CARBON EMISSIONS MANAGEMENT PLAN

Prepared for SWACO
February 2020

SWACO
FROM WASTE TO RESOURCES

prepared by

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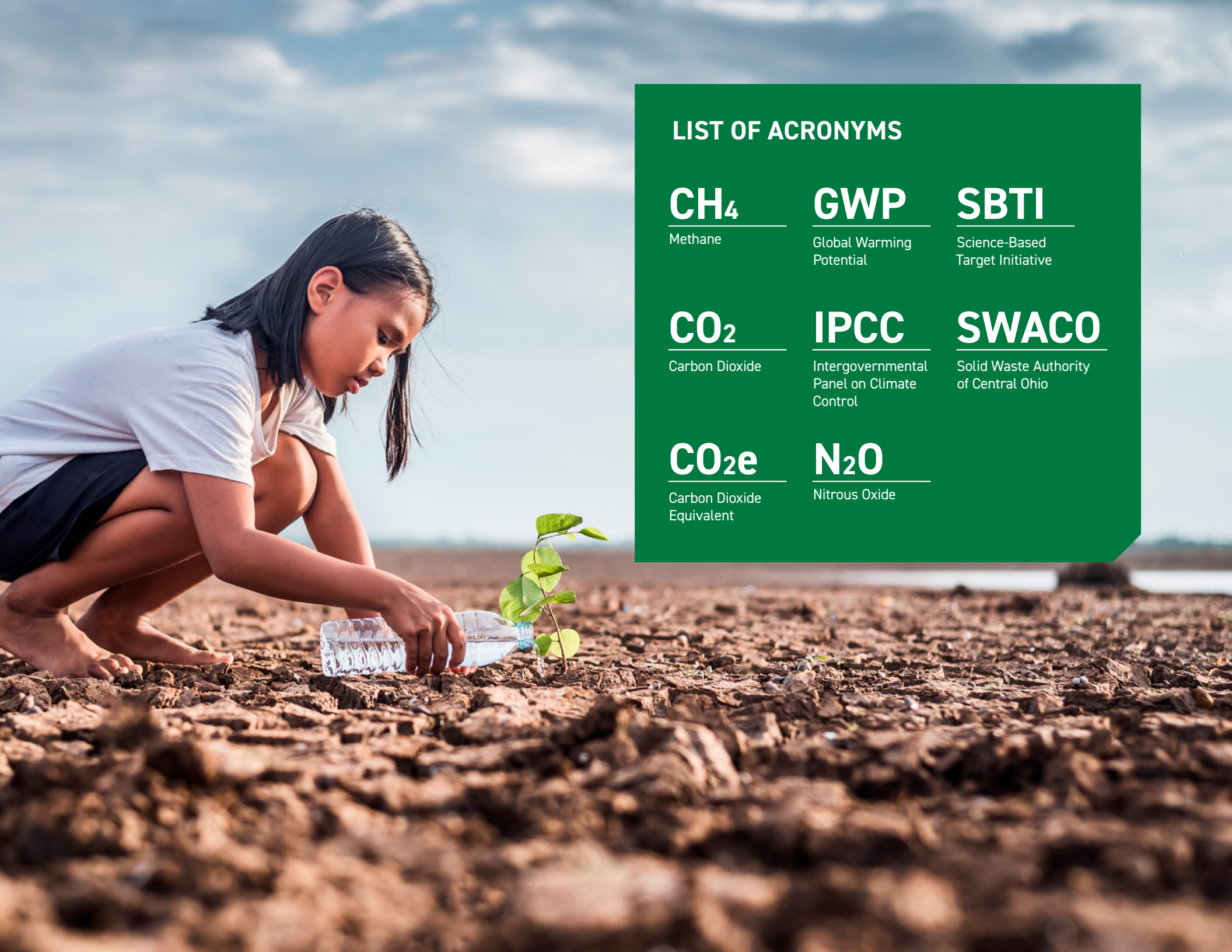
Contents



LIST OF ACRONYMS

CH_4
Methane

GWP
Global Warming Potential

SBTI
Science-Based Target Initiative

CO_2
Carbon Dioxide

IPCC
Intergovernmental Panel on Climate Control

SWACO
Solid Waste Authority of Central Ohio

CO_2e
Carbon Dioxide Equivalent

N_2O
Nitrous Oxide

SECTION 1.0

Introduction

A CHANGING CLIMATE

In the atmosphere, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and certain fluorinated gases, collectively referred to as "carbon emissions," absorb infrared radiation, thereby trapping and holding heat. As the concentration of these gases increase, an increase in the global average temperature occurs. This effect has the ability to alter the global climate, causing various cascading impacts including greater frequency and intensity of severe weather events and extreme temperatures; melting glaciers and arctic sea ice; a rise in sea levels; ocean acidification; changing precipitation patterns resulting in increased flooding or droughts; and related humanitarian crises. Human activities significantly contribute to the increase of carbon emissions through combustion of fossil fuels like coal, oil and natural gas; industrial processes; biomass burning and decomposition; and changes in land use.[1]

Reports by the United Nation's Intergovernmental Panel on Climate Change (IPCC), a scientific body of the United Nations assessing the current climate data, show the global average temperature is currently projected to increase as much as 4.8°C (8.64°F), above pre-industrial levels, by the end of the century.[2] Models have shown that an increase above 1.5°C (2.7°F) will result in increasingly significant impacts of climate change. To limit the increase to 1.5°C (2.7°F), it is projected that global emissions must be reduced by 45% by 2030 (relative to 2010 levels) and net zero emissions by 2050 must be achieved.[3]

In acknowledgement that urgent action must be taken, the international environmental treaty known as the United Nations Framework Convention on Climate Change adopted the Paris Agreement in 2015. As part of the Agreement, 195 governmental parties committed to pursuing efforts to limit the global average temperature increase to 1.5°C (2.7°F) and hold the average temperature increase to below 2°C (3.6°F).[4]

Countries, states, local governments and companies are setting significant long-term emission reduction targets in support of this effort. Across the United States over 400 city mayors, including those of Columbus, Cincinnati and Cleveland, have committed to adopt and uphold the Paris Agreement goals.[5] Additionally, cities such as Indianapolis, New York and Seattle are committing to carbon neutrality by 2050.[6] Currently, there are no commitment requirements by state or federal regulation in the United States.

1 IPCC AR5 WG1 Summary for Policymakers, p. 17. 2013.
2 IPCC AR5 WG1 Technical Summary, p. 57. 2013.
3 IPCC SR15 Report, Summary for Policymakers, p. 32 and C.1. 2018.
4 United Nations Treaty Collection, Paris Agreement. 2016.
5 Climate Mayors, Paris Climate Agreement. 2019.
6 Carbon Disclosure Project, Cities A List, 2019.

SWACO's stated vision is

"

a community that is environmentally safe and resourceful.

"

SWACO'S COMMITMENT

As an integral member of the community, the Solid Waste Authority of Central Ohio (SWACO) serves Franklin County and neighboring areas with solutions for solid waste. SWACO is one of 52 solid waste districts created by the Ohio General Assembly in 1989. These districts were established with the mission of reducing reliance on landfills.

SWACO's stated vision is "a community that is environmentally safe and resourceful." As such, SWACO's Board of Trustees has adopted a mission and guiding principles that demonstrate their commitment to this vision. As a component of this vision, SWACO is dedicated to sustainability and environmental stewardship. Strategic goals have been established for reducing the environmental impact of operations at their facilities.

In recognition that climate plays an important role in the quality of life, economic well-being and long-term sustainability of the community, SWACO is committed to lessening the impact of SWACO's contribution to climate change. SWACO has set a long-term strategic goal to reduce the organization's carbon footprint for assets managed by SWACO. To achieve this goal, SWACO has developed this Carbon Emissions Management Plan that identifies measures for reducing the carbon footprint of SWACO facilities through an informed decision-making process.

USING THIS PLAN

This Carbon Emissions Management Plan serves as the guiding framework to reduce the organization's carbon footprint for assets managed by SWACO and follows a stepwise approach, consisting of the following components:

Carbon Footprint Evaluation

Establish a baseline and routinely monitor the organization's carbon footprint for comparison;

Benchmarking

Identify industry best practices for carbon emission reductions

Goal Establishment

Setting a realistic, measurable goal for addressing carbon emissions

Implementation

Prioritize and carry out sustainable, economic and strategic initiatives

SECTION 2.0

Carbon Footprint Evaluation

FOOTPRINT DEFINITION

As a first step in evaluating its carbon footprint, SWACO developed an inventory of carbon emissions from SWACO operations, starting with the baseline year 2017. A carbon emissions baseline provides a reference point to develop future organizational goals and prioritize actions.

Facilities owned and operated by SWACO were identified and included in the carbon footprint. The list of facilities in the footprint include:

- Franklin County Sanitary Landfill - 3859 London Groveport Road
- Model Landfill – 3413 Jackson Pike
- Administration Office Building - 4239 London Groveport Road
- Community Resource Center - 4149 London Groveport Road
- Fleet Garage – 4109 London Groveport Road
- Jackson Pike Transfer Station - 2566 Jackson Pike
- Morse Road Transfer Station - 4262 Morse Road
- Georgesville Road Transfer Station – 1550 Georgesville Road (Closed)

Next, the sources of emissions were evaluated. Carbon emission sources are categorized as direct or indirect and are referred to as Scope 1, 2 and 3.

EACH OF THE THREE SCOPES ARE DEFINED AS FOLLOWS:

Scope 1 – Direct emissions from sources owned and/or controlled by SWACO such as company-owned vehicles/equipment or landfill emissions;

Scope 2 – Indirect emissions from generation of energy offsite and then purchased by SWACO, such as electricity or natural gas; and

Scope 3 – Other indirect emissions that are influenced by SWACO activities but occur from sources not owned and/or controlled by SWACO. Examples include activities conducted by contractors, off-duty employees or other stakeholders.

Due to available information, carbon emissions associated with activities from SWACO owned, controlled and purchased sources (i.e., Scope 1 and Scope 2 sources) were included in the calculated baseline carbon footprint and are the basis for this plan. Scope 3 emissions are not included within the footprint but may be addressed in the future.

METHODOLOGY

To accurately calculate SWACO's carbon footprint, an emissions inventory was developed following the Local Government Operations Protocol Version 1.1[7] , a well-regarded publicly available resource created by the International Council for Local Environmental Initiatives and The Climate Registry. The protocol provides methodologies for calculating carbon emissions and references to emission factor data sources. SWACO procured a software tool from VelocityEHS® for streamlining the input of carbon emissions data, completing the calculations, and for tracking and analysis. The emissions inventory was established in this tool. Emission source metrics (e.g., electricity invoices, fuel usage reports, etc.) were provided by SWACO personnel with knowledge of the associated processes.

The Protocol includes a methodology to calculate emissions using a standard unit of measurement (i.e., carbon dioxide equivalent (CO_2e). Each source in the inventory emits greenhouse gases that have a different Global Warming Potential (GWP), meaning they trap different amounts of heat in the Earth's atmosphere. Published emission factors account for the GWP of each greenhouse gas and through a series of calculations included in the Protocol, express total emissions as CO_2e. This standard unit of measurement is used for comparison purposes.

7 *ICLEI Greenhouse Gas Protocols*

GWP OF MAJOR GREENHOUSE GASSES

GWP for the major greenhouse gases emitted at SWACO

CO_2 Carbon Dioxide — 1 *(baseline unit)*

CH_4 Methane — 25

N_2O Nitrous Oxide — 298

Table 1. 2017 Baseline Carbon Emissions Summary

Emission Source	Annual CO_2e	% Total Emissions	% Total Emissions (Excluding Landfill Gas)
Landfill Gas	149,963	95.83%	-
Vehicle/Equipment Fuel	5,622	3.59%	80.51%
Building Electricity	1,647	1.05%	23.58%
Building Fuel	77	0.05%	1.10%
Waste Material	33	0.02%	0.48%
Recycled Material	-396	-0.25%	-5.67%
Total	**156,946**		
Total (Excluding Landfill Gas)	**6,983**		

The VelocityEHS® inventory tool calculates emissions by month and by year. A summary of the baseline emissions inventory is included in Table 1.

MONITORING

For ongoing evaluation of the carbon footprint, SWACO employees enter identified metrics by emission source and location on a monthly or annual basis, as allocated by the VelocityEHS® tool assignments. Emissions are automatically calculated by the VelocityEHS® tool and can be viewed on a dashboard or through generating detailed reports.

On an annual basis, the Carbon Emissions Management Working Group verifies that metrics for the preceding year have been entered and follow up on any gaps in metric data to ensure a complete data set. Once verification is complete, the working group reviews the report summarizing the annual emissions and compares the emissions to the previous year to note progress against the identified goal.

SECTION 3.0

Benchmarking

ASSESSMENT

A benchmarking assessment was conducted to identify best practices to reduce carbon emissions by organizations with similar operations to SWACO's. Organizations selected are recognized as having successful sustainability programs addressing waste management, fleet operations, purchasing and/or facility management. The assessment prioritized best-in-class operational practices. A summary of selected organizations is included as Table 2.

Table 2. Benchmarking Organizations

Organization	Organization Type	Key Attributes
Frito Lay (OH)	Manufacturer	• Fleet operations • Waste management
King County (WA)	County government	• Purchasing • Waste management • Facility Management
Recology (CA)	Private waste management company	• Waste management • Facility management • Fleet operations
Green Waste Recovery, Inc. (CA)	Private waste management company	• Waste management • Facility management • Fleet operations • Purchasing
Oberlin College (OH)	College	• Facility management
SteelCase (MI)	Design company	• Facility management

Data collected from the organizations included:

- Organizational vision or mission statement;
- Guiding policies, plans, or other governing mechanisms;
- Carbon emissions reduction goals, objectives and targets;
- Best-in-class carbon emission reduction initiatives;
- Carbon emissions tracking and reporting processes;
- Key sustainability-related successes and lessons learned; and
- Communication initiatives.

Results of the benchmarking assessment are included as Appendix A. Overall, the research revealed robust efforts by similar organizations to reduce carbon emissions.

SECTION 4.0

Goal Setting

METHODOLOGY

As part of a multi-disciplinary collaborative goal setting process that considered the 2017 baseline emissions, the standard of industry practice as identified during the benchmarking assessment, as well as SWACO's existing vision, mission, guiding principles and goals, SWACO identified an overarching goal for reducing carbon emissions with accompanying strategic initiatives. Recognizing that the measurement and formation of specific realistic goals often drive results and progress, SWACO set a science-based emission reduction target grounded in objective, current scientific data.

To calculate the target, SWACO utilized an industry-recognized model created by the Science-Based Target Initiative (SBTI), a collaboration between the Carbon Disclosure Project, the United Nations Global Compact, World Resources Institute, and the World Wide Fund for Nature. The model considers the carbon emission reductions necessary to meet the Paris Agreement objective to limit the global average temperature increase to 1.5°C (2.7°F). For SWACO's waste management industry type, the recommended method was an absolute contraction method that allocates the global carbon emissions budget applied to all companies equally. This equates to a minimum annual linear carbon emissions reduction rate of 4.2%.[8]

8 Science-Based Target Initiative Manual. April 2019.

ORGANIZATION-WIDE GOAL

As carbon emissions vary depending on the intensity of activities and processes, SWACO selected an operational metric of "tons of material processed" organization-wide goal. Tons of material processed includes the total tons of waste received by SWACO and the tons of recycling delivered to Rumpke's MRF. As of the 2017 baseline year, SWACO processed 1,038,215 tons of material, equating to a carbon emissions rate (i.e., intensity) of 0.14 tons of CO_2e per ton of material processed.

Factoring in intensity, SWACO has set the following science-based target for carbon emissions reduction from the baseline:

Achieve an emission rate of

0.05 tCO_2e

per ton of material processed *by*

2032

SECTION 5.0

Implementing

A series of strategic initiatives with measurable outcomes to systematically manage carbon emissions are included in the Carbon Management Strategic Initiatives Matrix presented in Appendix B. These initiatives are grouped into four environmental categories including landfill gas emissions management, vehicle/equipment fuel management, energy management and waste management. Each initiative identifies the action item/strategy, responsible party and schedule for implementation.

The initiatives for each category were selected to address the activities, operations and programs with the greatest emissions reduction impact and opportunities for continual improvement. During the collaboration process by the Carbon Emissions Management Working Group, initiatives were ranked utilizing defined criteria including, ease of implementation, affordability, and magnitude of potential emissions reduction.

Given the complexity of implementing initiatives with environmental, economic and operational considerations, SWACO identified several priority initiatives for further evaluation. A stepwise approach to evaluate each of these priority initiatives is presented in a series of Decision Trees included in Appendix C on the following topics:

- On-site Methane Use;
- Converting to Compressed Natural Gas Trucks;
- Converting to Electric Vehicles;
- On-site Geothermal Heating; and
- Converting to Solar Energy.

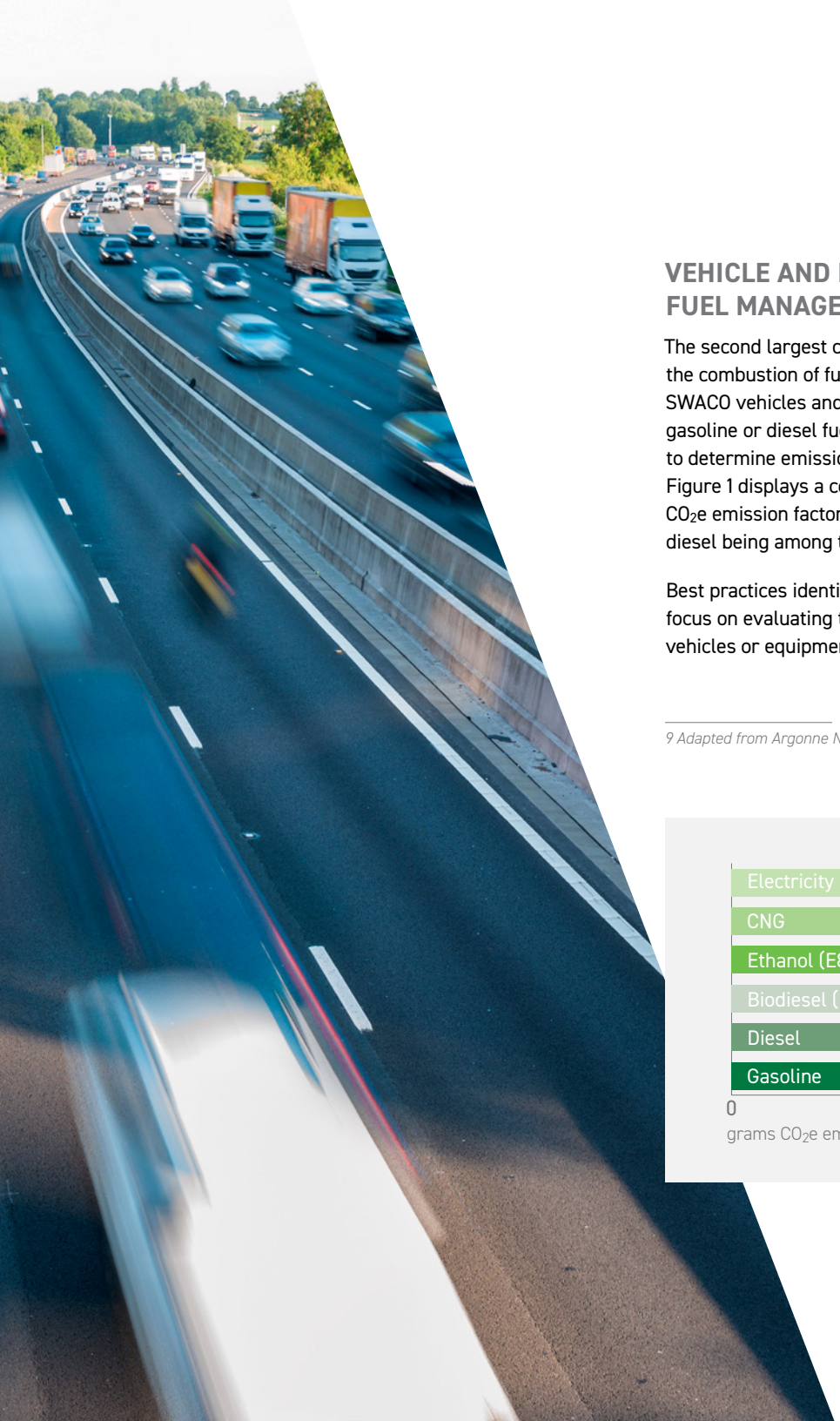
The Decision Trees guide evaluators through the process of determining when initiatives should be implemented based on the magnitude of emissions reduction, resource or technology availability and lifecycle costs. For each of these factors, best available industry resources are provided for assisting in the evaluation. The following subsections summarize the categories and associated priority initiatives for which Decision Trees have been developed. Implementing these initiatives will contribute to SWACO's carbon emission reduction goal.

LANDFILL GAS EMISSIONS MANAGEMENT

Common to most solid waste management facilities, landfill gas emissions are the most significant source of carbon emissions by several magnitudes. Decomposing landfilled materials contribute to the generation of methane, a potent greenhouse gas, among other air pollutants. Strategies focused on capturing emissions for beneficial reuse are the most impactful.

At SWACO, a portion of landfill gas is captured and provided to a strategic partner for generation of renewable natural gas. SWACO receives a share of the sale of the renewable natural gas. This portion of the landfill gas is subtracted from the total amount of landfill gas that is flared or emitted resulting in reduced carbon emissions for SWACO. As such, the identified strategic initiatives address landfill gas emissions management through continuation of this practice and expanding upon landfill gas capture for on-site electricity generation, as identified in the Decision Tree.

In addition to landfill gas capture, measures to reduce the amount of organic material entering the landfill will result in reduced emissions. In the anaerobic landfill environment, the decomposition of these materials results in a greater emissions rate compared to decomposition in an aerobic environment achieved through composting. Furthermore, when compost materials are land applied, the materials serve as a carbon sink resulting in a net reduction of emissions. As such, SWACO has developed initiatives for alternative organic materials management practices that divert organic waste from the landfill to use in composting.



VEHICLE AND EQUIPMENT FUEL MANAGEMENT

The second largest carbon emission source at SWACO is the combustion of fuels to power vehicles and equipment. SWACO vehicles and equipment are largely fueled by gasoline or diesel fuel. Although various criteria are used to determine emissions from vehicles and equipment, Figure 1 displays a comparison of simplified lifecycle CO_2e emission factors by fuel source with gasoline and diesel being among the fuel sources that emit the most.[9]

Best practices identified in the strategic initiatives focus on evaluating the feasibility of transitioning vehicles or equipment to alternate fuel sources that result in fewer emissions and obtaining more fuel-efficient vehicles or equipment. Decision Trees have been established for transitioning diesel trucks to compressed natural gas (CNG) and transitioning vehicles to electric, specifically. As these initiatives may require significant capital investment, measures focused on practices such as decreasing vehicle or equipment run time through enforcing the anti-idling policy and conducting training for operators, have been identified.

9 Adapted from Argonne National Laboratory GREET Tool

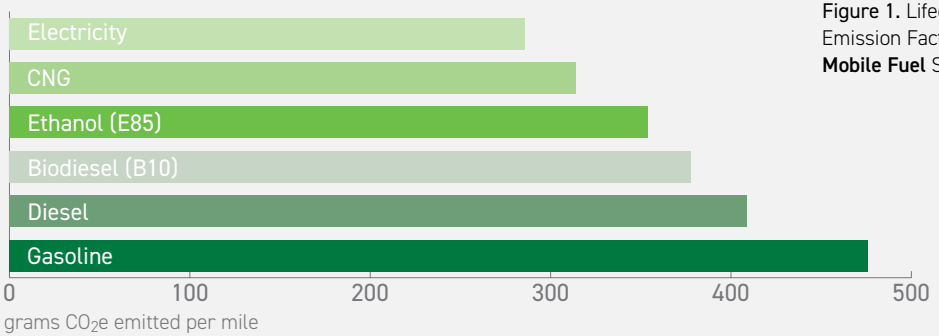


Figure 1. Lifecycle CO_2e Emission Factors by **Mobile Fuel** Source[9]

BUILDING ENERGY MANAGEMENT

Building operations and programs that take place at SWACO require energy use, either in the form of electricity, as supplied by the electrical utility, natural gas or propane. The electricity generated for central Ohio is largely by coal and natural gas which results in significant lifecycle emissions. Renewable energy sources, such as wind and solar, have less of a negative environmental impact than nonrenewable energy sources such as fossil fuels. Figure 2 displays a comparison of simplified lifecycle CO_2e emissions by electricity source.[10]

The strategies for building energy management with the greatest impact on emissions reductions incorporate renewable energy sources into the electricity portfolio or develop on-site renewable energy such as solar or geothermal energy, for which Decision Trees are developed. On-site energy sources add diversity to SWACO's energy portfolio. In addition to contributing to long-term operational resiliency by avoiding negative impacts associated with utility price fluctuations and/or electricity supply interruptions, increased energy portfolio diversity provides an opportunity for SWACO to purchase electricity from renewable sources offsite.

Energy conservation measures can reduce total energy use across the organization, thereby avoiding emissions altogether. Strategies include conducting a building energy audit of existing facilities to identify priority areas that could include integrating smart energy meter technology, retrofitting lighting systems or retrofitting mechanical systems. For new construction, strategies focus on utilizing energy efficient rating systems and incorporating the total cost of ownership.

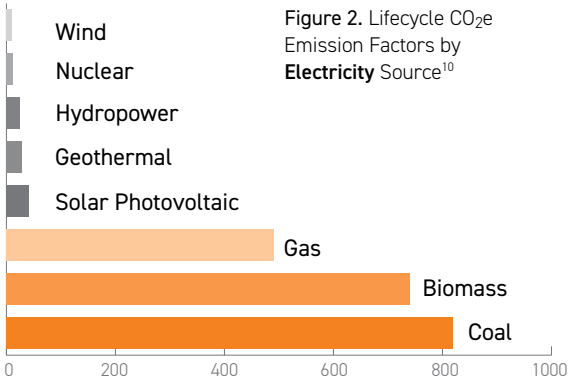


Figure 2. Lifecycle CO_2e Emission Factors by **Electricity** Source[10]

WASTE MANAGEMENT

Landfilled materials contribute to the generation of methane, while other greenhouse gas emissions from transporting waste are also attributed to general waste management activities. SWACO's waste management operations contribute the fewest emissions by source. Instead, when calculated holistically, lifecycle emissions from recycling in place for SWACO operations results in a net reduction of waste emissions.

Alternative materials management practices that reuse, recycle and otherwise divert waste from the landfill contribute to fewer overall emissions. Initiatives include conducting audits of SWACO facilities to identify opportunities for waste diversion. Supplemental initiatives include incorporating materials with recycled content, reducing paper use, and establishing a mechanism for office compost collection.

10 Adapted from IPCC WG3 Energy Systems (p. 539)

SECTION 6.0

Future Considerations

SWACO is committed to reducing emissions within its financial and operational control. Successful execution of this plan is dependent on continued SWACO leadership and public support to reduce emissions. Access to funding and staffing expertise to evaluate emission reduction policies, capital investments and operating procedures, are key to implementing this plan.

Coordinating with surrounding neighbors and existing regional programs may provide opportunities for future plan expansion. Also, continuing to engage, share resources and best practices with SWACO employees, contractors, partners, and local stakeholders will help to advance this plan and further reduce emissions to the benefit of the greater Central Ohio regional community.

As SWACO finds success in reducing carbon emissions from the current carbon footprint baseline, consideration should be given to the following:

- Broadening the carbon footprint to include emission reduction targets for Scope 3 emissions;
- Establishing a carbon emissions goal beyond carbon neutral; or
- Pursuing investment in carbon sequestration for unavoidable CO_2e emissions.

APPENDIX A

Benchmarking Assessment

Benchmarking Categories	Benchmarking Organization					
	Frito Lay (OH)	**King County (WA)**	**Recology (CA)**	**Green Waste Recovery, Inc. (CA)**	**Oberlin College (OH)**	**SteelCase (MI)**
Attributes	Fleet operations; waste management	Purchasing; waste management; facility management	Waste management; fleet operations; facility management	Waste management; fleet operations, facility management; purchasing	Facility management	Facility management
Organization Details	• As a subsidiary of PepsiCo, the Wooster facility manufactures core Frito Lay products • 350 employees	• County government • Serves ~2 million residents • 14,000 employees	• Private integrated resource recovery company that is parent company to 40 operating companies in over 132 municipalities in California, Oregon, and Washington • Facilities include 15 transfer stations, 12 materials recovery facilities, 9 organics processing facilities, 3 landfills and fleet of 2,000 vehicles • 2,000 employees	• Locally owned private company serving 19 communities in California that specializes in the collection and processing of residential and commercial trash, yard trimmings, curbside recyclables, food waste and construction and demolition debris • Facilities include 5 companies, 8 processing facilities, and 230 collection vehicles • 550 employees	• Private liberal arts college • 82 buildings and facilities • 330 employees	• Publicly traded company with furniture and technology solutions • Facilities include 150 offices, showrooms, manufacturing facilities, and distribution centers. • 11,7000 employees
Vision/Mission Statement	*"We are committed to delivering top-tier performance while being responsive to the needs of the more than 200 countries and territories we serve around the world."*	*"King County: a diverse and dynamic community with a healthy economy and environment where all people, businesses, and organizations have the opportunity to thrive. King County government provides fiscally responsible, quality-driven local and regional services for healthy, safe, and vibrant communities."*	*"Recology sees a world without waste. Recology builds exceptional resource ecosystems that protect the environment and sustain our communities."*	*"In an effort to safely service our communities and maximize our diversion from landfills, we focus on minimizing our carbon footprint and teaching future generations the value of our planet's limited resources."*	*"Oberlin College will achieve its commitment to carbon neutrality for its campus by 2025 in a meaningful manner, while providing equitable solutions and supporting a culture of learning and engagement for the campus and community."*	*"People are at the heart of everything we do and everything we create. This truth drives our approach to sustainability. With people at the center, we can deliver meaningful, lasting economic, environmental and social change through the choices we make and the behaviors and actions we demonstrate."*
Goals	• PepsiCo: Reduce absolute GHG emissions across value chain by 20% by 2030 • Achieve zero waste to landfill from direct operations by 2025	• Reduce GHG emissions from its operations, compared to a 2007 baseline, by at least 15% by 2015, 25% by 2020, and 50% by 2030. • Achieve net carbon neutrality for the Solid Waste Division by 2025 • Use 100% GHG-neutral electricity in government operations by 2025	• Achieve city goal of zero waste and state goal of GHG emissions reductions	Achieve operational efficiency of 0.07 metric tons CO_2e per ton processed by 2015 • Strive for zero waste at all facilities • Exceed air quality compliance standards for fleet • Achieve a combined overall recycling rate of 90% for all facilities	• Achieve carbon neutrality by 2025	• Reduce global GHG emissions by 25% by 2020, compared to a 2010 baseline, while continuing to invest in 100% renewable energy equivalent to global electricity consumption • Reduce total waste sent to landfill by 25% by 2020 compared to a 2010 baseline
Development/ Governance	• PepsiCo's Performance with Purpose (PwP) 2025 Agenda • Maintain an Environmental Management System for environmental compliance and sustainability metric tracking and continual improvement • There is a zero waste to landfill policy • Internal Green Team consisting of technicians and management, led by an environmental coordinator	• A series of countywide planning policies are in place with several listing GHG emission reduction targets • For example, Countywide Planning Policy, Environment 18A - States the county will assess and report on GHG emissions every 2 years and update the comprehensive GHG emissions inventory every 5 years • The Strategic Climate Action Plan is the guiding document for GHG related emissions.	• Assembly Bill 341- Commercial Recycling is designed to reduce GHG emissions in the state by 5 million tons of carbon dioxide • Resolution 670-02 - 75% landfill diversion by 2010 and zero waste by 2020 • Recology Strategic Plan (guiding document)	• Assembly Bill 341- Commercial recycling is designed to reduce GHG emissions in the state by 5 million tons of carbon dioxide.	• American President's Climate Commitment - Achieve carbon neutrality by 2025 • Board of Trustees adopted the environmental policy stating new buildings to achieve LEED silver standard • The Committee on Environmental Sustainability (CES) has been formed • The Carbon Neutrality Resource Master Plan, Implementation Strategy, and Economic Approach serves as the college's guiding document	• Board of Directors, Executive Leadership Team and the Global Sustainability Steering Committee directs program • An Environmental Management System is used for tracking and continual improvement.

Benchmarking Categories	Benchmarking Organization					
	Frito Lay (OH)	**King County (WA)**	**Recology (CA)**	**Green Waste Recovery, Inc. (CA)**	**Oberlin College (OH)**	**SteelCase (MI)**
Key Successes	• Since 1999, reduced electricity use by 6.6%, natural gas by 24% and water use by 39%. • During 2008-2015, the facility met the internal definition of zero-waste landfill, sending less than 1 percent waste for landfilling.	• 21,000 tons CO_2e removal from recycling more than 18,000 tons of cardboard, metals and other resources. • 37,000 tons CO_2e removal associated with productive reuse of 26,000 tons of Loop Biosolids • 114,000 tons CO_2e removal associated with planting 41,000 trees	• In 2016, composting operations prevented the release of over 337,000 tons of CO_2e • In 2016, recycling operations prevented the release of nearly 1 billion tons of CO_2e. • LED lighting retrofit resulted in 65% reduction in annual electricity consumption.	• Recycling efforts from 2009-2011 reduced GHG emissions by 1.7 million tons • In 2009, GreenWaste avoided over 250,000 tons of GHGs, resulting in avoided emissions 20 times higher than the emissions emitted by operations. • GreenWaste has begun generating renewable on-site power at the MRF, to offset over 100 tons of GHG's a year.	• Since 2007, the college has halved on-campus emissions through the purchase of green electricity, installation of a 2.27 MW solar array, energy efficiency projects, and ending the use of coal for heating. • The college buys 60% of electricity from renewable sources and generates 12% from solar, saving $100,000 per year.	• Reduced GHG emissions by 21% since 2010 • Reduced waste by 45% since 2010
Applicable Initiatives	• Install new Energy Star roofing material that exhibits solar reflectance • Install energy efficient lighting and ovens • Install quick charge systems for forklift batteries • Replace forklift motors and gear boxes with high efficiency units • Install pressure regulators to reduce water use and water recycling in certain processing areas • Install baler for packaging recyclables • Replace paper towel dispensers with hand dryers • Utilize 30% recycle office paper and print double-sided • Establish composting of organic waste • Incorporate fuel-efficient vehicles, electric delivery vehicles, and compressed natural gas tractors and delivery trucks into flee • Incorporate regenerative braking and Opus digital readout • Utilize smart road technology, GPS integration and cell connectivity • Create a robust preventative maintenance program • Develop economical routing	• Developed Sustainable Purchasing Guide - Buy and promote use of recycled and other environmentally-preferable products and services • Partner with utilities and others to phase out coal-fired electricity by 2025 and support development of increasing amounts of renewable energy resources • Plant at least one million trees in King County by 2020 • For all vehicle fuel use, ensure 2% of diesel fuel dispensed at the pump is biodiesel • Use a life-cycle cost assessment, including a cost of carbon pollution, to integrate more fuel efficient vehicles and technologies into fleet • Leverage technology to maximize efficient vehicle use and implement operational strategies, such as anti-idling, fuel-saving driving techniques, car sharing, and vehicle rightsizing • For all capital projects, evaluate and strive for a LEED Platinum level or other approved rating system	• Continue to implement CNG, LNG, and hybrid technologies • Utilize renewable diesel fuels in several fleets • Introduce an automated 3-minute idle shut down for collection trucks • Utilize Bio-Fleet™, vegetable-based hydraulic fluids and lubricants • Utilize a route management system for collection fleets and tracks via GPS for route optimization • Constructed solar array - 664-kilowatt system at transfer Station • Developed large-scale composting operations • Send wood material to cogeneration facilities for use as biomass fuel • Utilize hydroelectric power source • Fuel Inbound collection fleet with 100% alternative fuels • Retrofit buildings with LED lighting • Installed gas-to-energy collection systems at landfill sites • Constructed integrated material recovery facility	• Commissioned the material recovery facility • Utilize biodiesel fuels in fleet • Replace aging fleet with CNG vehicles • Implemented company-wide Environmentally • Preferable Purchasing Policy • Increase route efficiencies • Installed 80,000 sq. ft. of solar panels • Compost organics using best composting practices and covered aerated static piles to control emissions • Electrification of material recovery operations that were formerly diesel-powered • Retrofit lighting with T-8 fluorescent lighting and motion sensors	• Conversion of central utility plant fuel from coal to natural gas Installed a 2.27MW solar photovoltaic array • Leveraged waste heat from Lorain County • Landfill for campus heating needs • Developed a requirement that new buildings must meet LEED standards • Installed vacancy sensor lighting controls on new and existing systems • Installed photovoltaic skylights • Replace inefficient windows • Improved HVAC systems and heat recovery • Community based social marketing to effect behavior changes that could impact energy consumption	• Launched system to allow operations teams to actively track energy consumption and optimization • Integrated smart meter technology for energy tracking • Currently utilize cloud-based remote control technology for electricity use • Developed virtual power purchase agreement for wind power • Implement processes to explore opportunities within supply chain to reduce packaging • Incorporate cardboard baling process • Improve sorting and diversion methods for waste streams • Reduced heat island effect by planting 958 trees to shade impervious surfaces. • Provided alternative transportation and fuels by constructing bicycle lock-up areas, showers, and electric refueling stations • Installed high-performance insulating glass and roof systems increase the building's thermal performance • Prioritize use of recycled or low carbon building materials by conducting life-cycle cost assessments • Installed sensor-controlled interior lighting

Benchmarking Categories	Benchmarking Organization					
	Frito Lay (OH)	**King County (WA)**	**Recology (CA)**	**Green Waste Recovery, Inc. (CA)**	**Oberlin College (OH)**	**SteelCase (MI)**
Partnerships/ Funding	• Clean Fuels Ohio partnership including funding from the U.S. Dept of Energy for alternative fuel and advanced technology vehicles and infrastructure and Ohio EPA's Diesel Emission Reduction Grant • Ferrel Gas partnership to establish propane fueling stations	• GHG emission inventory conducted in partnership with the Puget Sound Clean Air Agency, the City of Seattle, and the U.S. Department of Energy • Shared funding and planning with King County-Cities Climate Collaboration (K4C) Safe Energy Leadership Alliance (SELA) coalition for raising awareness of impacts of coal terminals • Leadership role in EPA West Coast Climate and Materials Management Forum	• Partnered with American Solar to design and construct the company's largest solar array - 664-kilowatt system at the • Recology San Francisco Transfer Station. • Partnered with Wildlands to preserve wetland habitat • Contract with electric utility to purchase GHG emission reductions • Partnerships with local municipalities for waste diversion • Partnership with IMP Smarter Computing to mine large data sets related to waste streams	• Partnerships with local municipalities and non-profit organizations for waste diversion • Grant funding from Bay Area Air Quality • Management District's Carl Moyer Grant • Program to assist with retiring aging engines and replaced with new Tier 3 engines.	• Engage students and faculty • Partnership with Oberlin Municipal • Light and Power System for solar and alternative fuel	• EPA Green Power Partnership for assisting in purchasing renewable power Partner with RE100, a global initiative uniting more than 100 businesses committed to 100% renewable electricity • Work with Business Climate Leaders for effective non-partisan climate advocacy
Lessons Learned	Program ownership is important. The Green Team is a cross functional team consisting of all levels of employees. Company invests in team members through training and education and rewards/recognizes members.	Key findings of the Strategic Climate Action Plan (SCAP) audit included: • The SCAP update and its subsequent implementation and monitoring should be informed by input from a broad representation of community stakeholders. • The SCAP should establish explicit, and whenever possible, quantifiable connections between the overarching climate goals and specific strategies and actions. • The SCAP should incorporate verifiable economic analysis of the cost-effectiveness of current and potential actions to reach SCAP targets; subsequent SCAP annual reports should provide explicit information about progress toward the overarching climate targets and goals. • The County Executive should ensure there is an effective management structure in place to produce the 2015 SCAP and should ensure this project team has sufficient resources and support, to the extent possible, to complete the update.	Not identified	Not identified	Leadership at Oberlin will need to make decisions in the near future regarding how to implement preferred strategies, and the structure with which strategies should be implemented. While these recommendations are projected to reduce Oberlin's Scope 1 and 2 carbon emissions when compared to the 2007 baseline, to achieve carbon neutrality by 2025 Oberlin must still address the ongoing electricity generation, its remaining natural gas consumption, carbon offsets, Scope 3 carbon, travel, waste, and ongoing behavioral change.	Careful measurement is key to managing impact. True progress takes continuous and coordinated efforts to create the economic, environmental and social conditions that allow people and communities to thrive.
Reporting	Annual reporting as part of the Performance with Purpose (PwP) 2025 Agenda	Biennial report to public	Climate Registry	Climate Registry	Not identified	Global Reporting Initiative
GHG Emissions	Not tracked	587,900 tons CO_2e in 2014 from county operations	99,181 tons CO_2e in 2017	14,217 tons CO_2e in 2017	44,693 tons CO_2e in 2007 14,456 tons CO_2e in 2015	165,742 tons CO_2e in 2010 127,217 tons CO_2e in 2017
Recognition	• Ohio EPA's Encouraging Environmental Excellence program EPA's National Environmental Performance Track Program Governor's Award for Environmental Stewardship	• Not identified, but provides awards to organizations	• The Climate Registry 2018 Award	• The Climate Registry 2018 Award Bay Area Green Business Certified	• Ohio EPA's Encouraging Environmental Excellence program	• Low Carbon Leader - The Climate Group

Benchmarking Categories	Benchmarking Organization					
	Frito Lay (OH)	King County (WA)	Recology (CA)	Green Waste Recovery, Inc. (CA)	Oberlin College (OH)	SteelCase (MI)
Communication	Awareness activities include: an Earth Day celebration, recognized Eco Hero of the Month, periodic meetings, company publications, billboards, rewards and recognition	• Biennial report to stakeholders • Website • Education and outreach to community	• Employee training programs Education and outreach to community Volunteer program Publications/newsletters	• Employee training programs Education and outreach to community Publications/newsletters	• Engage community through Ecolympics, the Oberlin Project, the Real Food Challenge, campus dining services students, student educators, an annual zero-waste community and culture fest and the Green EDGE Fund offering loans repaid with the savings of implemented energy efficiency improvements. Development of dashboards to share consumption/emission information with students	• Reporting to stakeholders annually through Corporate Sustainability Report Website
Primary Data Source	https://www.fritolay.com/making-a-positive-impact/environment	https://www.kingcounty.gov/depts/finance-business-operations/procurement/for-government/environmental-purchasing.aspx	https://41k4p01v6nzq13r4y42jb9xv-wpengine.netdna-ssl.com/wp-content/uploads/2018/03/Recology-Community-and-Environmental-Benefit-Report_2018.pdf	http://www.greenwaste.com/sites/default/files/GreenWaste-Zanker_Sustainability%20Report_2012.pdf	https://www.oberlin.edu/environmental-sustainability/about	https://www.steelcase.com/content/uploads/2018/12/SC_CSR_2018.pdf
Contact Information	Keshav Sondhi, PepsiCo Sustainability Manager Keshav.sondhi@pepsico.com	Karen Hamilton, Sustainable Purchasing Program Manager EPP@kingcounty.gov (206) 263-9400	Amy Dietz, Director of Environmental - Corporate (415) 875-1000	Katelyn Lewis, Director of Sustainability and Strategy (408) 283-4800	Meghan Riesterer, Assistant Vice President, Campus Energy and Sustainability Meghan.Riesterer@oberlin.edu	Sustainability@steelcase.com
Website	https://www.fritolay.com/	https://kingcounty.gov/	https://www.recology.com/	http://www.greenwaste.com/	https://www.oberlin.edu/	https://www.steelcase.com/

APPENDIX B

Strategic Initiatives

Emissions Source Scope 1&2	Action Item/Strategic Initiative Description	Ranking Criteria 1 (lowest) - 5 (highest)			Weighted Score	Lead Representative(s)	Target Date
		Ease of Implementation	Afford-ability	Emissions Reduction*			
General							
Gen-1	Annually, complete carbon emission inventory for operations.				Not Applicable**	Jeff Wilkins, Molly McGuire	Annually - beginning 2019
Gen-1	Evaluate third-party certification and/or reporting programs that communicate commitments to emissions reductions.				Not Applicable**	Jeff Wilkins, Molly McGuire	2021
Building Electricity							
BE-1	Conduct a building energy audit of existing facilities to identify and prioritize energy conservation measures. Review initiatives BE-3 through BE-11 for prioritization, following the audit.				Not Applicable**	J.D. Compston, Jeff Wilkins	Develop the scope by Q2 2020
BE-2	Incorporate renewable energy sources (i.e., solar, wind, hydro, geothermal, etc.) in electricity portfolio through utility or virtual power purchase agreement.	4	3	2	11	J.D. Compston	Q4 2020
BE-3	Integrate smart meter technology for monitoring building systems to optimize use and increase efficiency.	4	3	2	11	J.D. Compston, Bernie Davis, Jeff Wilkins	TBD after building energy audit
BE-4	Retrofit existing buildings with efficient lighting systems (i.e., LED).	4	3	2	11	J.D. Compston	Ongoing - Occuring as lighting burns out and needs replaced
BE-5	Retrofit roofing with solar reflectance technology.	3	3	1	8	J.D. Compston, Jeff Wilkins	To occur as buildings undergo renovations
BE-6	Evaluate the feasibility of installing onsite (i.e., buildings and/or landfill) solar electricity.	4	3	1	9	J.D. Compston, Jeff Wilkins	TBD after building energy audit
BE-7	Apply reflective coating to windows.	4	3	1	9	Chris Sarina, Rick Romine, J.D. Compston	Ongoing
BE-8	Install motion sensor controlled lighting and evaluate turning off road signs when FCSL is closed.	4	3	1	9	Dwayne Hall, Tim Gulick, J.D. Compston	2022
BE-9	Implement a screen saver and sleep mode timing default for computers.	5	4	1	11	Bernie Davis	Q1 2020
BE-10	For new buildings, commission mechanical systems.	3	2	2	9	Jeff Wilkins	As new buildings are designed with input from the building energy audit
BE-11	For existing buildings, retrocommission mechanical systems.	3	2	2	9	Jeff Wilkins	TBD after building energy audit
BE-12	Develop and implement a policy requiring LEED or other third-party verified energy-efficient rating system certification for new buildings.	3	2	2	9	Jeff Wilkins	TBD after building energy audit
BE-13	Require total cost of ownership (TCOO) calculations for new construction mechanical systems, at a minimum, to account for life-cycle impacts. Use TCOO to evaluate the best cost and performance options prior to investing.	3	3	1	8	Jeff Wilkins	TBD after building energy audit
Landfill Gas							
LFG-1	Collect and utilize methane not already allocated to power/heat onsite facilities.	2	2	4	12	Matt Reardon	PTI projections will allow a determination on feasiblity to be made in Q1 2020

Emissions Source Scope 1&2	Action Item/Strategic Initiative Description	Ranking Criteria 1 (lowest) - 5 (highest)			Weighted Score	Lead Representative(s)	Target Date
		Ease of Implementation	Afford-ability	Emissions Reduction*			
LFG-2	Install methane capture infrastructure as each cell is filled. Once closed start collecting methane in less than the 5-year compliance window. Continue current process and evaluate best practices as technology becomes available.	2	2	4	12	Matt Reardon	Ongoing
LFG-3	Develop additional outreach methods to reduce and recover food and other organic waste.	3	2	3	11	Lucy Schroder, Brian Zimmerman, Andrew Booker, Kristi Higginbotham	Ongoing - Q2 2020 education campaign launch
LFG-4	Continue implementing best practices as regulated by the Ohio EPA to continue collecting the methane at the Model landfill.	3	3	4	14	Matt Reardon	Ongoing - Monitored weekly and as repairs are needed
LFG-5	Work with stakeholders to develop residential compost collection, beyond yard waste, within service area.	2	2	3	10	Andrew Booker	Feasibility study will be completed by end of 2019 - results will guide development of plan in 2021/2022
Vehicles/Equipment							
V/E-1	Evaluate feasibility of transitioning vehicles from diesel to CNG. Consider size of load versus number of trips required.				Not Applicable**	Bill Burns	Continually evaluate as grant funding becomes available
V/E-2	Transition vehicles from diesel to CNG, electric, or alternative fuels.	3	2	2	9	Bill Burns, Scott Perry	Dependent upon infrastructure/ availibity of grant funding
V/E-3	Enforce anti-idling policy.	4	4	2	12	Adam Burleson, Bill Burns	Evaluate data gathered from camera system in 2020 to formulate policy and enforcement strategy
V/E-4	Conduct annual equipment and operator behavior training sessions. Track cost and fuel use per hour to operate to inform future training focus areas.	2	3	2	9	Adam Burleson	Evaluate data and make updates to training in 2020
V/E-5	Update puchasing evaluation criteria for new equipment and vehicles to include carbon emissions impact.	2	3	2	9	Barbara Colebank	2020
Waste Management							
WM-1	Conduct a waste audit of SWACO facilities to identify opportunities to divert additional waste (i.e., recycling, composting, reuse, etc.).				Not Applicable**	Brian Zimmerman	2020
WM-2	Conduct an audit to identify supplies purchased with excessive packaging and look for alternatives with less packaging as part of a green purchasing policy.				Not Applicable**	Barbara Colebank, Brian Zimmerman	Evaluate and research in 2020 as well as create a reference guide for Staff after Waste Audit is conducted
WM-3	Utilize more office products with recycled content.	4	3	1	9	Brian Zimmerman	2020
WM-4	Establish and track office composting.	4	3	2	11	Brian Zimmerman, Kristi Higginbotham, Lucy Schroder	Provide estimated cost of service in Q1 2020
WM-5	Continue using reusable serving ware and water bottles in SWACO facilities and encourage the use of reusable serving ware for external partnered events.	4	3	1	9	Andrew Booker, Hanna Greer-Brown	2020
WM-6	Reduce paper use by or transitioning to electronic communications or documentation, where possible consider the use of electronic signatures. Continue implementing double-sided printing default settings.	4	3	2	11	Jeff Wilkins	2020
WM-7	Continue grasscycling in place and composting SWACO's seasonal yard waste.	5	4	1	11	J.D. Compston	Ongoing
WM-8	Implement a procedure to order less frequently to reduce delivery emissions. (Scope 3 emissions.)	5	4	1	11	Sherry Ryan	2020

APPENDIX C1

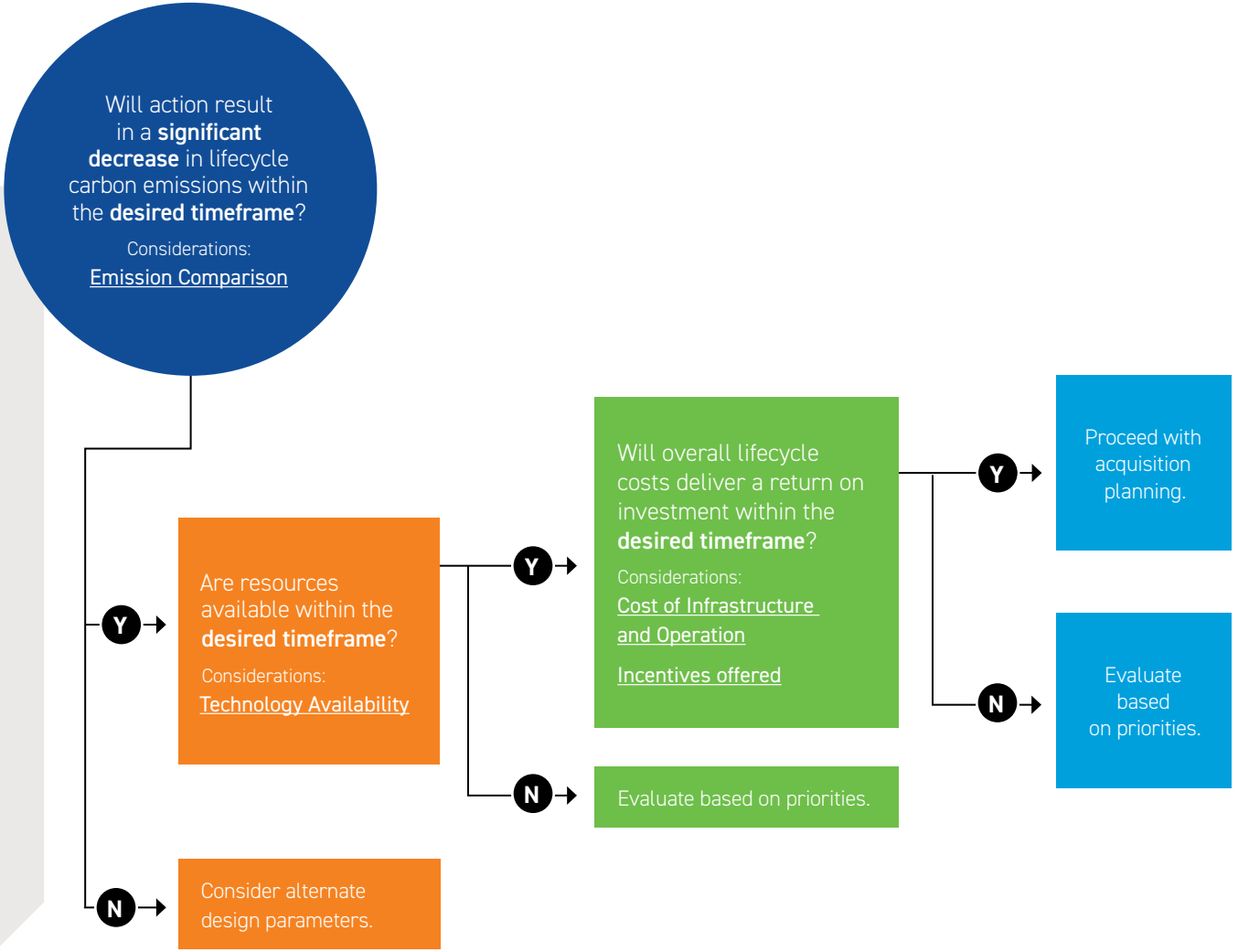
Decision Tree: On-Site Methane Use

Description: Method to evaluate feasibility of transitioning from grid electricity use to on-site conversion of methane for electricity generation.

Reasons to Evaluate: Carbon emissions reduction goals, electricity cost exceeds threshold, political will, availability of infrastructure.

Considerations

- Methane conversion technology type (reciprocating internal combustion engine, cogeneration, gas turbine, microturbine, steam turbine, combined cycle, Stirling cycle engine, etc.) (Technology Options)
- Design parameters of methane conversion technology treatment system



Decision Tree: On-Site Methane Use (Appendix C1)

Resource Guide

Emissions Comparison:

"Landfill Gas Energy Benefits Calculator." Photovoltaic Watts Calculator." U.S. Environmental Protection Agency, Landfill Met ha ne Outreach Program.

https://www.epa.gov/lmop/landfill gas energy benefits calculator

Enter capacity of technology.

Technology Options and Availability:

"Landfill Gas Energy Project Development Handbook, Chapter 3 Project Technology Options." U.S. Environmental Protection Agenc y, Landfill Methane Outreach Program.

https://www.epa.gov/sites/production/files/2016 09/documents/pdh_chapter3.pdf

See description of options. Availability resources vary depending on technology

Cost of Infrastructure and Operation:

"Landfill Gas Energy Cost Model." U.S. Environmental Protection Agency, Landfill Methane Outreach Program.

https://www.epa.gov/lmop/lfgcost-web-landfill-gas-energy-cost-model

Enter parameters of project.

Incentives Offered:

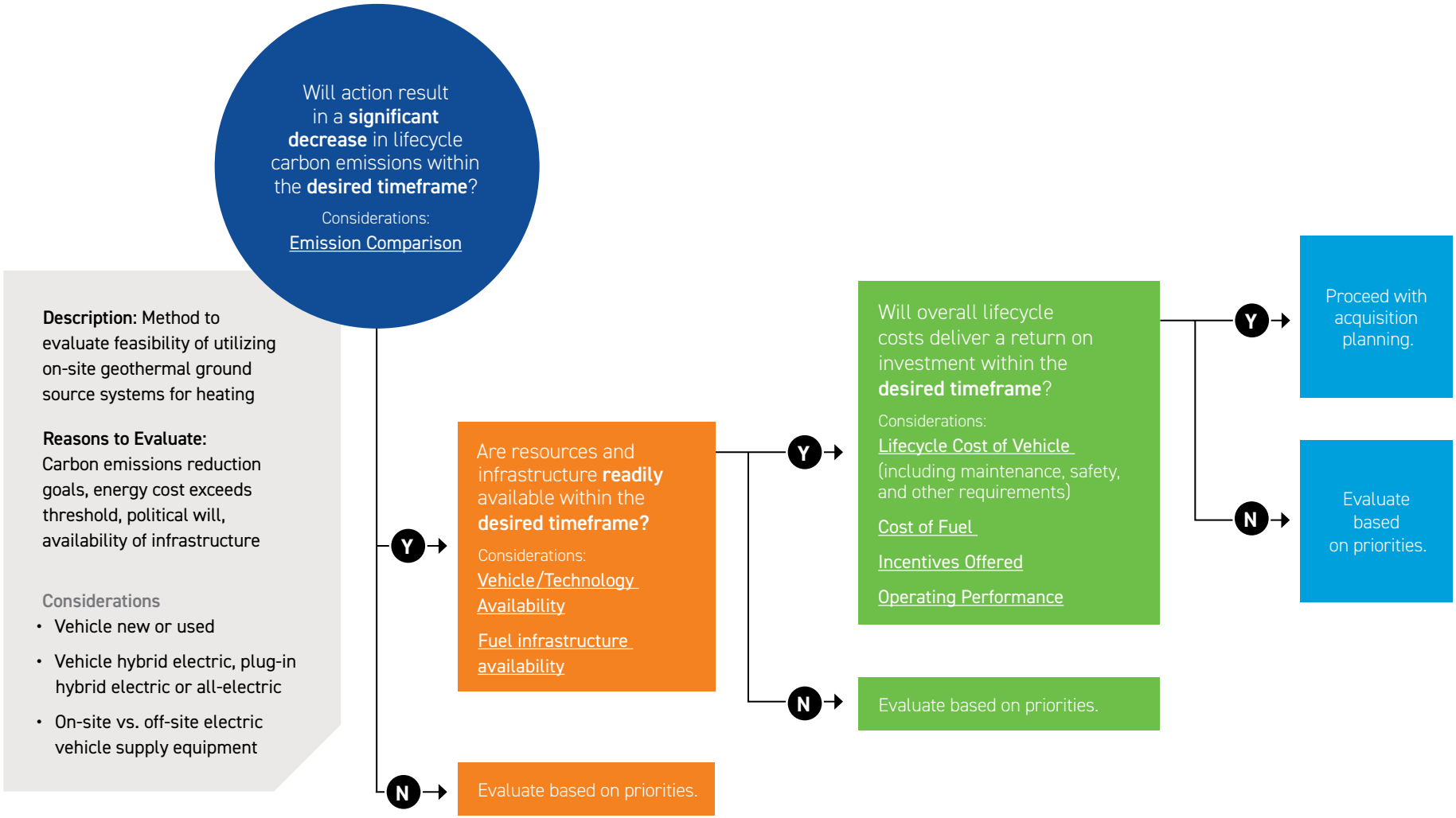
"DSIRE Database of State Incentives for Renewables and Efficiency." U.S. Department of Energy.

https://programs.dsireusa.org/system/program?zipcode=43123

Search by state.

APPENDIX C2

Decision Tree: Diesel to Compressed Natural Gas Trucks



Decision Tree: Diesel to Compressed Natural Gas Trucks (Appendix C2)

Resource Guide

Emissions Comparison:
"Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool." (2018). Argonne National Laboratory. https://afleet-web.es.anl.gov/afleet/

Select vehicle and fuels to be compared.

Vehicle/Technology Availability:
"Alternative Fuel and Advanced Vehicle Search." (2019). U.S. Department of Energy, Alternative Fuels Data Center.

https://afdc.energy.gov/vehicles/search/

Search by vehicle and fuel/technology.

Fuel Infrastructure Availability:
"Alternative Fuel Stations." (2019). U.S. Department of Energy, Alternative Fuels Data Center.

https://afdc.energy.gov/fuels/natural_gas_locations.html#/analyze?show_map=true&location_mode=address&location=43123&radius=10

Conduct advanced search by desired proximity and fuel type.

Lifecycle Cost of Vehicle:
"GREET Model Platforms." (2019). Argonne National Laboratory. https://greet.es.anl.gov/greet.models

Input parameters by vehicle type.

Cost of Fuel:
"Clean Cities Alternative Fuel Price Report." (2019). Allegheny Science and Technology

https://afdc.energy.gov/publications/search/keyword/?q=alternative%20fuel%20price%20report

Review most recent fuel price report.

Incentives Offered:
"Federal and State Laws and Incentives" (2019). U.S. Department of Energy, Alternative Fuels Data Center. https://afdc.energy.gov/laws

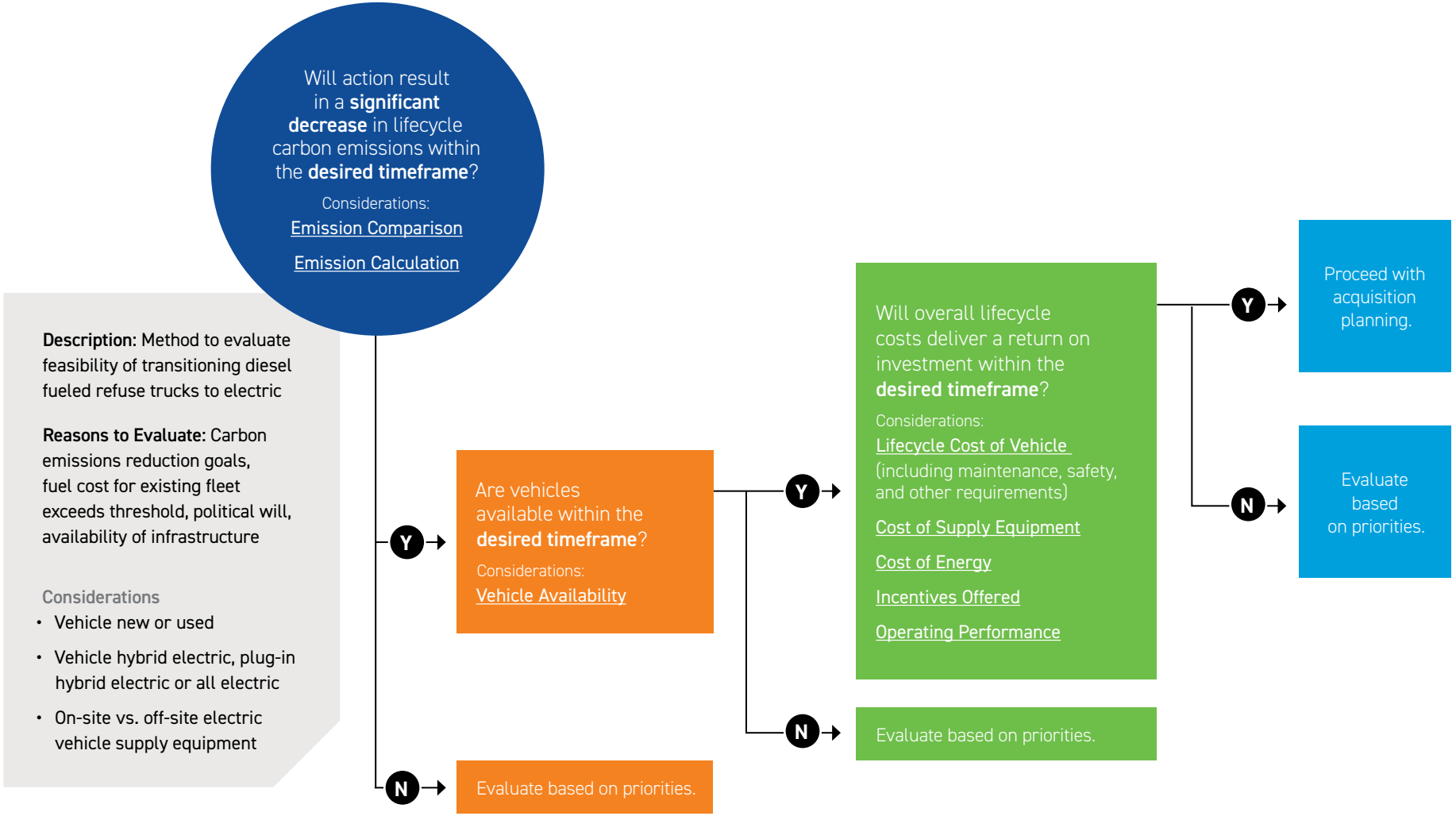
Search by state and federal.

Operating Performance:
"Fleet DNA Project Data." (2019). National Renewable Energy Laboratory. Accessed January 15, 2019: www.nrel.gov/fleetdna

Compare operating performance of vehicles.

APPENDIX C3

Decision Tree: Diesel to Electric Gas Refuse Trucks



Decision Tree: Diesel to Electric Gas Refuse Trucks (Appendix C3)

Resource Guide

Emissions Comparison:
"Alternative Fuel Life Cycle Environmental and Economic Transportation (AFLEET) Tool." (2018). Argonne National Laboratory. https://afleet-web.es.anl.gov/afleet/

Select vehicle and fuels to be compared.

Emission Calculation:
"Well to Wheels Energy Use and Greenhouse Gas Emissions Analysis." (2019). Argonne National Laboratory. https://afdc.energy.gov/vehicles/electric_emissions.html and https://publications.anl.gov/anlpubs/2009/03/63740.pdf

Vehicle/Technology Availability:
"Alternative Fuel and Advanced Vehicle Search." (2019). U.S. Department of Energy, Alternative Fuels Data Center. https://afdc.energy.gov/vehicles/search/

Search by vehicle and fuel/technology.

Lifecycle Cost of Vehicle:
"GREET Model Platforms." (2019). Argonne National Laboratory. https://greet.es.anl.gov/greet.models

Input parameters by vehicle type.

Cost of Supply Equipment:
Costs Associated with Non Residential Electric Vehicle Supply Equipment." (2015). U.S. Department of Energy. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

Cost of Energy:
"Saving on Fuel and Vehicle Costs." (2019). U.S. Department of Office of Energy Efficiency and Renewable https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs

Search by state.

Incentives Offered:
"Federal and State Laws and Incentives" (2019). U.S. Department of Energy, Alternative Fuels Data Center. https://afdc.energy.gov/laws

Search by state and federal.

Operating Performance:
"Fleet DNA Project Data." (2019). National Renewable Energy Laboratory. Accessed January 15, 2019: www.nrel.gov/fleetdna

Compare operating performance of vehicles.

APPENDIX C4

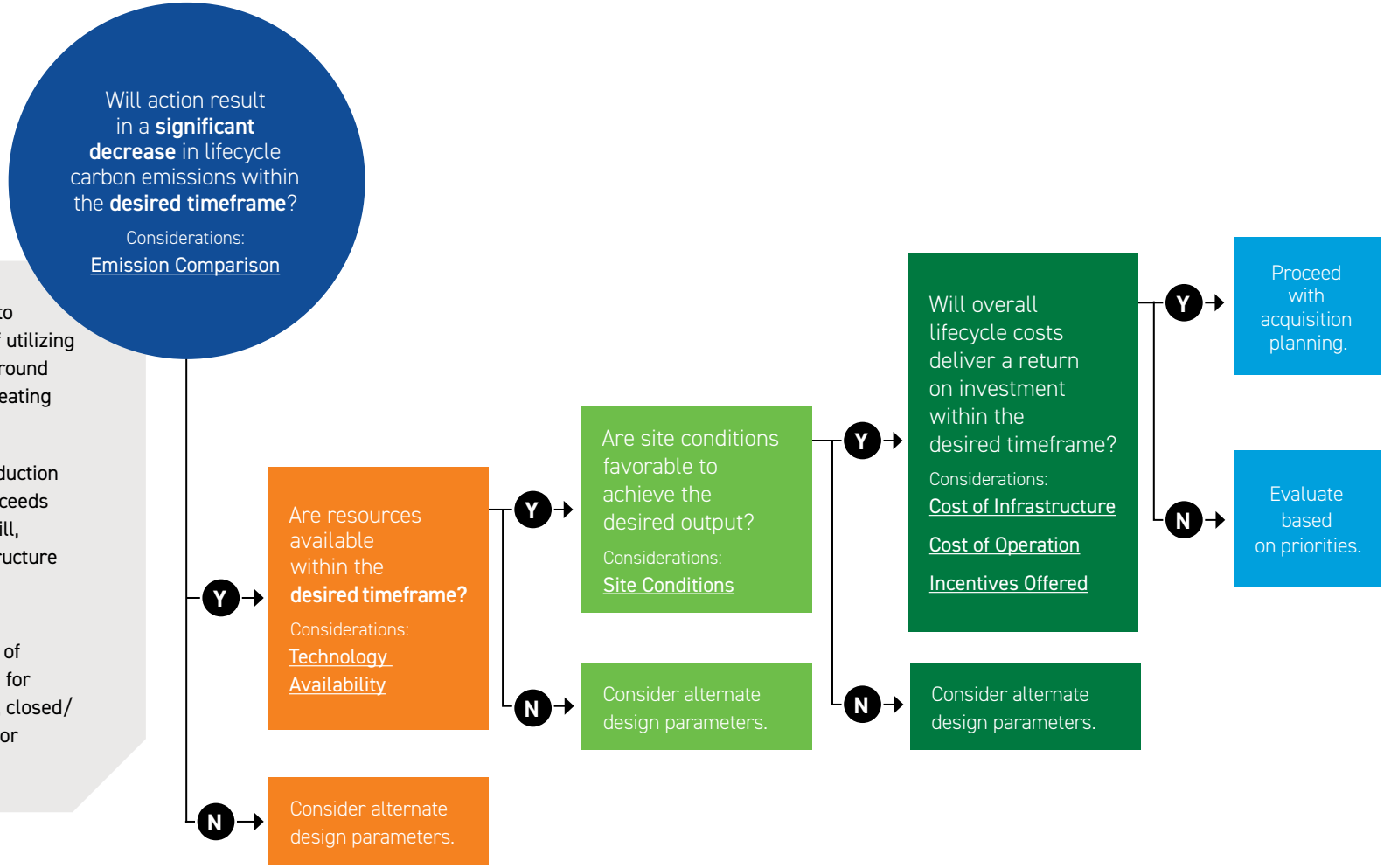
Decision Tree: On-Site Geothermal Heating

Description: Method to evaluate feasibility of utilizing on-site geothermal ground source systems for heating

Reasons to Evaluate:
Carbon emissions reduction goals, energy cost exceeds threshold, political will, availability of infrastructure

Considerations

- Design parameters of geothermal system for desired output (i.e., closed/ open-loop, vertical or horizontal design)



Decision Tree: On-Site Geothermal Heating (Appendix C4)

Resource Guide

Emissions Comparison:

"Strategic GHG reduction through the use of ground source heat pump technology." Institute of Resources, Environment and Sustainability, University of British Columbia. https://iopscience.iop.org/article/10.1088/1748-9326/2/4/044001/fulltext/#erl258190s3

Calculate based on heat load, fuel choice, heat pump efficiency, and carbon intensity.

Technology Availability:

"Geothermal Business Directory – Ohio." Geothermal Exchange Organization. https://www.geoexchange.org/state/oh

Site Conditions:

"Geothermal Energy GIS Services." Ohio Department of Natural Resources, Division of Geological Survey. http://geosurvey.ohiodnr.gov/energy-resources/geothermal-energy/geothermal-gis-services

Cost of Infrastructure:

"Renewable Heating and Cooling - Costs of RHC Technologies." U.S. Environmental Protection Agency. https://www.epa.gov/rhc/rhc-municipal-governments#Cost

Cost of Operation:

"OpenEI - Open Energy Information, Transparent Cost Database." National Renewable Energy Laboratory. https://openei.org/apps/TCDB/

Incentives Offered:

"DSIRE – Database of State Incentives for Renewables and Efficiency." U.S. Department of Energy. https://programs.dsireusa.org/system/program?zipcode=43123

Search by state.

APPENDIX C5

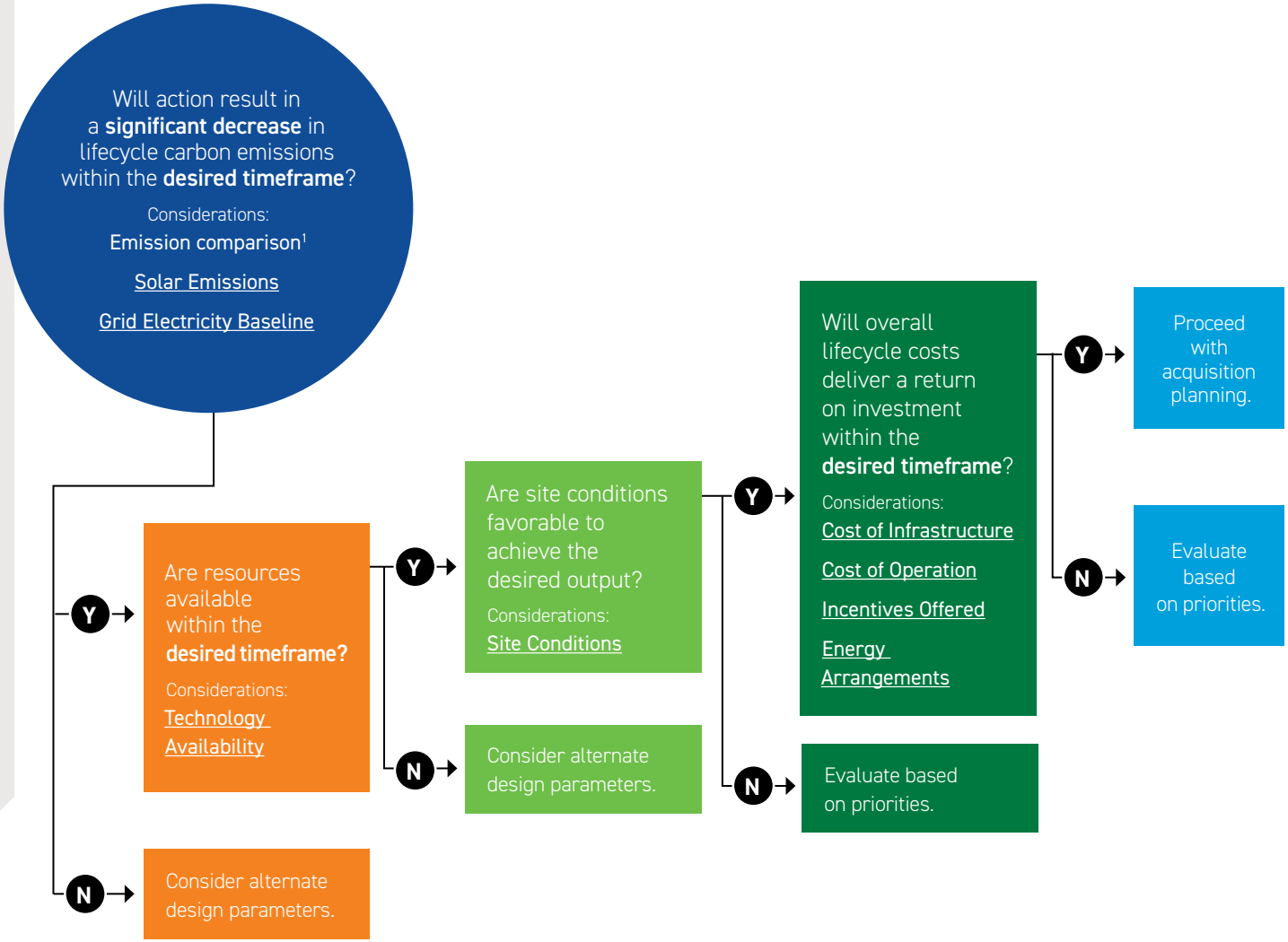
Decision Tree: Converting to Solar Energy

Description: Method to evaluate feasibility of transitioning from grid electricity to use to on-site solar electricity generation

Reasons to Evaluate: Carbon emissions reduction goals, electricity cost exceeds threshold, political will, availability of infrastructure

Considerations

- Design parameters of photovoltaic solar array and energy storage for desired output (Energy production calculator)
- Use of battery storage (i.e., lead-acid, lithium-ion, vanadium redox flow, or all iron flow)
- Integration with electric grid and other financial arrangements through power purchase agreements, third-party ownership or lease agreement



1 Emission comparison details: Solar emissions from project = 54.05 g CO_2e/kWh (median harmonized published life cycle emission factor of solar photovoltaic energy) x energy use Grid electricity emissions baseline = 567.67 g CO_2e/kWh (life cycle emission factor of regional electricity composition converted for unit comparison) x energy use

Decision Tree: Converting to Solar Energy (Appendix C5)

Resource Guide

Energy Production:
"Photovoltaic Watts Calculator." National Renewable Energy Laboratory.
https://pvwatts.nrel.gov/index.php

Enter information on capacity and size of project.

Solar Emissions:
"OpenEI - Open Energy Information, Life Cycle Analysis Harmonization Application." National Renewable Energy Laboratory.
https://openei.org/apps/LCA/

Search for photovoltaic type.

Grid Electricity Emissions Baseline:
"eGRID – Emissions and Generation Resource Integrated Database Power Profiler."
https://www.epa.gov/energy/power-profiler#/

Search for the RFCW region-specific output emission rates (1251.5 lb CO_2e/ MWh as of date of access 10/19/19).

Technology Availability:
Quarterly Solar Industry Update. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.
https://www.energy.gov/eere/solar/quarterly-solar-industry-update

Search for most recent quarter.

Site Conditions:
"U.S. State Solar Resource Maps." National Renewable Energy Laboratory.
https://www.nrel.gov/gis/solar.html

Cost of Infrastructure:
"REopt Lite - Renewable Energy Integration and Optimization." National Renewable Energy Laboratory.
https://reopt.nrel.gov/tool

Enter organization and project criteria.

Cost of Operation:
"OpenEI - Open Energy Information, Transparent Cost Database." National Renewable Energy Laboratory.
https://openei.org/apps/TCDB/

Incentives Offered:
"DSIRE – Database of State Incentives for Renewables and Efficiency." U.S. Department of Energy.
https://programs.dsireusa.org/system/program?zipcode=43123

Search by state.

Energy Arrangements:
"Green Power Supply Options Screening Tool." U.S. Environmental Protection Agency.
https://www.epa.gov/greenpower/green-power-supply-options

https://www.epa.gov/sites/production/files/2018-02/green_power_supply_options_screening_tool.xlsm

Enter organization and project criteria.

Solid Waste Authority of Central Ohio
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www.swaco.org

Gresham Smith
GS-OH Inc.
An Affiliate of Gresham Smith