources Authority (MWRA) communities: Water Treatment average energy cost = 1.1 kWh/1,000 gallons treated http://web1.env.state.ma.us/EEA/emepa/ghg.aspx
1.4	Page 22 Table 1-1 Unit Energy (Electric) Consumption for Water Supply - Public Supply 1401 kWh/Million gallons http://www.circleofblue.org/wp-content/uploads/2010/08/EPRI-Volume-4.pdf
1.8	National average of electricity consumption for conventional surface water plants is 700-1800 kWh per million gallon of water treated http://www.tnenvironment.com/Pres12/MooreL.pdf
1.6	Page 85 Table 4-6 Estimates Electric Energy Use by the US Public Water Supply Industry by System Type and Source Water - Community Surface Water = 1600 kWh per million gallons http://www.waterrf.org/Pages/Projects.aspx?PID=4454
Wastewater Treatment average energy cost (kWh/1000 gallons)	**Data Source**
1.7	For projects located outside Massachusetts Water Resources Authority (MWRA) communities: Wastewater Treatment average energy cost = 1.7 kWh/1,000 gallons treated http://web1.env.state.ma.us/EEA/emepa/ghg.aspx
1.5	Page 22 Table 1-1 Unit Energy (Electric) Consumption for Wastewater Treatment - Publically Owned Treatment Works (advanced wastewater treatment) 1541 kWh/Million gallons http://www.circleofblue.org/wp-content/uploads/2010/08/EPRI-Volume-4.pdf
2.7	Page 102 Table 5-5 Treatment based Estimate of Nationwide Electric Use by Municipal Wastewater Industry - Greater than secondary treatment 2690 kWh per million gallons http://www.waterrf.org/Pages/Projects.aspx?PID=4454