Life Cycle Assessment – Overview and Value

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Agenda

- What is an LCA?
- Methodology for Typical LCA
- Assumptions and Calculations
- Carbon Footprint Examples
- Results and Conclusions from Example LCA
- Getting An LCA Started

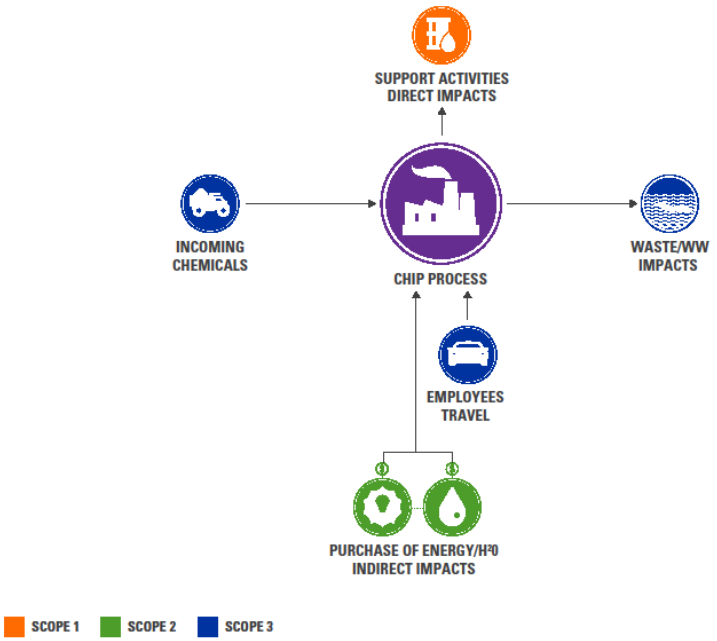
What is an LCA?

LCA considers the entire life cycle of a product, from raw material extraction and acquisition, through energy and material production and manufacturing, to use and end of life treatment and final disposal.

Through such a systematic overview and perspective, the shifting of a potential environmental burden between life cycle stages or individual processes can be identified and possibly avoided.

Ref: EN ISO 14040:2006

Work Scope of an LCA in the Semiconductor Industry



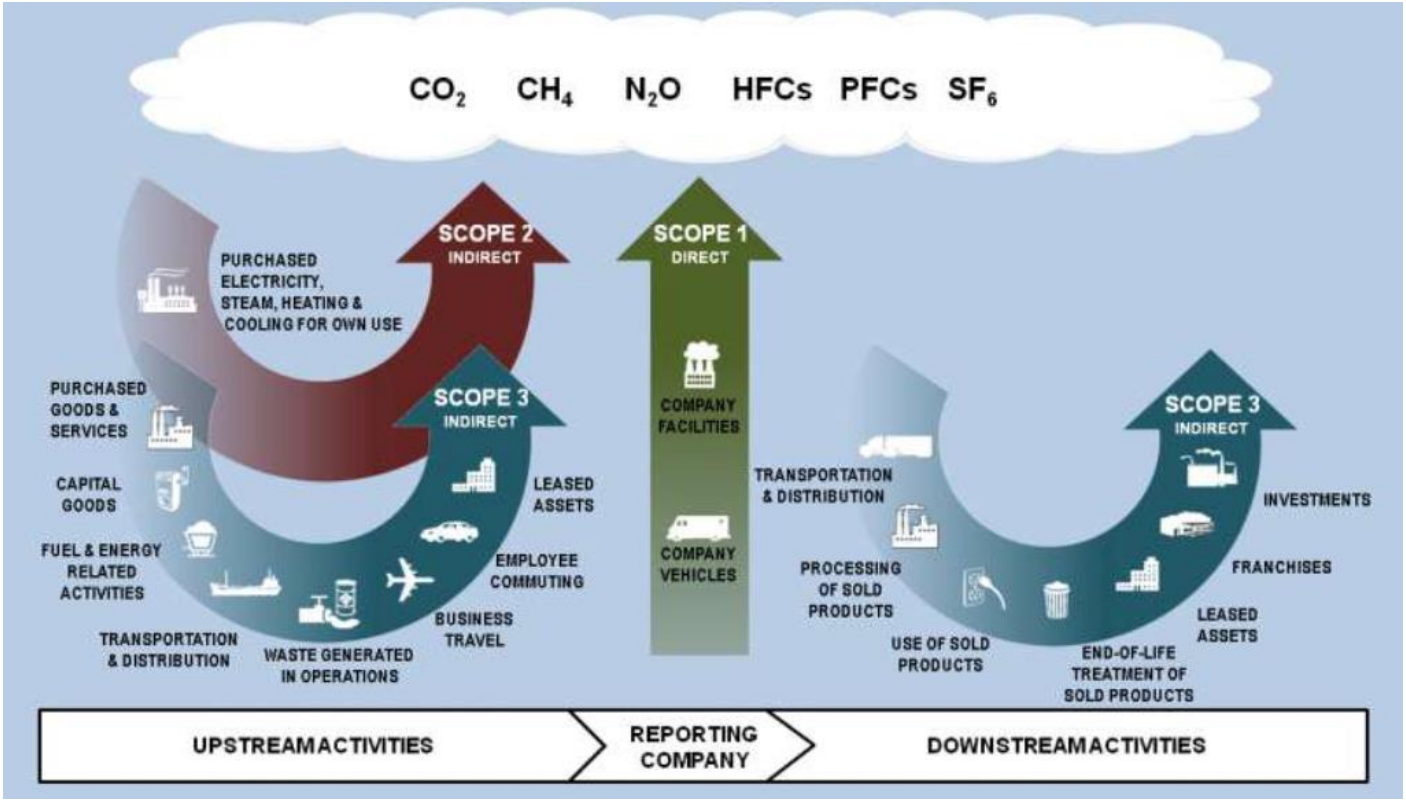
Scope 1, 2 and 3

Scope 1, or direct GHGs, are defined as emissions from sources that are owned or controlled by the organization

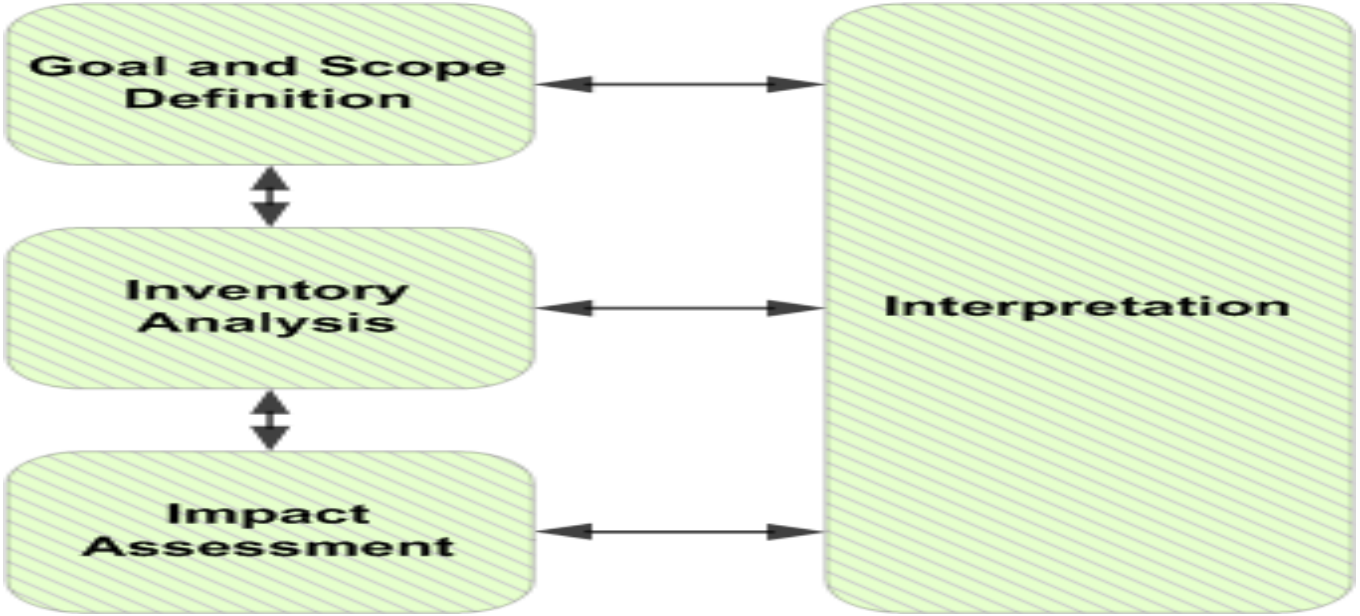
Scope 2 are referred to as energy indirect GHG and are defined as emissions from the consumption of purchased electricity, steam, or other sources of energy generated upstream from the organization

Scope 3 are referred to as other indirect GHG and are defined as emissions that are a consequence of the operations of an organization, but are not directly owned or controlled by the organization

Scope 1, 2 and 3



ISO 14044



Typical LCA Tasks Under ISO 14044

1

Task 1. Develop goals and establish an LCA scope.

2

Task 2. Determine and document life cycle inventory.

3

Task 3. Conduct Life Cycle Impact Assessment and develop impact indicators.

4

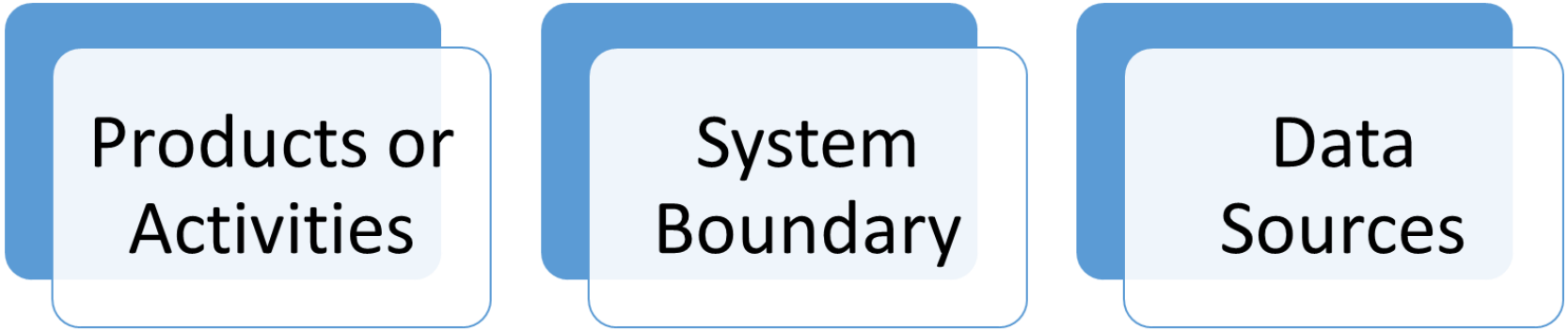
Task 4. Impact data interpretation and analysis

5

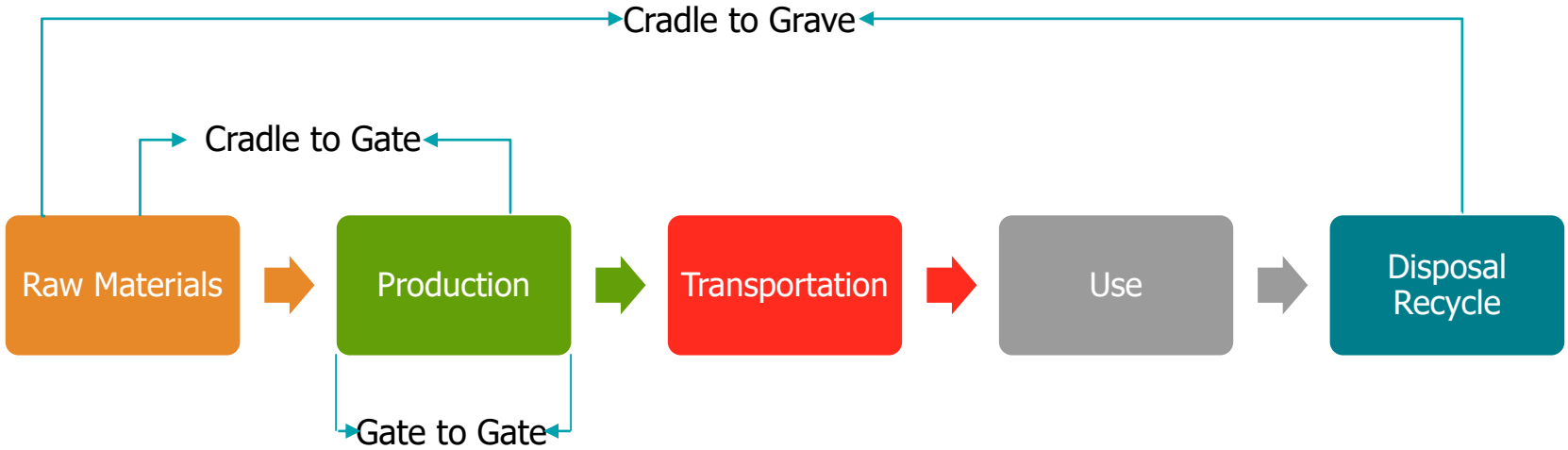
Task 5. Deliver of a written LCA report.

Methodology

Methodology for Typical LCA

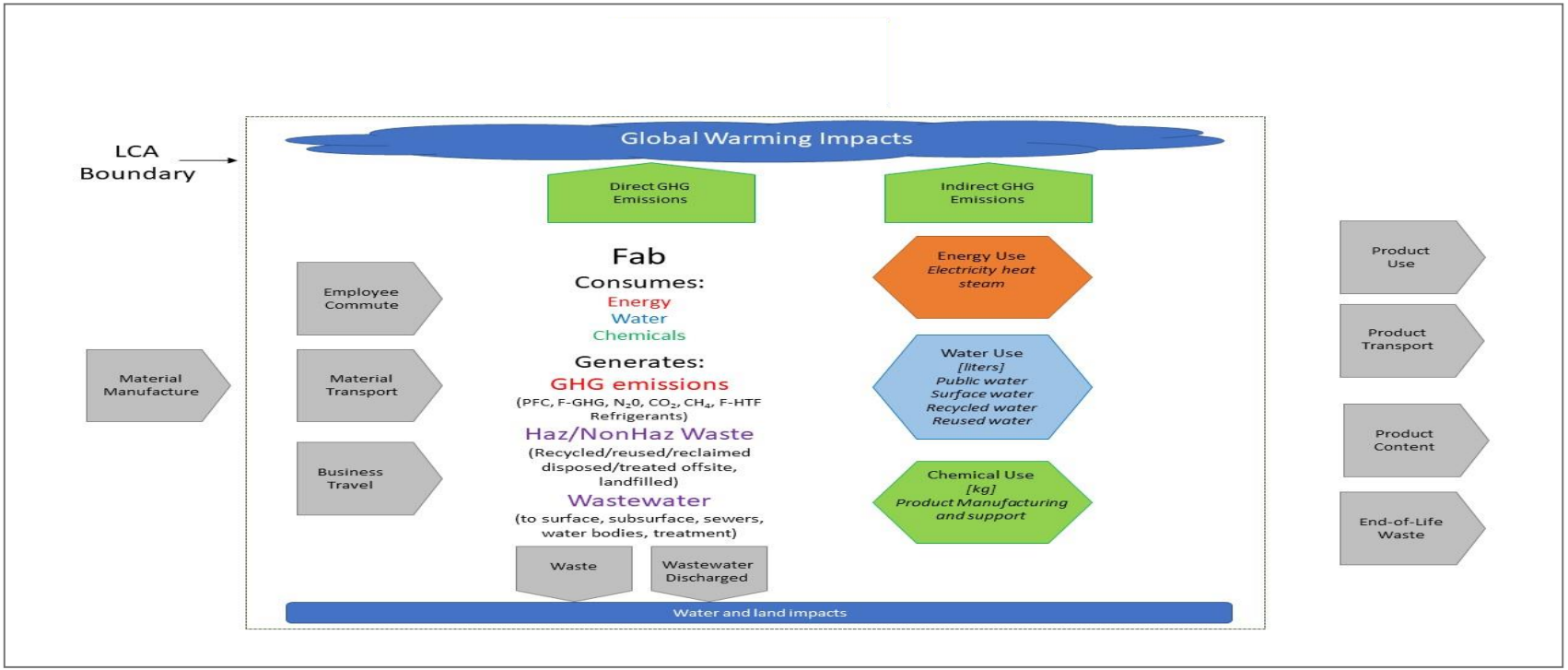


Types of LCA Boundaries



Cradle to Gate: Raw Materials to finished goods
Gate to Gate: Considers everything from receiving to shipping gate
Cradle to Grave: Considers everything from harvesting materials to the disposal of the finished goods

System Boundary Example – Semiconductor Operations



Example Data Sources

- Process Data for activity
- List of chemicals purchased, purchased volumes, supplier locations, and shipment method
- Reported greenhouse gas air emissions
- Total Water Use
- Total IWW Discharge
- Total Hazardous and Non-Hazardous Waste Generated
- Total Electrical Use
- Employee Electric Vehicle use
- Total Natural Gas Use
- Employee Vanpool Data
- Business Travel

Examples of Assumptions

Impact Source	Key Assumptions
Transport of Chemicals from Supplier Location	Total miles for "ship" is based on miles from an assumed port of export nearest supplier location to the Port of Long Beach, CA, plus miles from the Port of Long Beach to the US city of manufacturing.
Top Chemicals	Chemical usage from process emissions and fabrications operations worksheets was used to revaluate top usage for chemicals for each fab. Top chemicals assumed to make up over 95% of all chemical usage.
Treating wastewater	The local municipality buys a significant amount of renewable energy. Zero carbon emissions were assumed for this % electricity used by wastewater treatment plants.
Water consumed	Amount of water re-used for irrigation was assumed to be the sum of water from CTs, air handling units and storm water collection. Amount of water re-used by the UltraPure Water system was assumed to be the same for the two years analyzed

Calculations – Example of Transport of Chemicals

- Process data and % total throughput for year
- List of chemicals transported to site

Top 35 Chemicals	Shipment Frequency	Supplier Location	Shipping Method
HYDROFLUORIC ACID; HF 49%,SA-X,220KG	weekly	Gongju, Korea	Ocean
PHOSPHORIC ACID;H3PO4,H3PO4,6N,300KG,RIN	weekly	Toyama, Japan	Ocean
STRIPPER;EKC-580 200L,H2O/Heterocyclic/a	weekly	Hayward, CA	Truck
CHEMICAL;MCPQ-22L,CuSo4,N/A,55GAL,MLI	twice a month	Moses Lake, WA	Truck
CHEMICAL;PCMP5620 200L,Mixing,N/A,200L,E	twice a month	Hayward, CA	Truck
ETCHANT,POLY ETCH,MAE,95%,200L,KMG	obsolete	Pueblo, CO	Truck
CU EP SOLUTION;TCE-C,40MG/L,200L,CU MAKE	monthly	Paju, Korea	Ocean
HCL 200L	monthly	Kurosaki, Japan	Ocean
AMMONIUM HYDROXIDE;Mesa,NH4OH,29%,Lorry,	Few times a week	Mesa, AZ	Truck
CHEMICAL;ESC-784,C2H7NO/C4H13NO,208L,ATM	every 2 weeks	Austin, TX	Truck

bsi.

Example Supply Chain

Other Calculations- Available Information

- Total Water Use
- Total IWW Discharge
- Waste
- Electrical Use
- Natural Gas Use
- Employee Commute
- Business Travel







Calculations Example

- Developing an Emission Factor for determining CO_2 emissions from annual commute
- Step 1- how far is your commute from home to office
- Step 2- look up average mileage for your car
- Step 3- Average times a week at office (Figure 48 weeks/year)
- Step 4- Emission Factor (metric ton CO_2/mile) = [CO_2 Emissions from a gallon of gasoline: 8,887 grams CO_2/gallon] / [Average MPG] / [1,000,000 grams/metric ton]

Commute Miles (mi/yr) * Emission Factor (mt CO_2/mile) = Commute Emissions (mt CO_2/yr)

GHG Protocol Calculation Tools

Tool: GHG Emissions from Transport of Mobile Sources

GREENHOUSE GAS PROTOCOL

Total GHG Emissions, exclude Biofuel CO2 (metric tonnes CO2e)	2744567.608
Biofuel CO2 Emissions (metric tonnes)	0

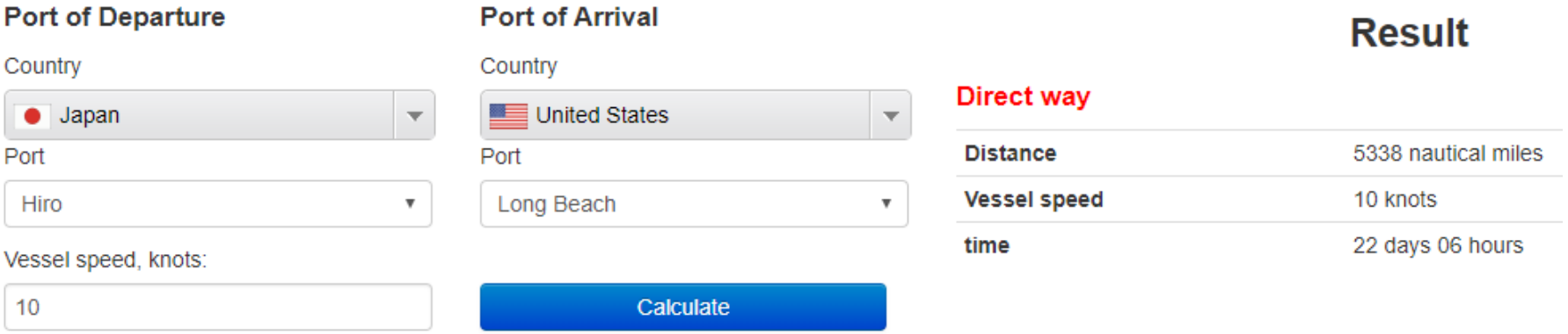
Activity Data

The default emission factors are sourced from the US EPA Climate Leaders program or from the UK DEFRA (for air travel only).

Status	Source Description	Region	Mode of Transport	Scope	Type of Activity Data	Activity Data				
						Vehicle Type (For air transport, see footnote)	**Distance Travelled**	**Total Weight of Freight**	**# of Passenger**	**Units of Measurement**
	Air Travel	US	Aircraft	Scope 1	Passenger Distance (e.g. Public Transport)	Air - Long Haul - Seating Unknown	164250		1	Passenger Mile
	Truck Travel	US	Road	Scope 1	Vehicle Distance (e.g. Road Transport)	Heavy Duty Vehicle - Rigid - Diesel - Year 1960-present	2971587			Mile
	Ship Travel	Other	Water	Scope 1	Weight Distance (e.g. Freight Transport)	Watercraft - Shipping - Large Bulk Carrier (14201 tonnes deadweight)	5812152	14201		Tonne Kilometer

Ocean Transport – Nautical Miles Calculator

To determine Port to Port distances: https://sea-distances.org/



Flight Distance Calculations

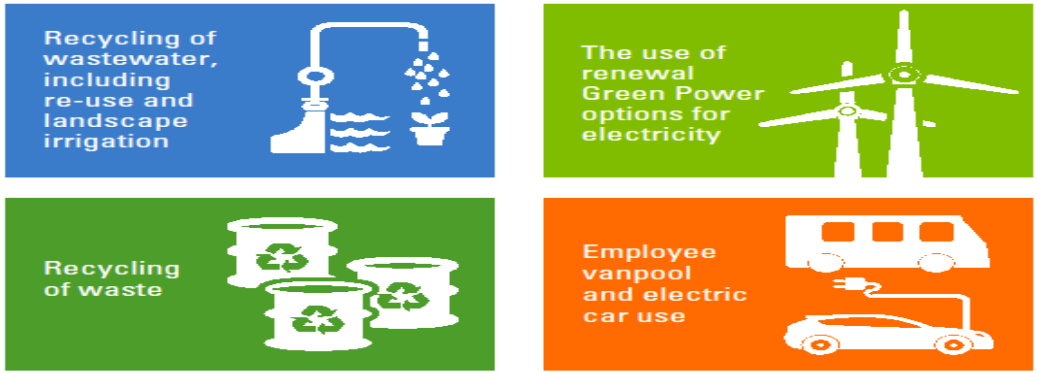
To determine distance for multiple legs of a flight: http://webflyer.com/travel/mileage_calculator/

Results

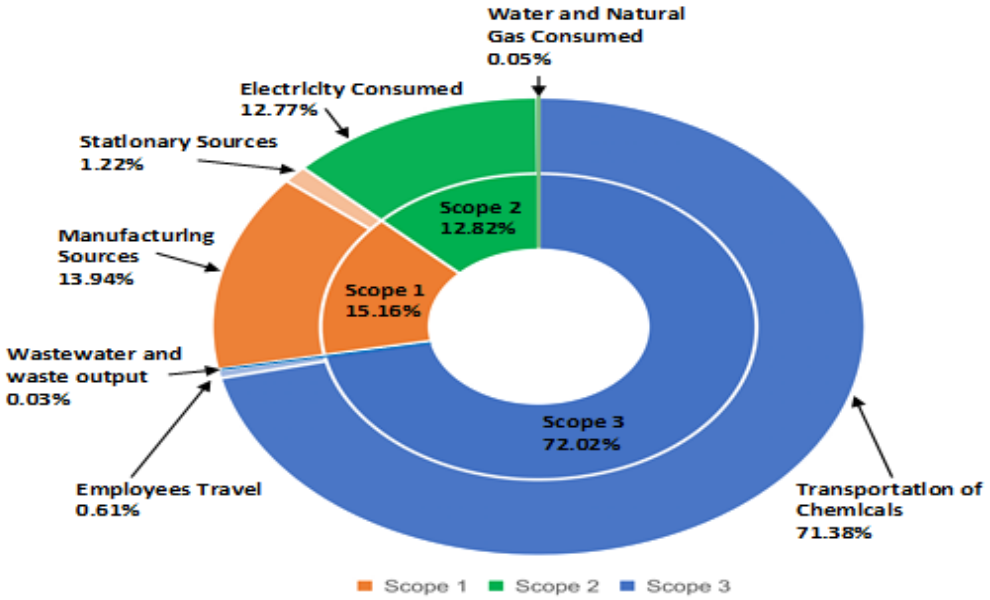
Travel Route:		
Albuquerque Intl Arpt, Albuquerque, NM (ABQ) to		
Dallas Ft Worth Intl, Dallas, TX (DFW) to		
Austin Bergstrom International Airport, Austin, TX (AUS)		
One Way Distances:		
Distance	751 miles	1209 km
Elite bonus	0 miles	0 km
Class of service bonus	0 miles	0 km
Special promotion bonus	0 miles	0 km
TOTAL	751 miles	1209 km
Round Trip Distances:		
Distance	1502 miles	2418 km
Elite bonus	0 miles	0 km
Class of service bonus	0 miles	0 km
Special promotion bonus	0 miles	0 km
TOTAL	1502 miles	2418 km

(in statute measurements)

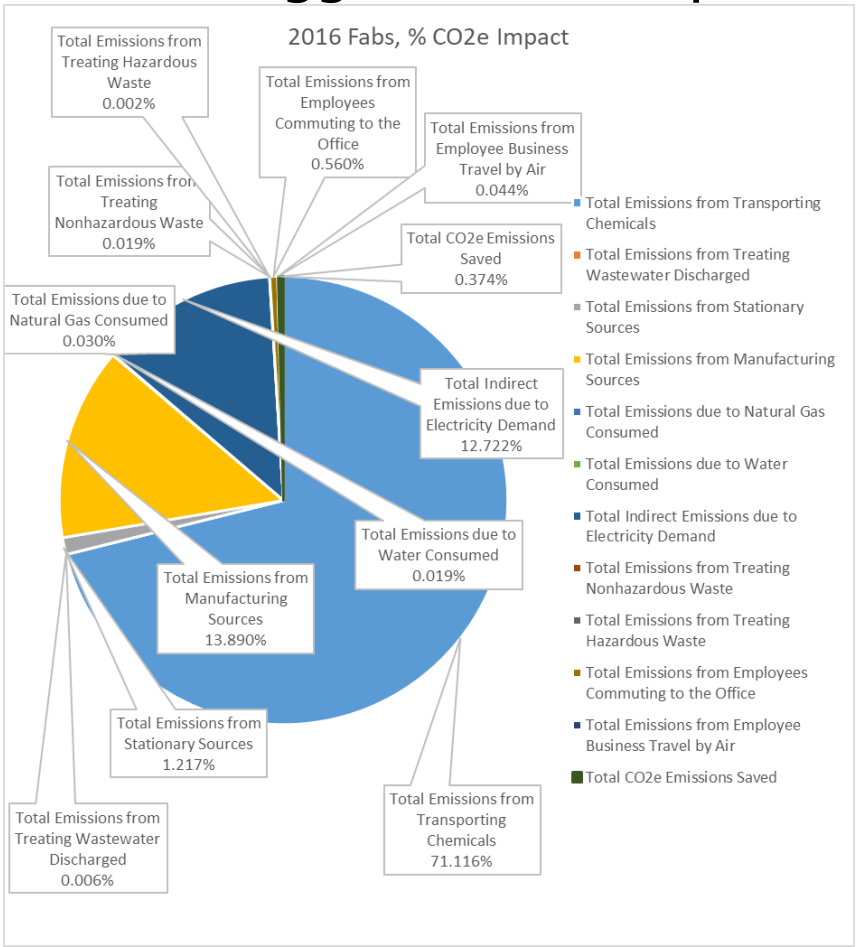
What does the LCA show for the Beneficial Impacts from your Sustainability Program?



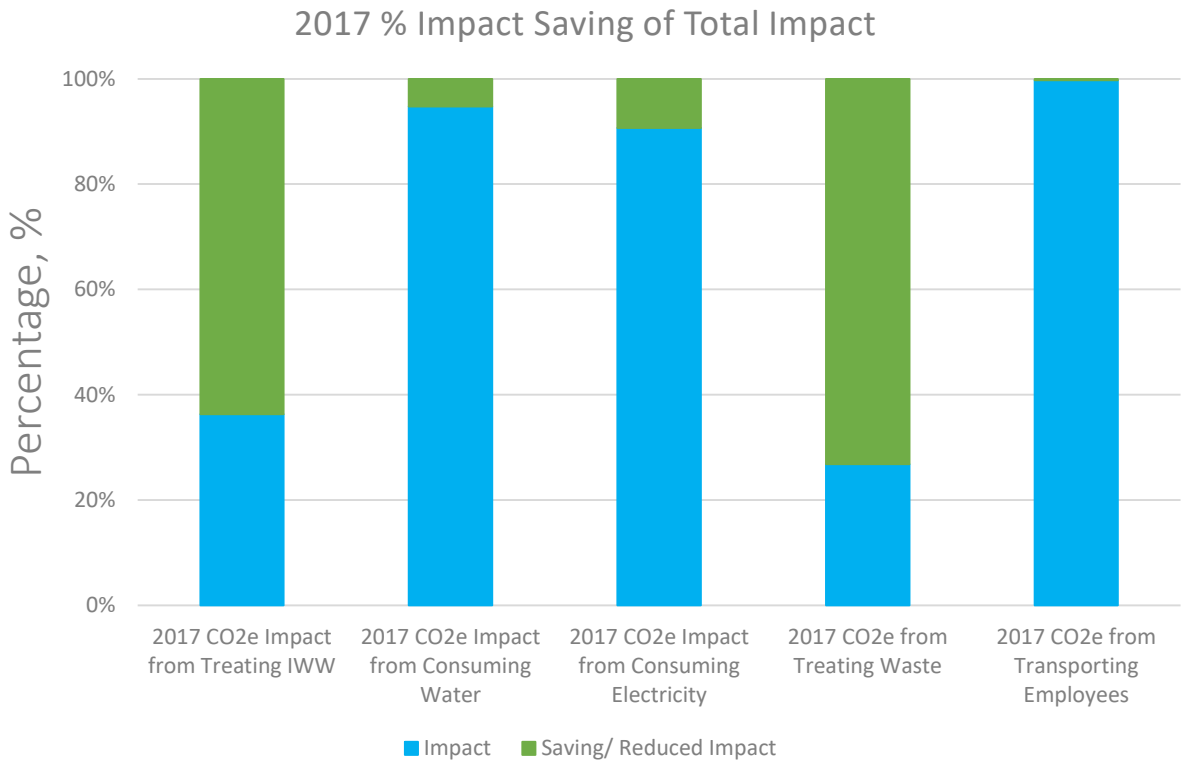
Results and Conclusions- Biggest CO2e Impacts



Results and Conclusions- Biggest CO2e Impacts



Results and Conclusions- Showing Savings and Impacts



Next Steps That Can Usually Be Recommended

Why Do An LCA?

LCA is a valuable decision-support tool for company, external customers and policy makers

Three forces are driving this evolution:

Government regulations are moving in the direction of "life-cycle accountability;" manufacturer is responsible direct production impacts, and impacts product inputs, use, transport, and disposal

Voluntary initiatives which contain LCA and product stewardship components and continuous improvement through EMS

- ISO 14040/14044
- Responsible Business Alliance (RBA)

Environmental "preferability" has emerged as a criterion in both consumer markets and government procurement guidelines.

Means LCA a central role as a tool for identifying cradle-to-grave impacts both of products and the materials from which they are made

Tell Management

Getting An LCA Started

Useful for internal decision-making processes, including product development and improvement, strategic planning, public policy making, marketing, and continuous operational improvement.

Provide pertinent information to external and internal stakeholders

Questions and Answers

Thank you for attending