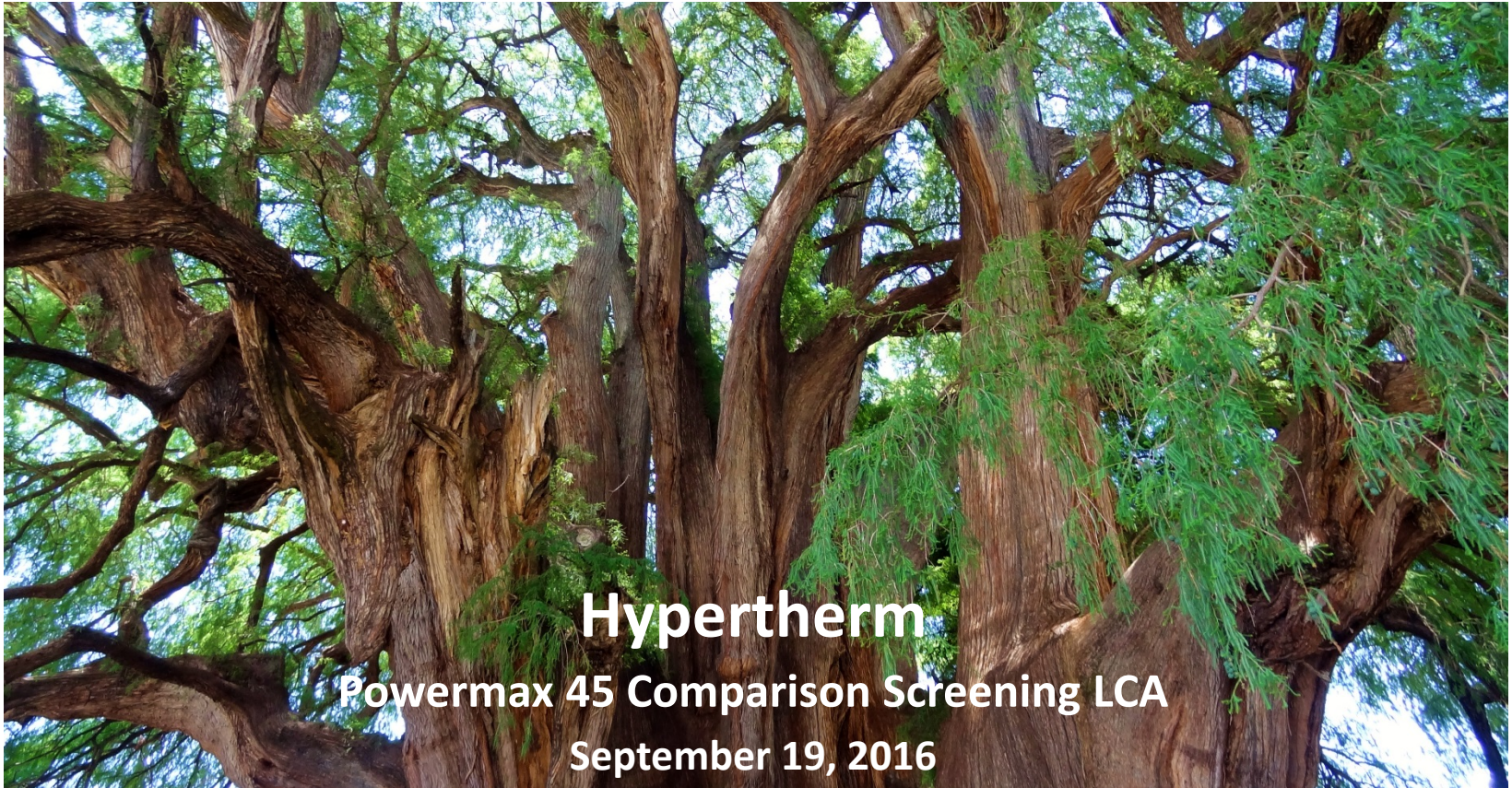


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Hypertherm

Powermax 45 Comparison Screening LCA

September 19, 2016

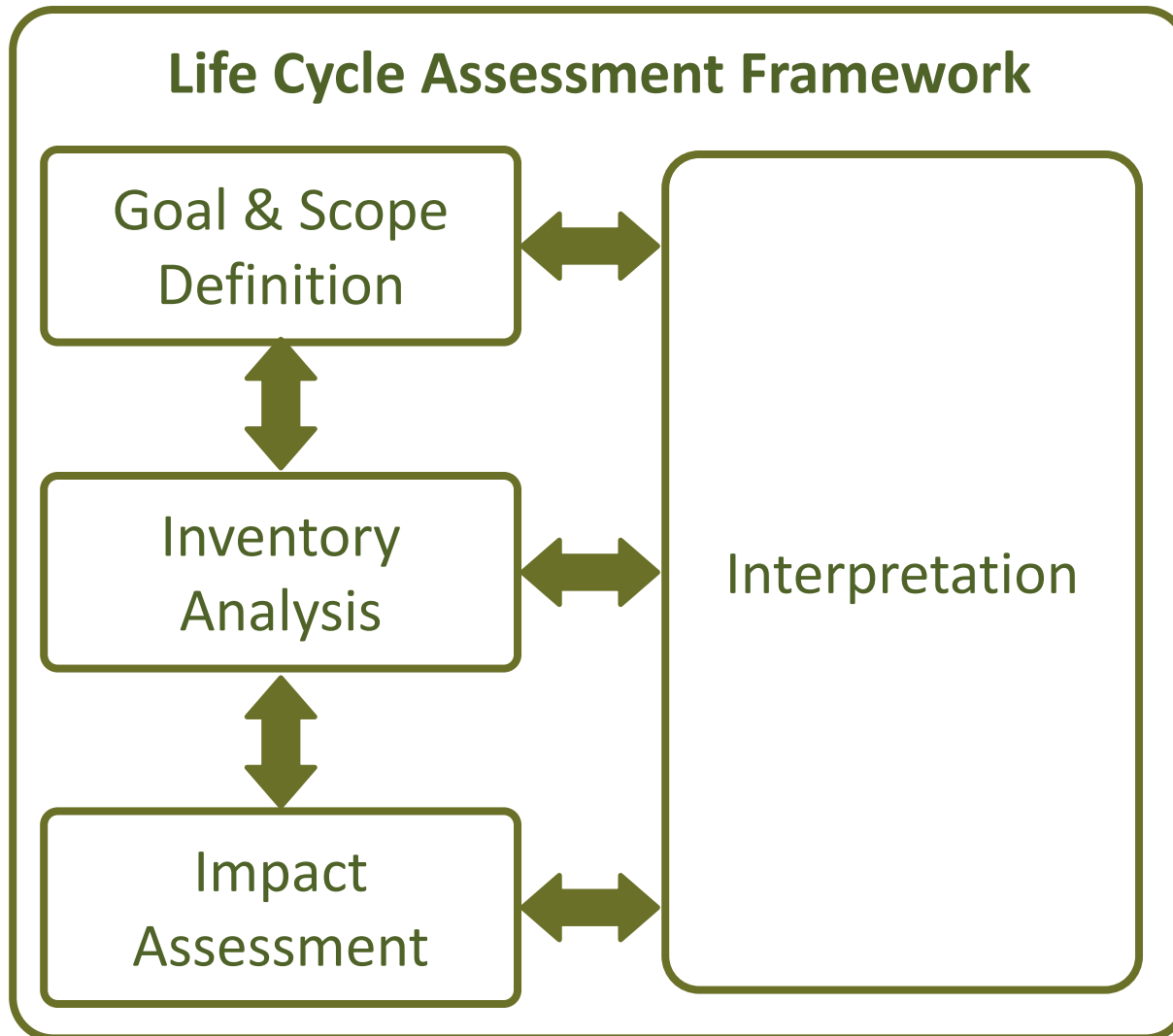
Melissa Hamilton

Melissa@earthshiftsustainability.com

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Shelly@earthshiftsustainability.com

The Steps of an LCA



What is the goal of the study? What does the study entail?

GOAL AND SCOPE

Goal & Scope

- **Intended applications**
 - Cradle-to-grave screening LCA of the Powermax 45 and Powermax 45 XP plasma arc cutting systems.
- **Reasons for carrying out the study**
 - To help drive product innovation, meet customer demands for information and identify where the biggest impacts are occurring throughout the life cycle.
- **Target audience**
 - The initial audience will be internal to Hypertherm: the sustainability team, the light industrial manufacturing and engineering teams, the marketing team, the operations and facilities team.
- **Functional units**
 - Cutting one foot of ½” thick mild steel at a feed rate of 20 inches per minute for the Powermax 45 and 24 inches per minute for the Powermax 45 XP.

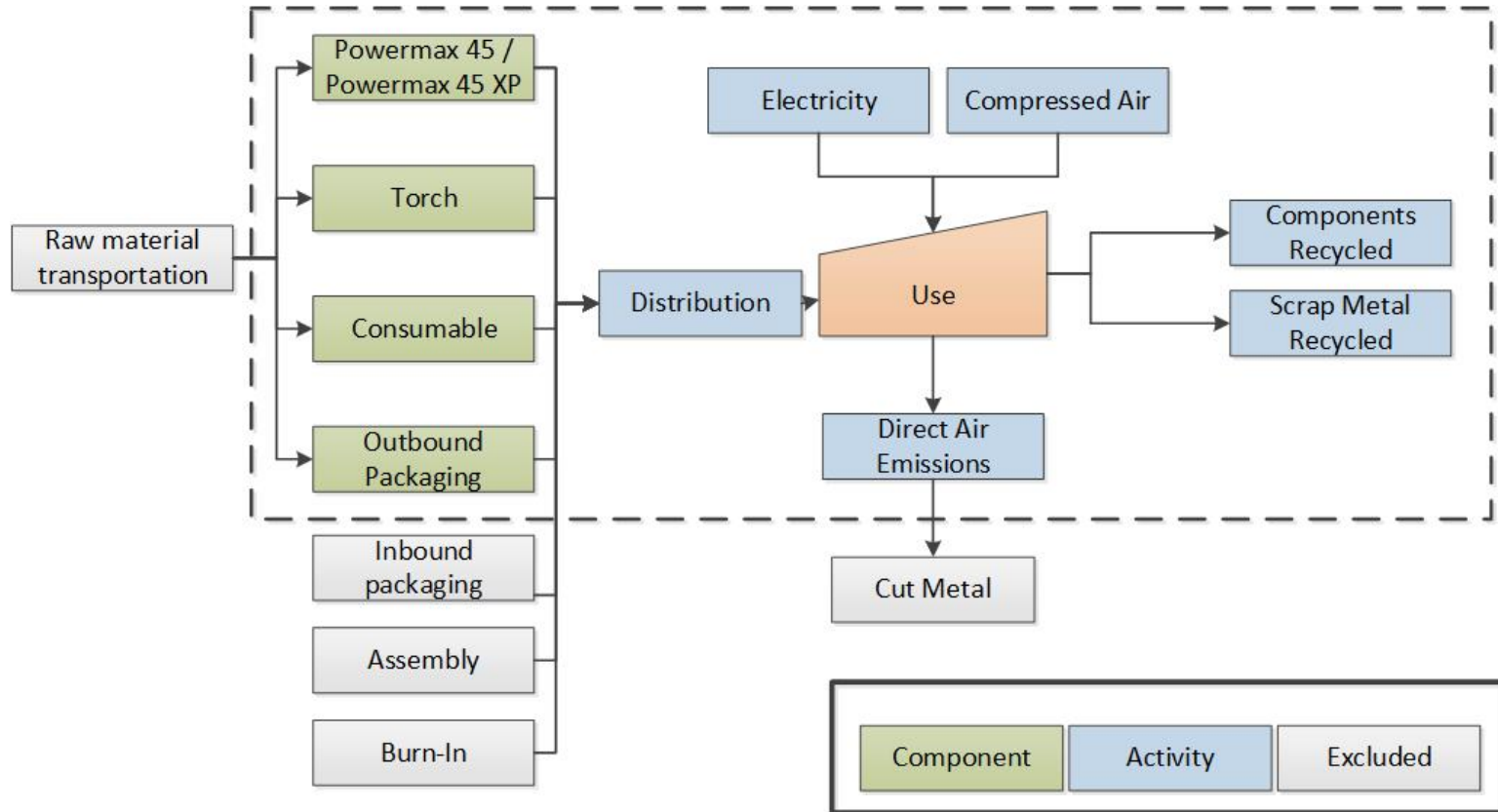
Hypertherm[®]
powermax 45[®]
Plasma arc cutting system



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System Boundaries

Powermax 45 and Powermax 45 XP Systems



Excluded Processes:

- Infrastructure; Human activities; R&D; Services.

What data was used? What assumptions were made?

LIFE CYCLE INVENTORY

Life Cycle Inventory

- **Primary data** (Provided by Hypertherm)
 - Components and materials.
 - Distribution.
 - Packaging.
 - Use phase.
 - Disposal.
- **Secondary data** (Used literature, US-EI¹ and Ecoinvent 2.2²)
 - LCI data for raw materials, machining, energy production, transport and disposal.

¹ See www.earthshiftsustainability.com/services/software/datasmart-life-cycle-inventory for more information about US-EI.

² See www.Ecoinvent.ch for more information about Ecoinvent 2.2.

Assumptions

Raw materials & manufacturing

- Hypertherm supply chain is equivalent to “average” supply chain within our LCI dataset.
- Hypertherm machining is similar to “average” processing of a similar type within our dataset.
- No additional production emissions captured.
- Assuming a 7 year life (Tested with 15 year life).
- Scrap generation is 2.48 lbs/foot of cut, based on HPR260xd study.
- Traditional consumable is used.

Use

- Air emissions from customer sites are similar to emissions from Hypertherm labs.
- Torch lasts 2 years.

Distribution

- China – Represented by 12,500 km to Shanghai by air.
- Europe – Represented by 5,575 km to Netherlands by air.
- North America – Represented by 2,250 km to Kansas by truck.

Disposal

- All components are recycled.

Life Cycle Inventory

Use

- Annual cutting 43.6 hours per year:
 - Handheld cutting 96% (40 feet/year)
 - Mechanized cutting 4% (100 feet/year)

Activity	Powermax 45	Powermax 45 XP
Total weight (Lbs)	32	28
Electricity (kWh/foot)	0.0688	0.0618
Compressed Air (Cu.Ft./foot)	3.20	2.67
Electrode and Nozzle Lifetime in Arc Hours (and Feet)	6.00 hours (600 feet)	4.76 hours (571 feet)

*For full modeling details, including material and processing processes, as well as packaging data, please see *Hypertherm_Powermax 45 Comparison_Data Collection Workbook.xlsx*

Life Cycle Inventory

Traditional Consumable Components	Powermax 45 Consumable Weights (Lbs)	Powermax 45 XP Consumable Weights (Lbs)	Usage Ratio for Both (X to Electrode)
Cap 1	0.0163	0.025	15
Cap 2	0.0763	0.058	15
Cap 3	0.0028	0.009	15
Electrode body	0.0240	0.038	1
Hafnium insert	0.0001	0.0001	1
Nozzle	0.0120	0.032	1
Plunger	N/A	0.004	1
Hand Shield	0.0361	0.042	7
Mechanized Shield	0.0469	0.058	
Weighted Shield Weight*	0.0366	0.043	
Spring	N/A	0.001	1
Swirl ring	0.0034	0.006	15
TOTAL WEIGHT	0.1715	0.216	
*Handheld cutting 96%, Mechanized cutting 4%			

*For full modeling details, including material and processing processes, as well as packaging data, please see *Hypertherm_Powermax 45 Comparison_Data Collection Workbook.xlsx*

Impact Assessment Method

Damage Category	Units	From	Comments
Human health	DALYs	ReCiPe Endpoint (H)	Accounts for years lived disabled as well as life cut short
Climate change	kg CO ₂ -eq.	IPCC 100a	Same method used by most GHG accounting programs
Ecosystems	Species.Yr	ReCiPe Endpoint (H)	Assessed in units of species * yr, or the number of species that may disappear due to the impact times the area over which they are affected times the duration that the species are affected
Resources	\$	ReCiPe Endpoint (H)	Puts a future value on resources which will be unavailable since we are using them today
Water	m ³	ReCiPe Midpoint (H)	Counts the amount of water consumed. Does not show impact. Used for benchmarking only.
CED	MJ eq.	Cumulative Energy Demand	Adds up different categories of energy

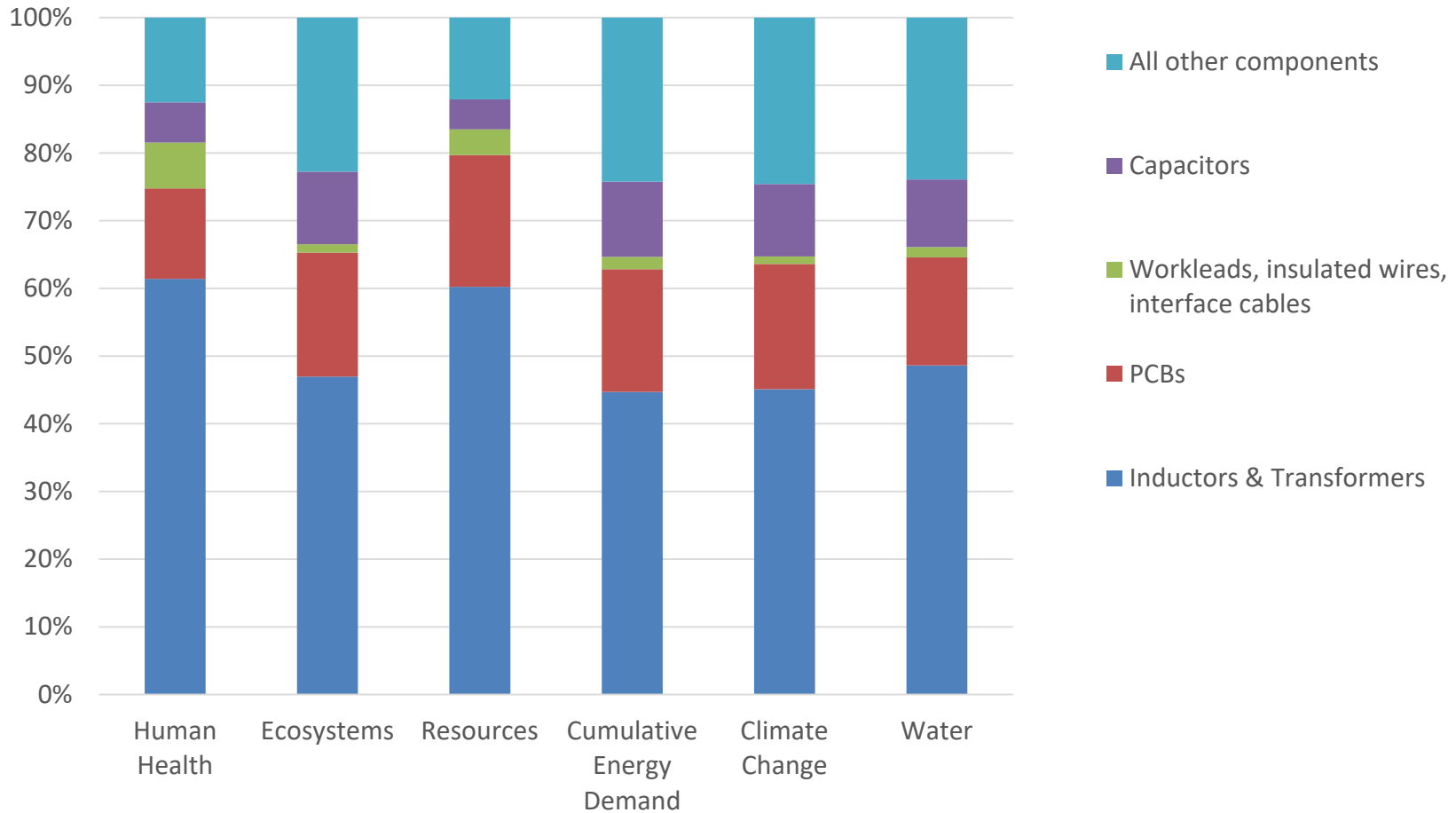
What are the environmental hotspots?

CONTRIBUTION & COMPARATIVE ANALYSIS

POWERMAX 45

Contribution Analysis

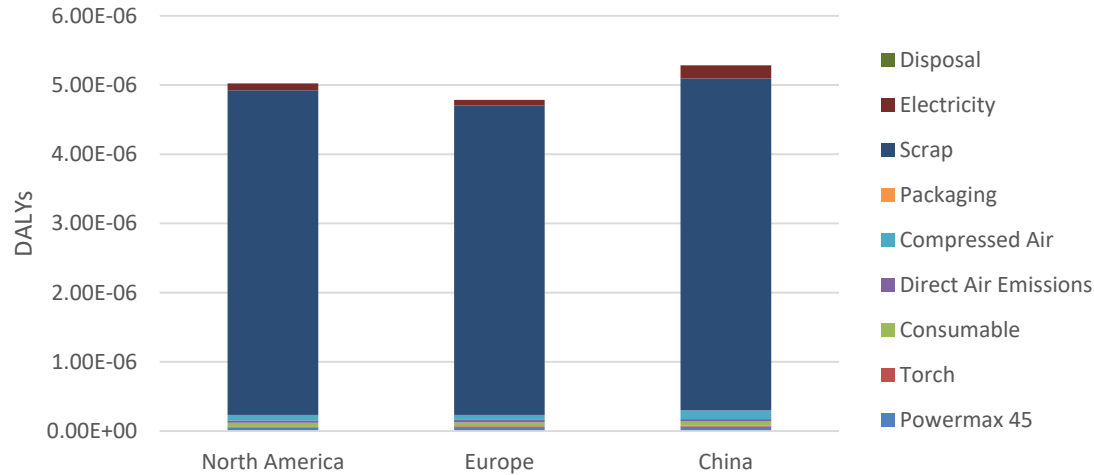
Powermax 45, cradle-to-gate, components only



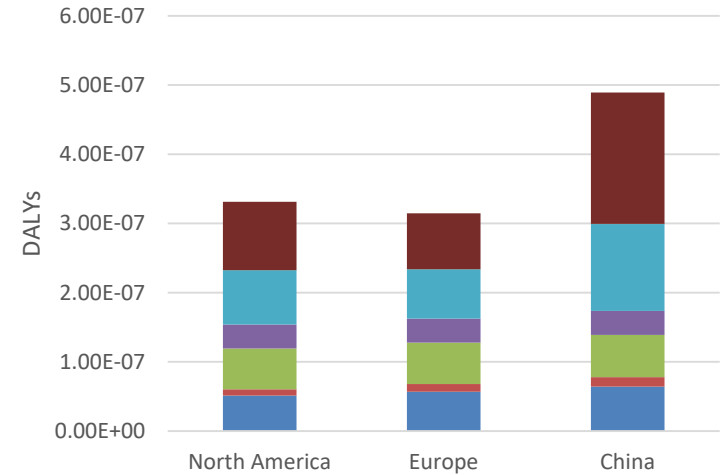
Contribution Analysis

Powermax 45, per foot of cut, cradle-to-grave, with and without scrap

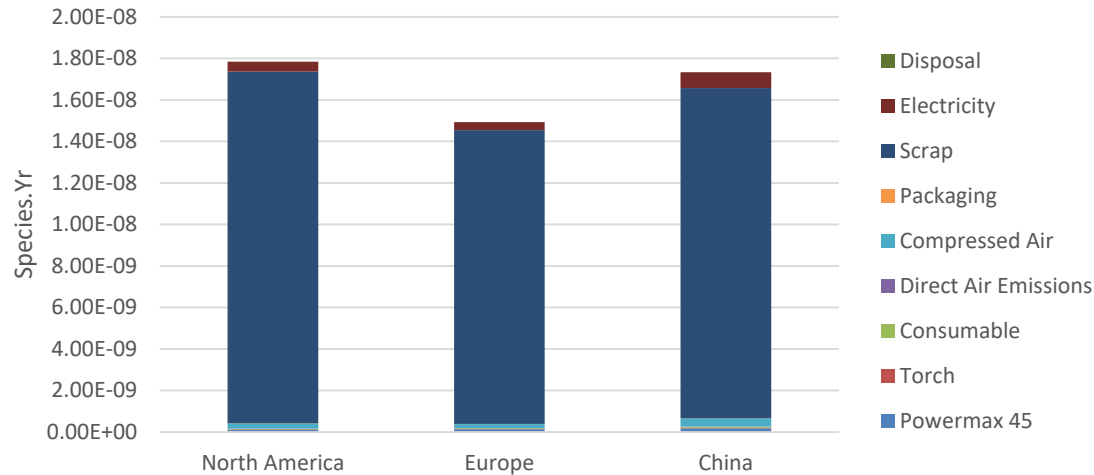
Human Health, with scrap



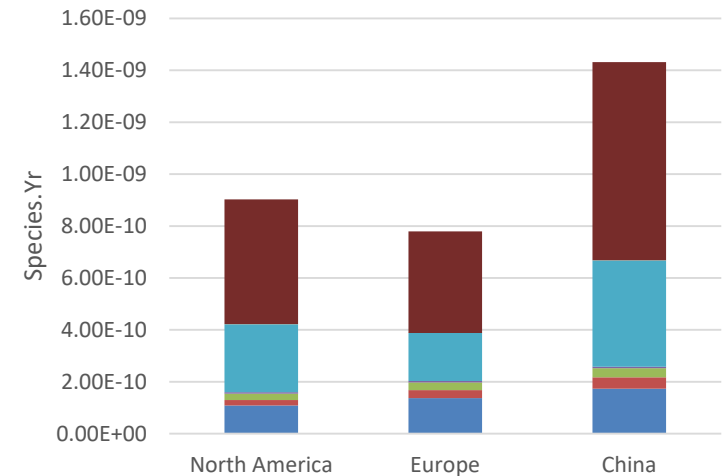
Human Health, without scrap



Ecosystems, with scrap



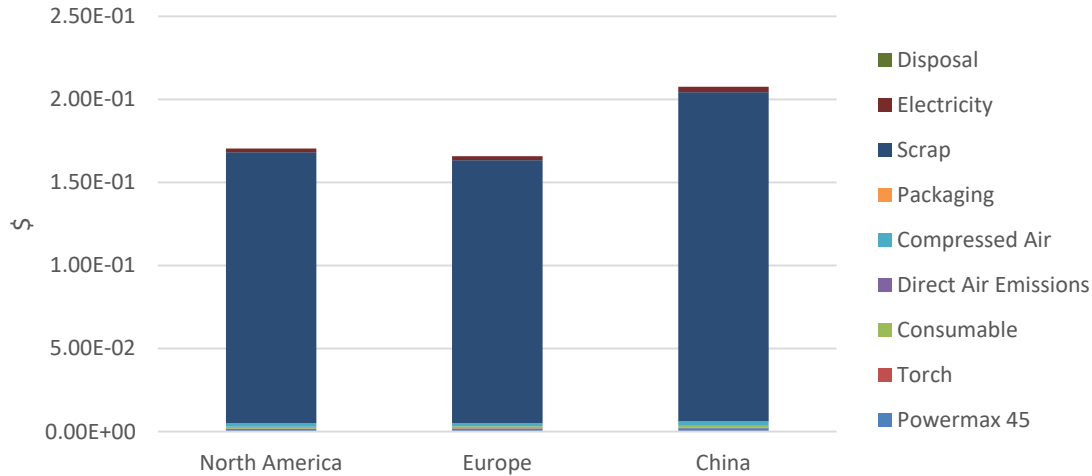
Ecosystems, without scrap



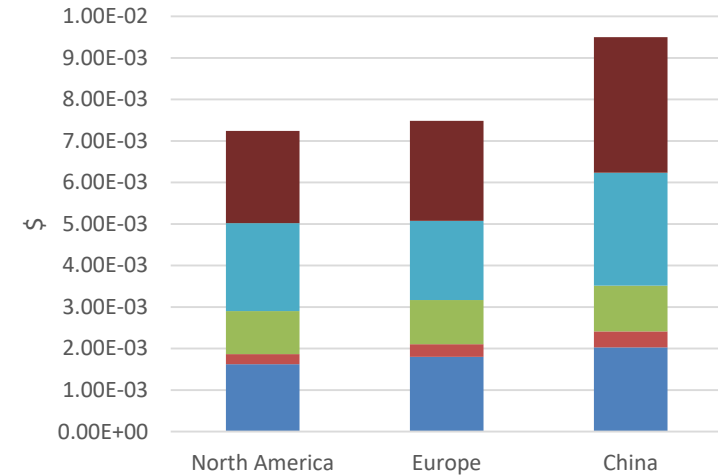
Contribution Analysis

Powermax 45, per foot of cut, cradle-to-grave, with and without scrap

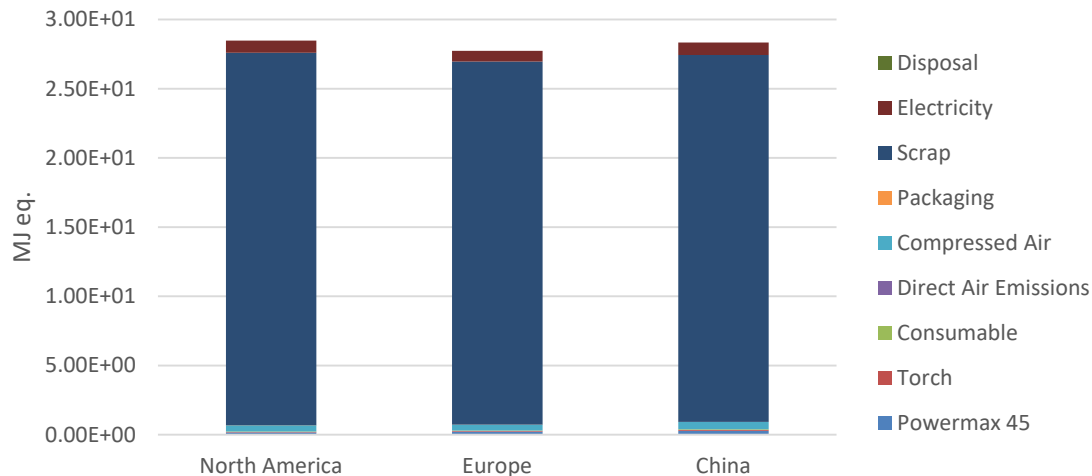
Resources, with scrap



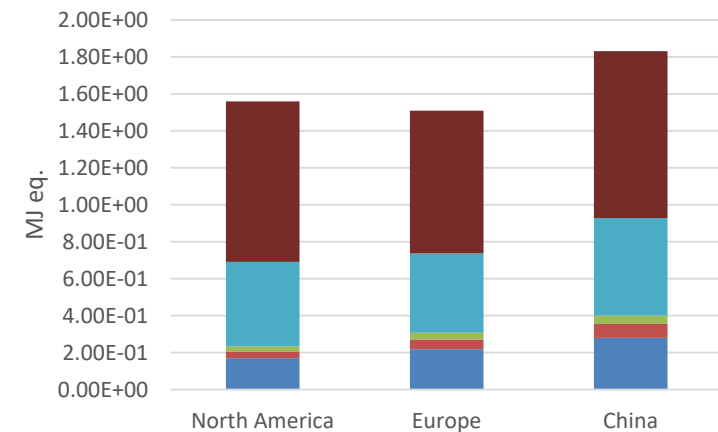
Resources, without scrap



Cumulative Energy Demand, with scrap



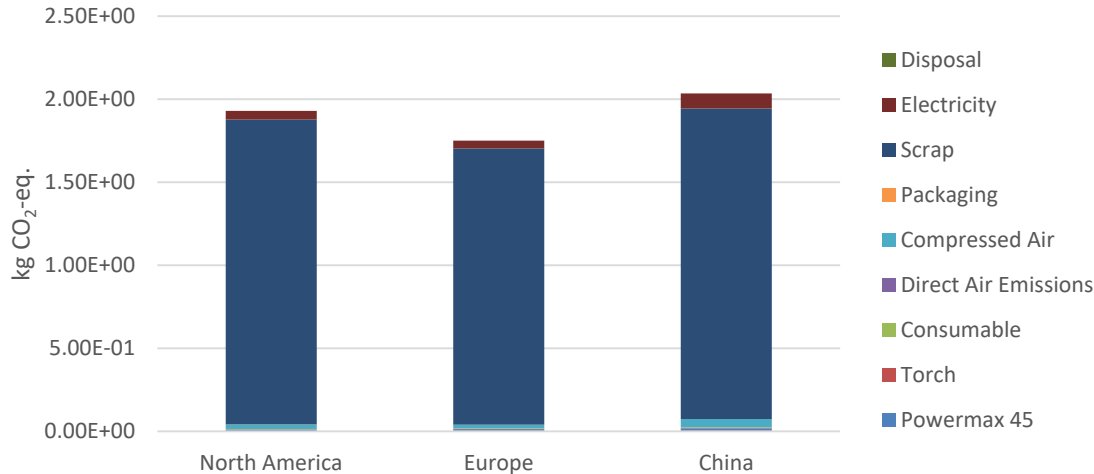
Cumulative Energy Demand, without scrap



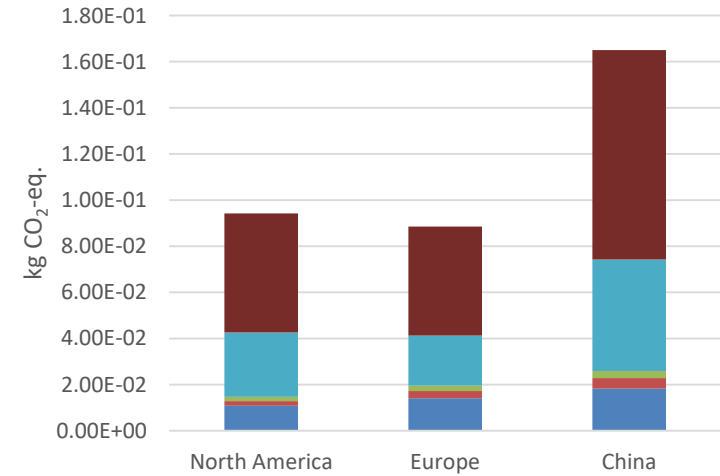
Contribution Analysis

Powermax 45, per foot of cut, cradle-to-grave, with and without scrap

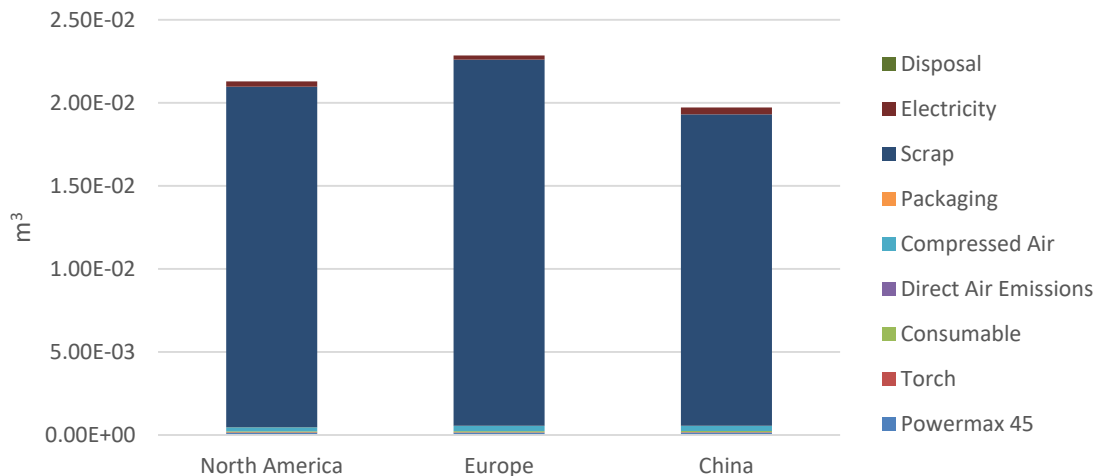
Climate Change, with scrap



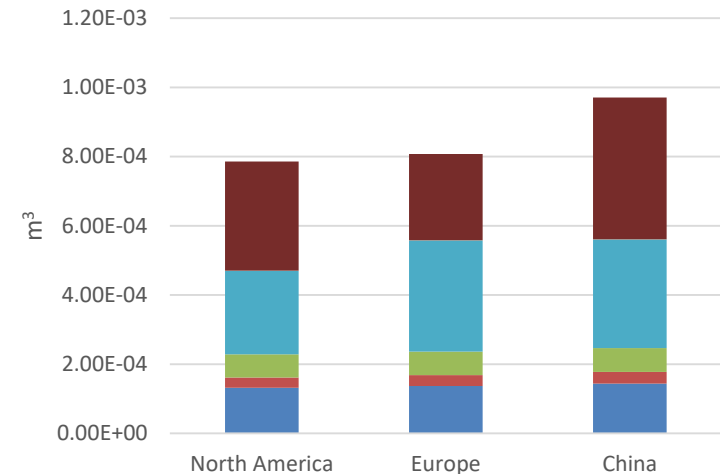
Climate Change, without scrap



Water, with scrap



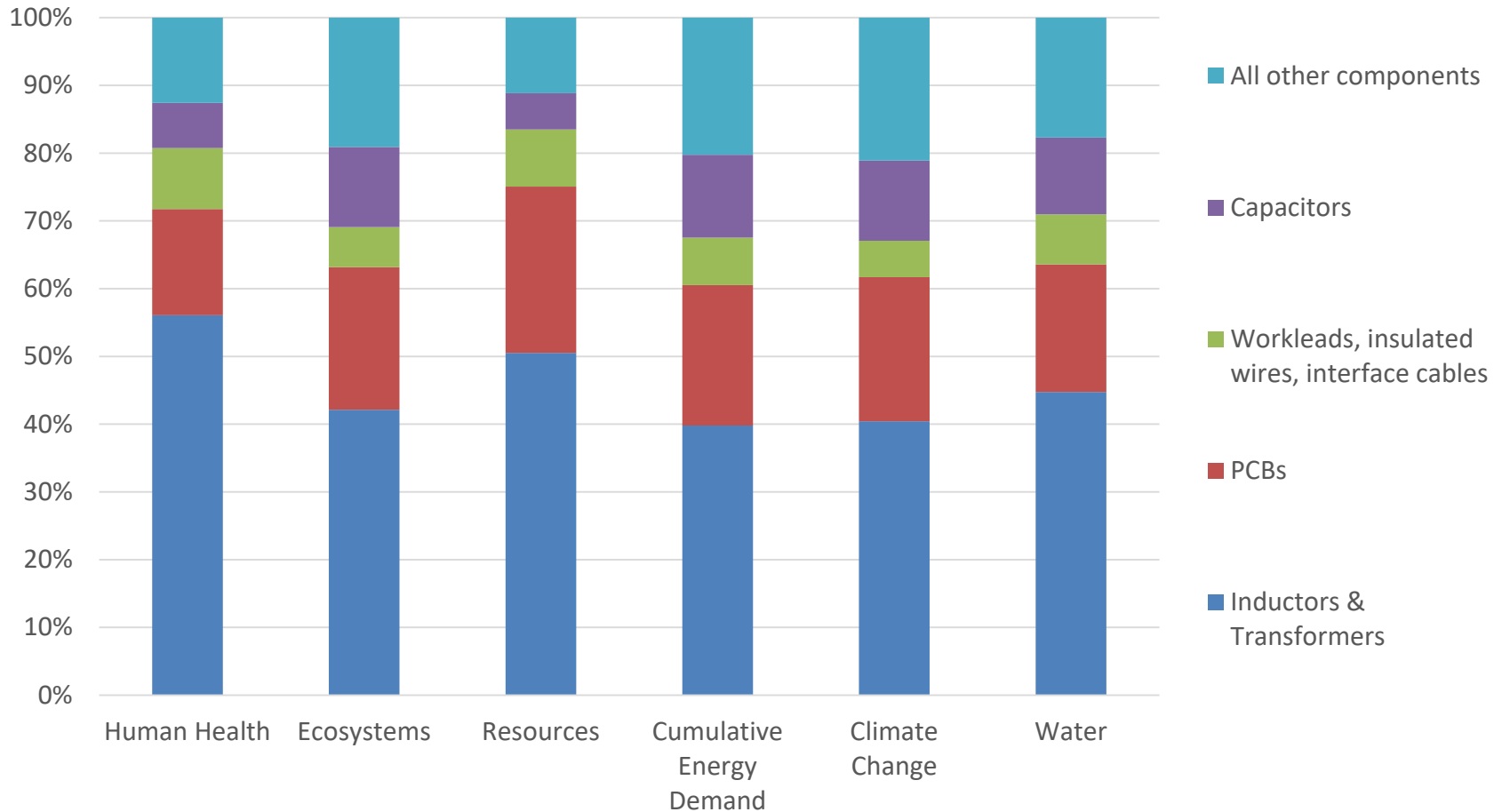
Water, without scrap



POWERMAX 45 XP

Contribution Analysis

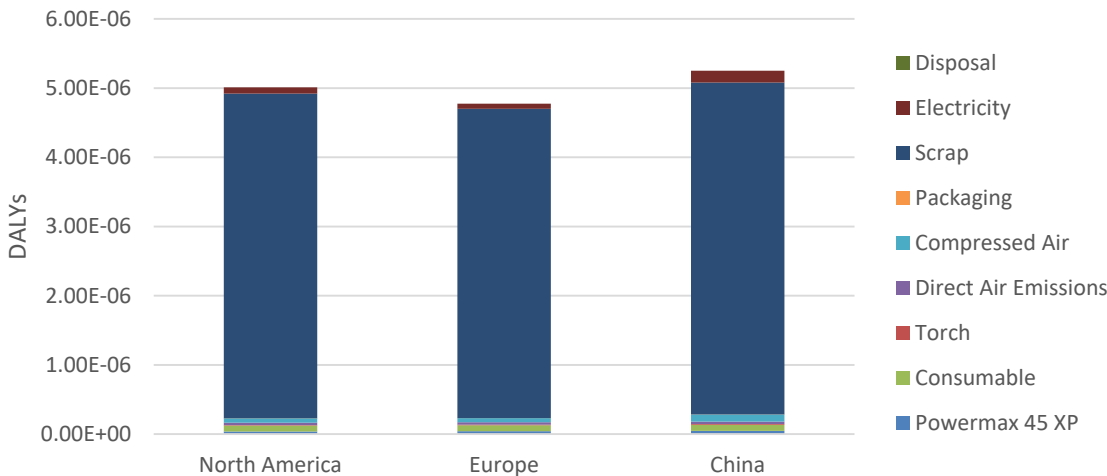
Powermax 45 XP, cradle-to-gate, components only



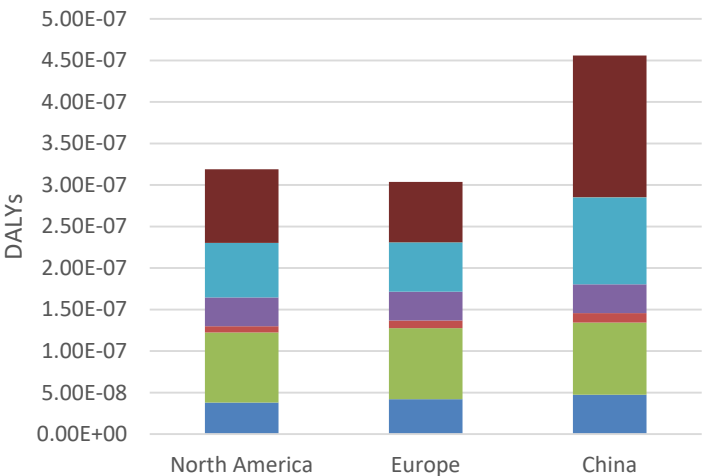
Contribution Analysis

Powermax 45 XP, per foot of cut, cradle-to-grave, with and without scrap

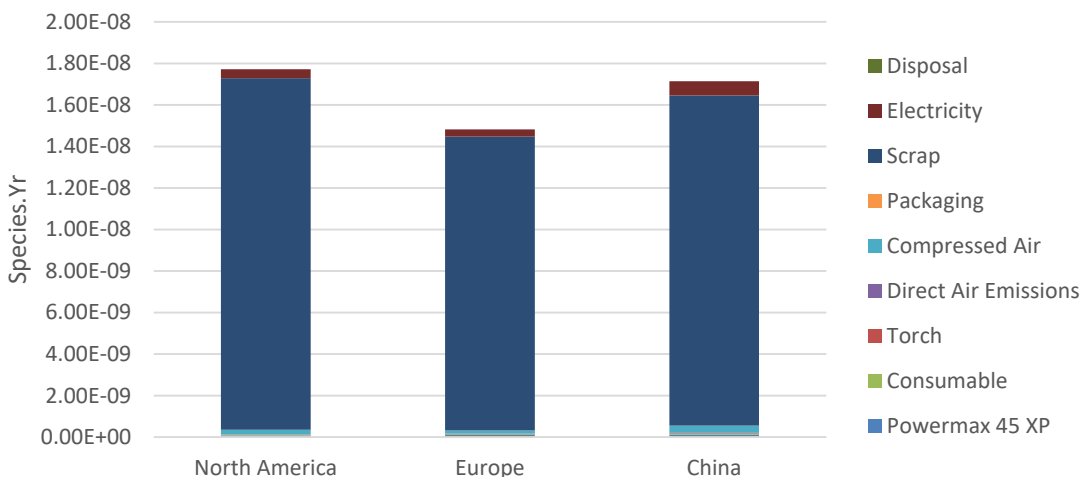
Human Health, with scrap



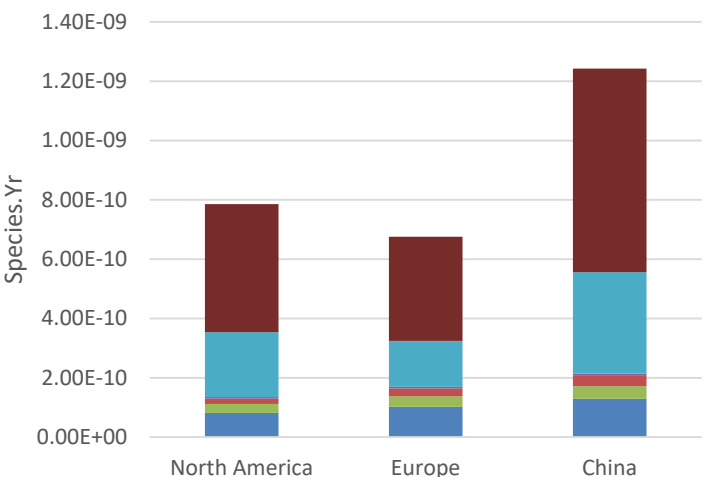
Human Health, without scrap



Ecosystems, with scrap

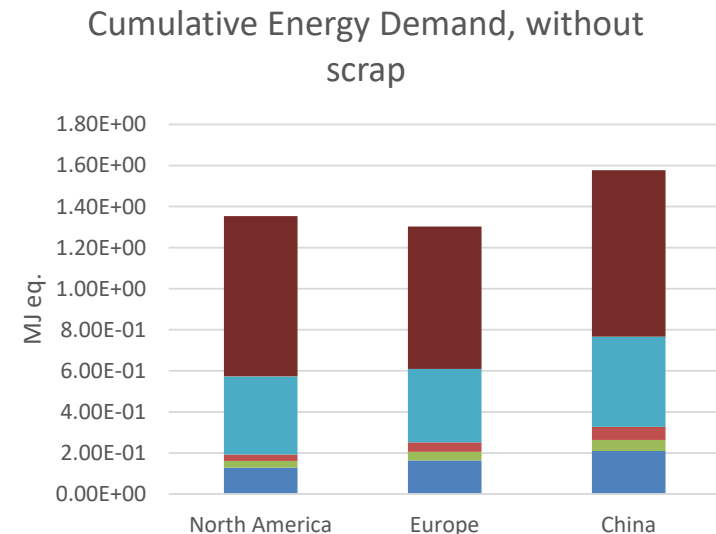
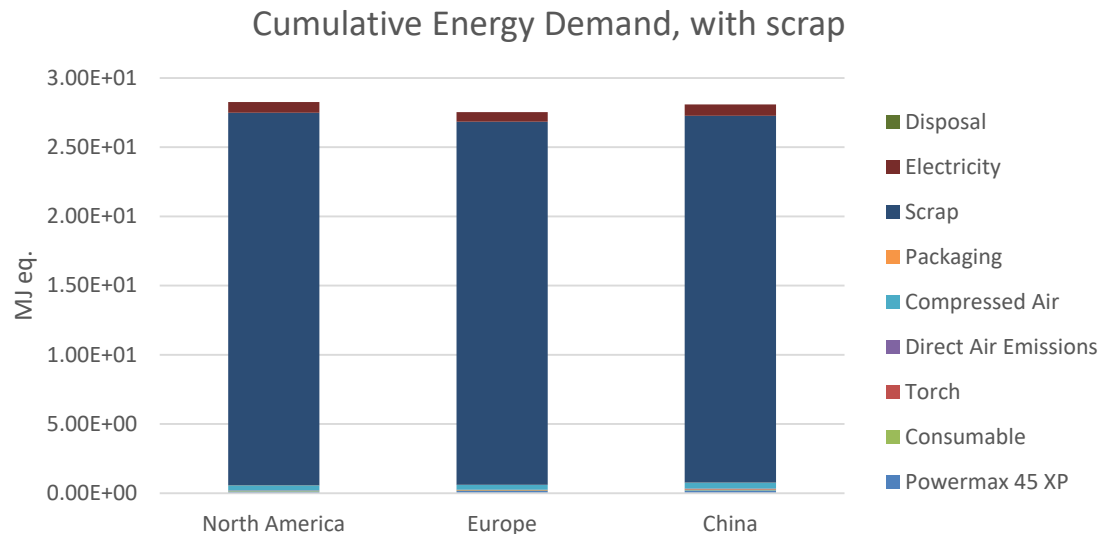
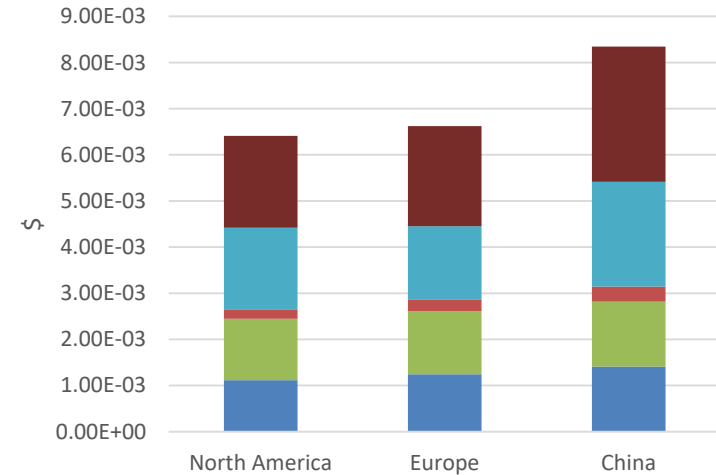
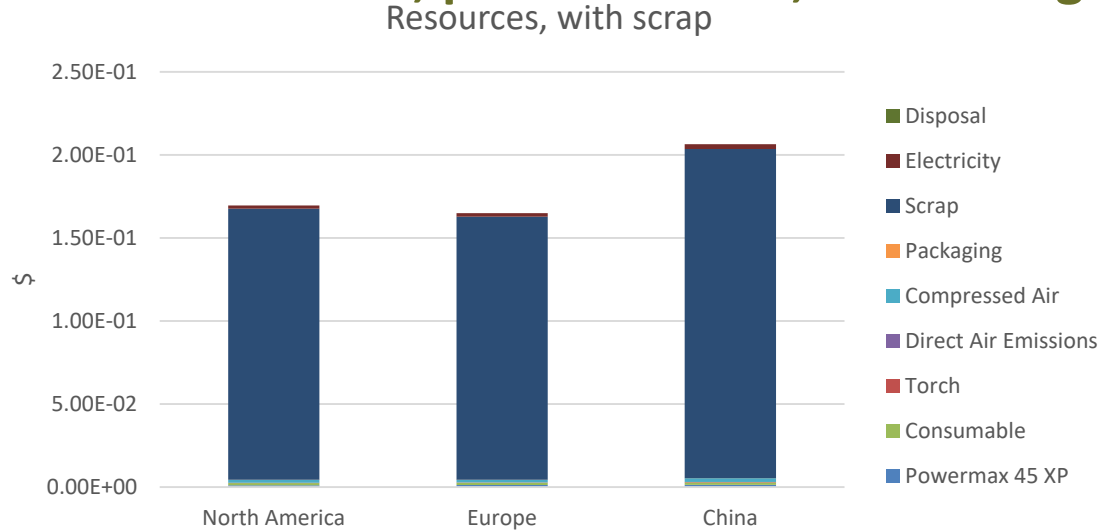


Ecosystems, without scrap



Contribution Analysis

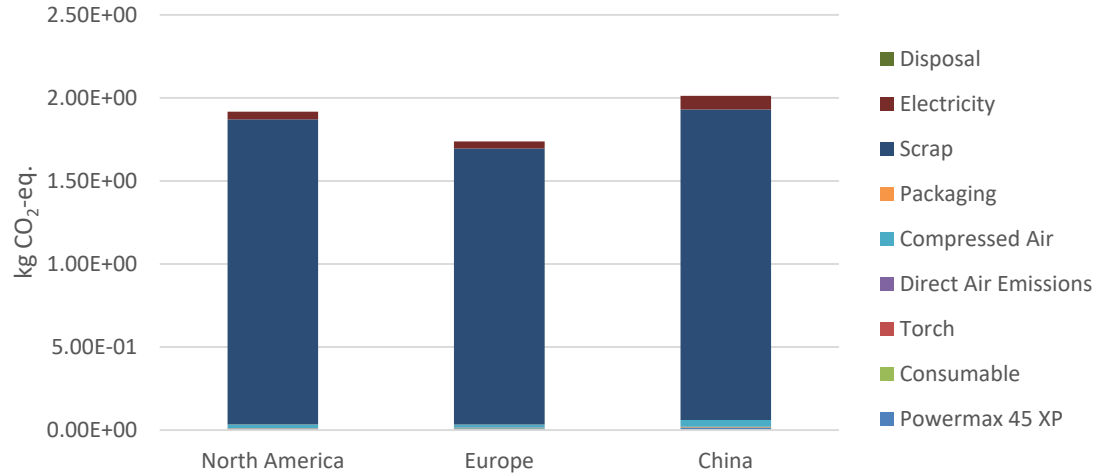
Powermax 45 XP, per foot of cut, cradle-to-grave, with and without scrap



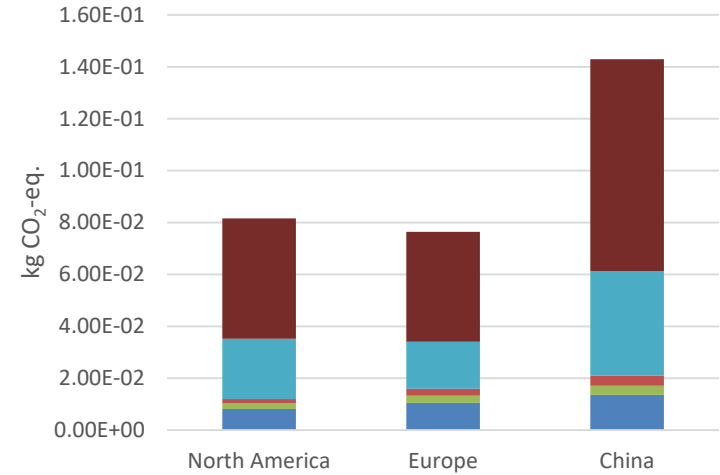
Contribution Analysis

Powermax 45 XP, per foot of cut, cradle-to-grave, with and without scrap

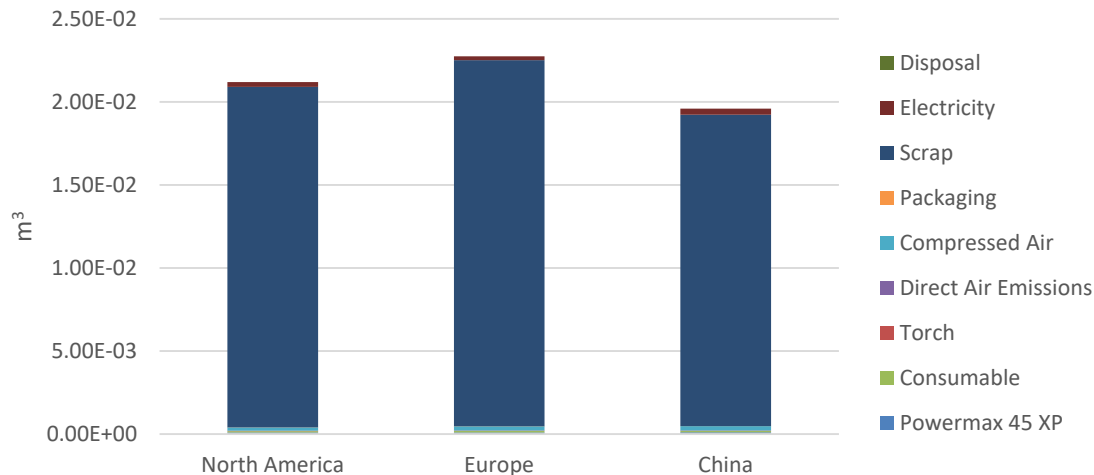
Climate Change, with scrap



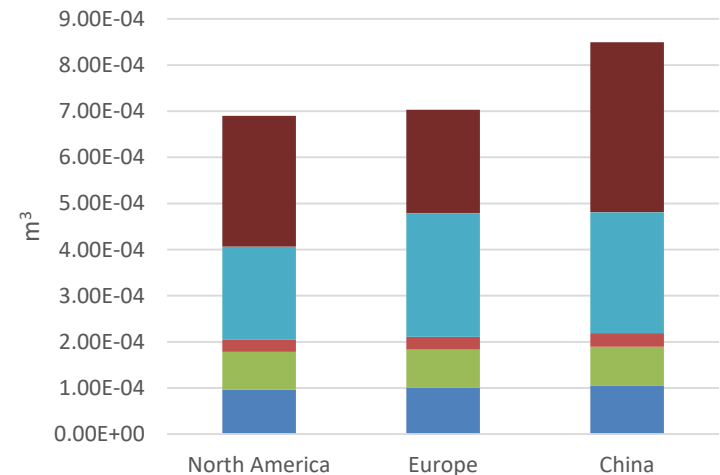
Climate Change, without scrap



Water, with scrap



Water, without scrap

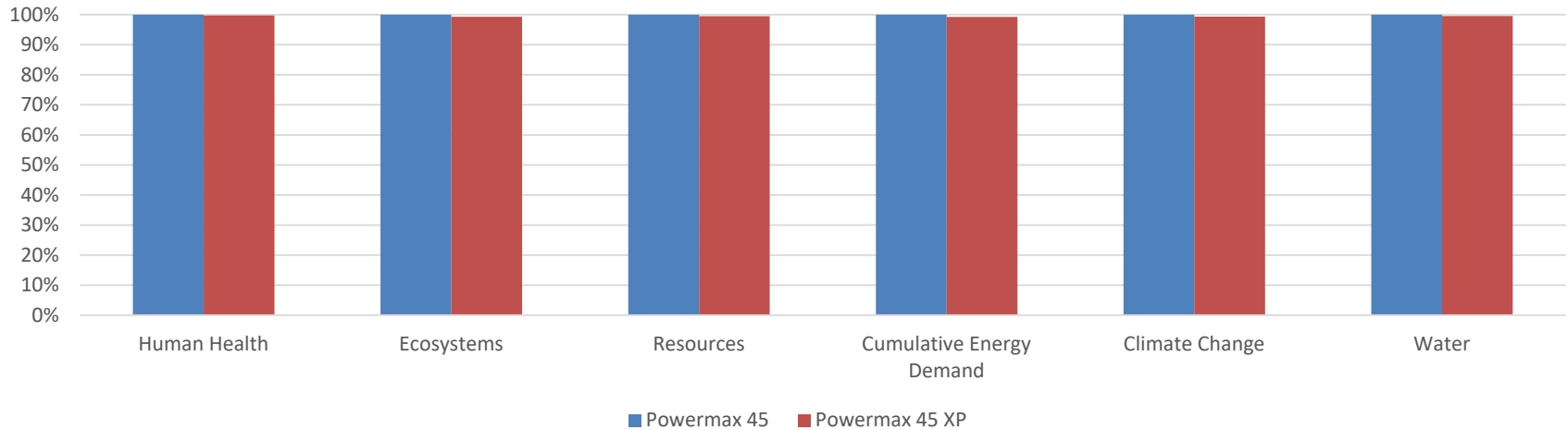


COMPARISON

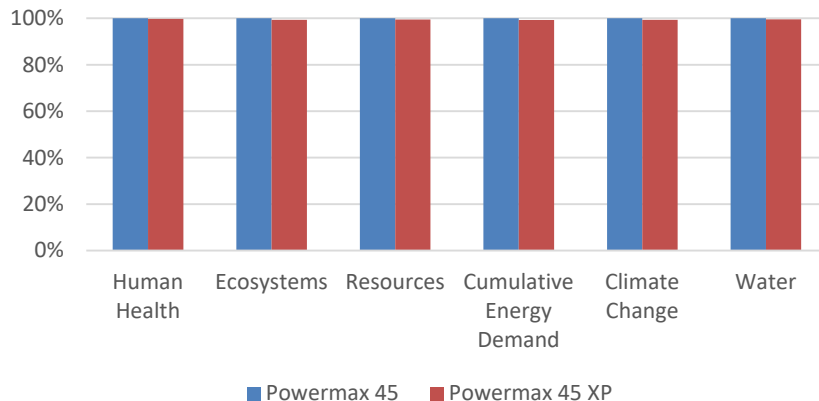
Comparative Analysis

Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, with scrap

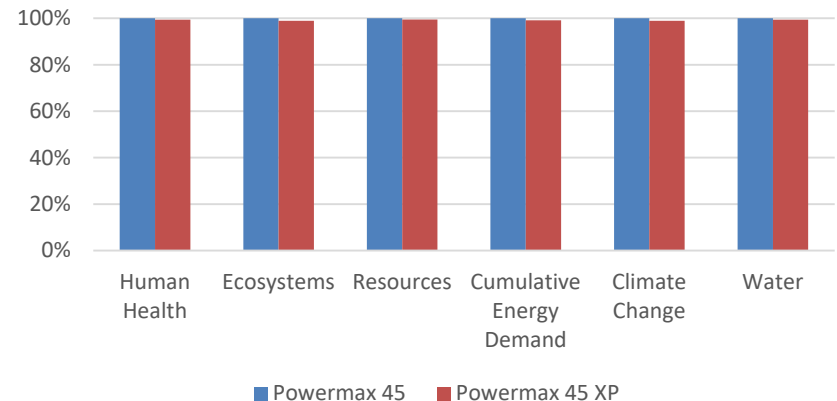
With scrap, in North America



With scrap, in Europe



With scrap, in China



Comparison with other tools

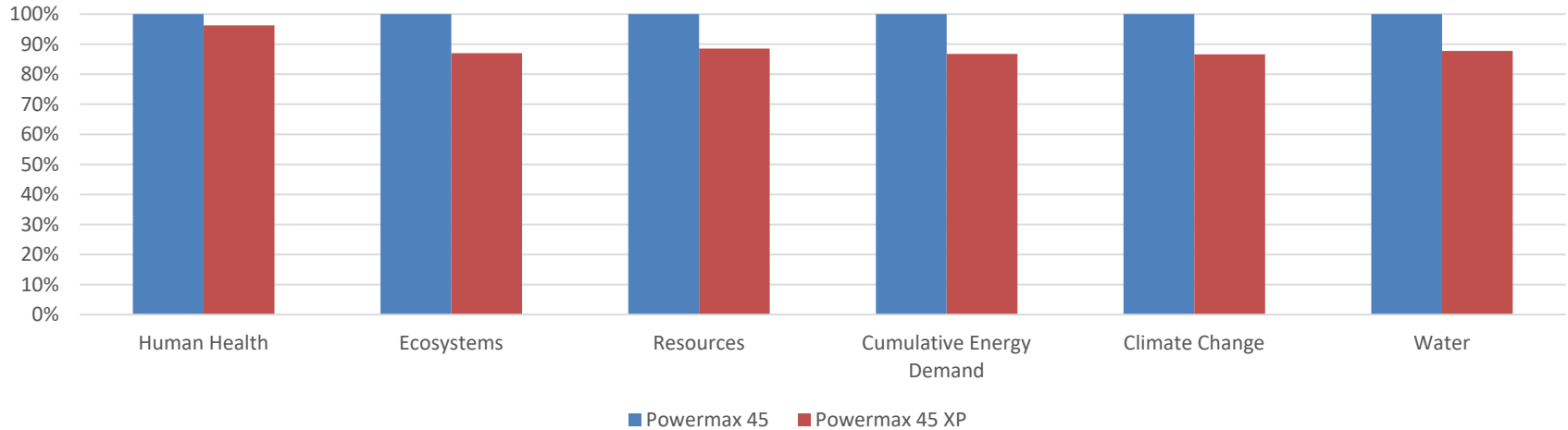
Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, with scrap

Impact Category	North America			Europe			China		
	Powermax 45	Powermax 45 XP	Percent Difference	Powermax 45	Powermax 45 XP	Percent Difference	Powermax 45	Powermax 45 XP	Percent Difference
Human Health (DALY)	5.02E-06	5.01E-06	-0.2%	4.79E-06	4.77E-06	-0.2%	5.28E-06	5.25E-06	-0.6%
Ecosystems (species.yr)	1.78E-08	1.77E-08	-0.7%	1.49E-08	1.48E-08	-0.7%	1.73E-08	1.71E-08	-1.1%
Resources (\$)	1.70E-01	1.70E-01	-0.5%	1.66E-01	1.65E-01	-0.5%	2.08E-01	2.06E-01	-0.6%
Cumulative Energy Demand (MJ)	2.85E+01	2.83E+01	-0.7%	2.77E+01	2.75E+01	-0.7%	2.83E+01	2.81E+01	-0.9%
Climate Change (kg CO2-eq)	1.93E+00	1.92E+00	-0.7%	1.75E+00	1.74E+00	-0.7%	2.03E+00	2.01E+00	-1.1%
Water (m3)	2.13E-02	2.12E-02	-0.5%	2.28E-02	2.27E-02	-0.5%	1.97E-02	1.96E-02	-0.6%

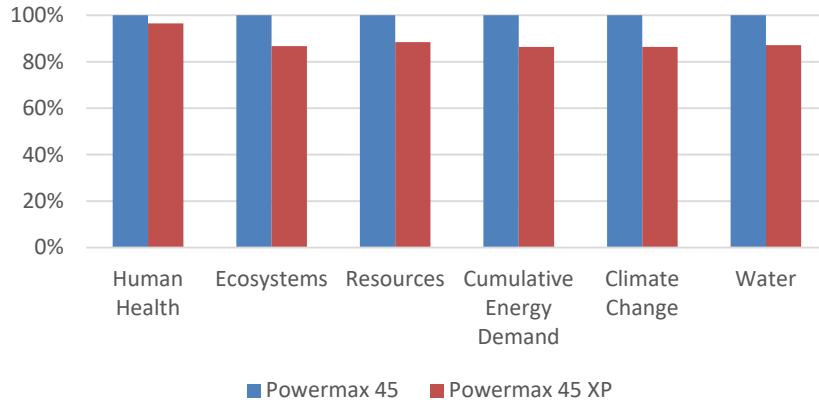
Comparative Analysis

Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, without scrap

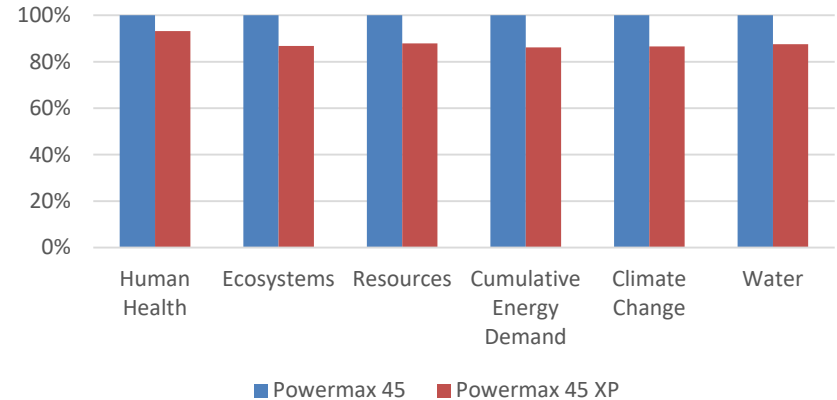
Without Scrap, in North America



Without Scrap, in Europe



Without Scrap, in China



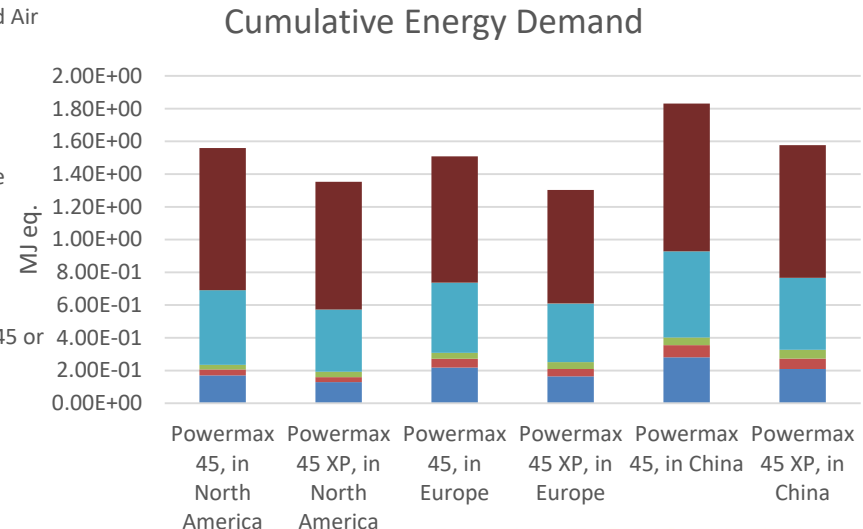
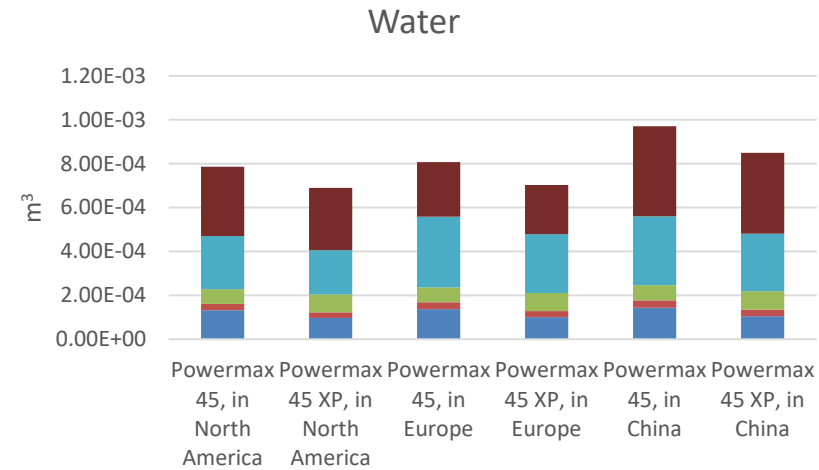
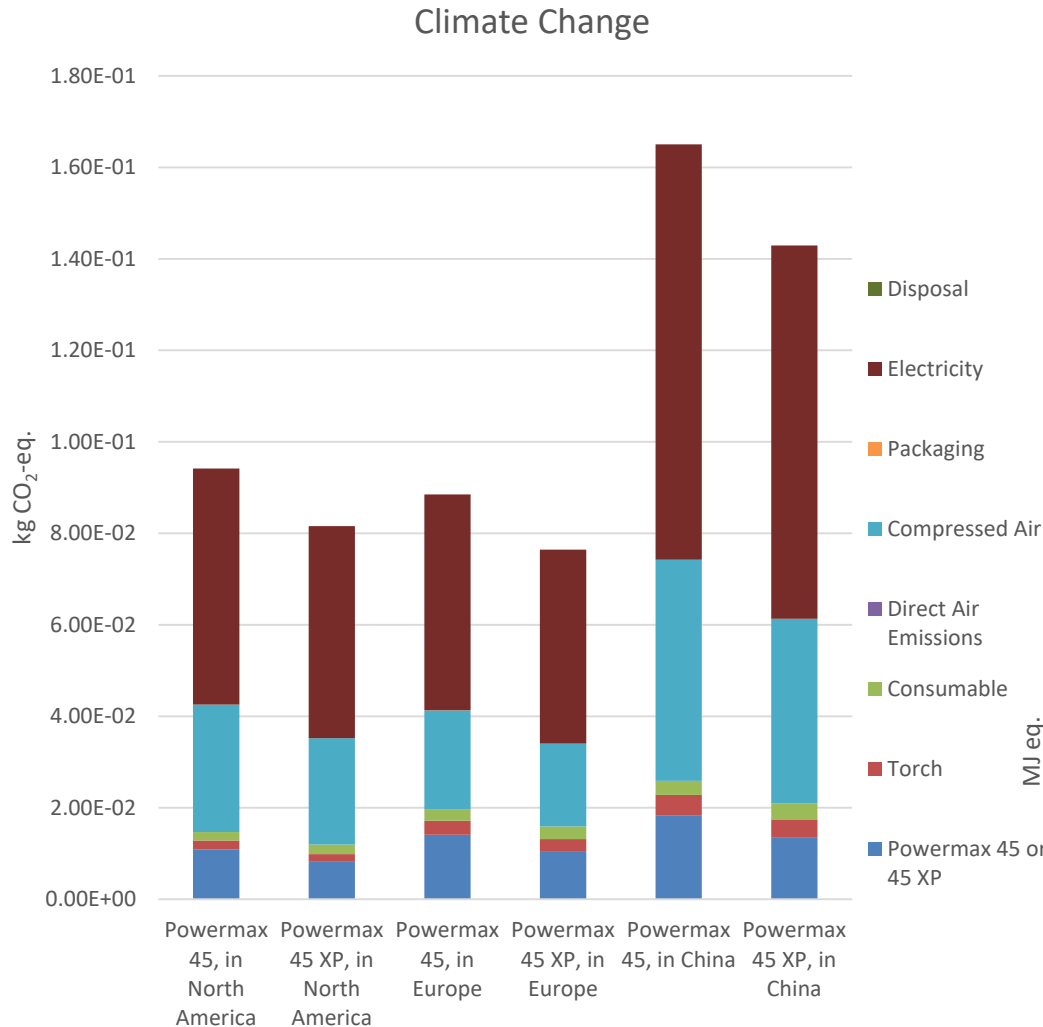
Comparison with other tools

Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, without scrap

Impact Category	North America			Europe			China		
	Powermax 45	Powermax 45 XP	Percent Difference	Powermax 45	Powermax 45 XP	Percent Difference	Powermax 45	Powermax 45 XP	Percent Difference
Human Health (DALY)	3.31E-07	3.19E-07	-4%	3.15E-07	3.04E-07	-3%	4.89E-07	4.56E-07	-7%
Ecosystems (species.yr)	9.03E-10	7.86E-10	-13%	7.79E-10	6.76E-10	-13%	1.43E-09	1.24E-09	-13%
Resources (\$)	7.24E-03	6.41E-03	-11%	7.49E-03	6.62E-03	-12%	9.50E-03	8.35E-03	-12%
Cumulative Energy Demand (MJ)	1.56E+00	1.35E+00	-13%	1.51E+00	1.30E+00	-14%	1.83E+00	1.58E+00	-14%
Climate Change (kg CO2-eq)	9.42E-02	8.16E-02	-13%	8.85E-02	7.64E-02	-14%	1.65E-01	1.43E-01	-13%
Water (m3)	7.86E-04	6.90E-04	-12%	8.07E-04	7.03E-04	-13%	9.71E-04	8.49E-04	-12%

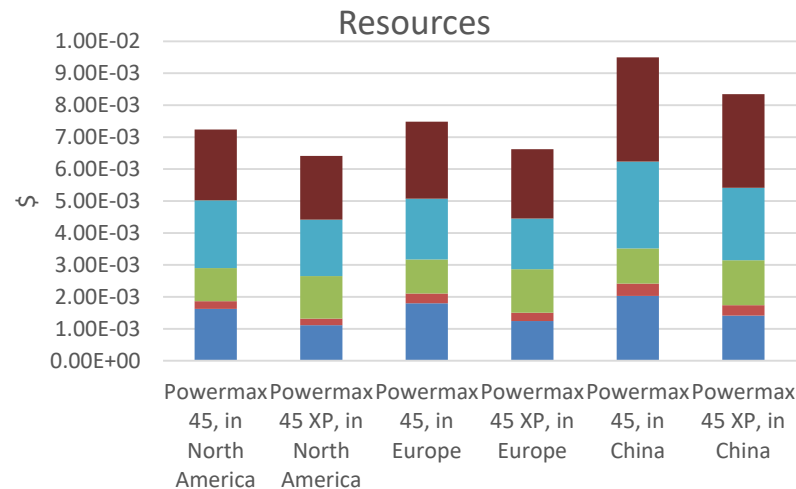
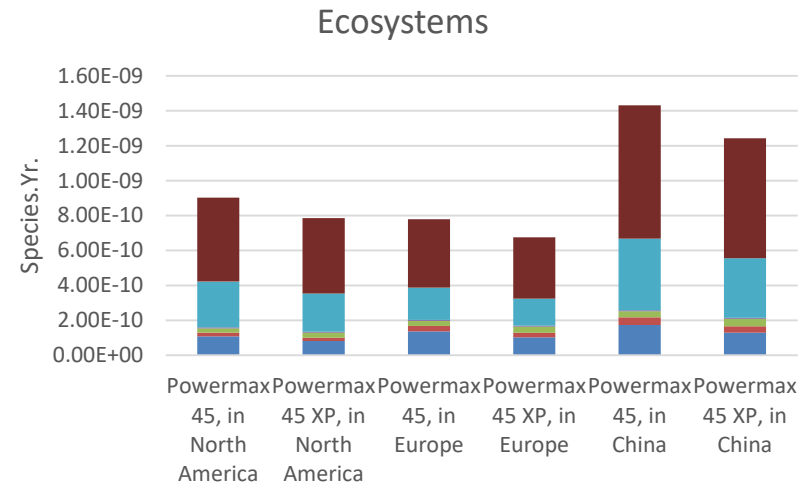
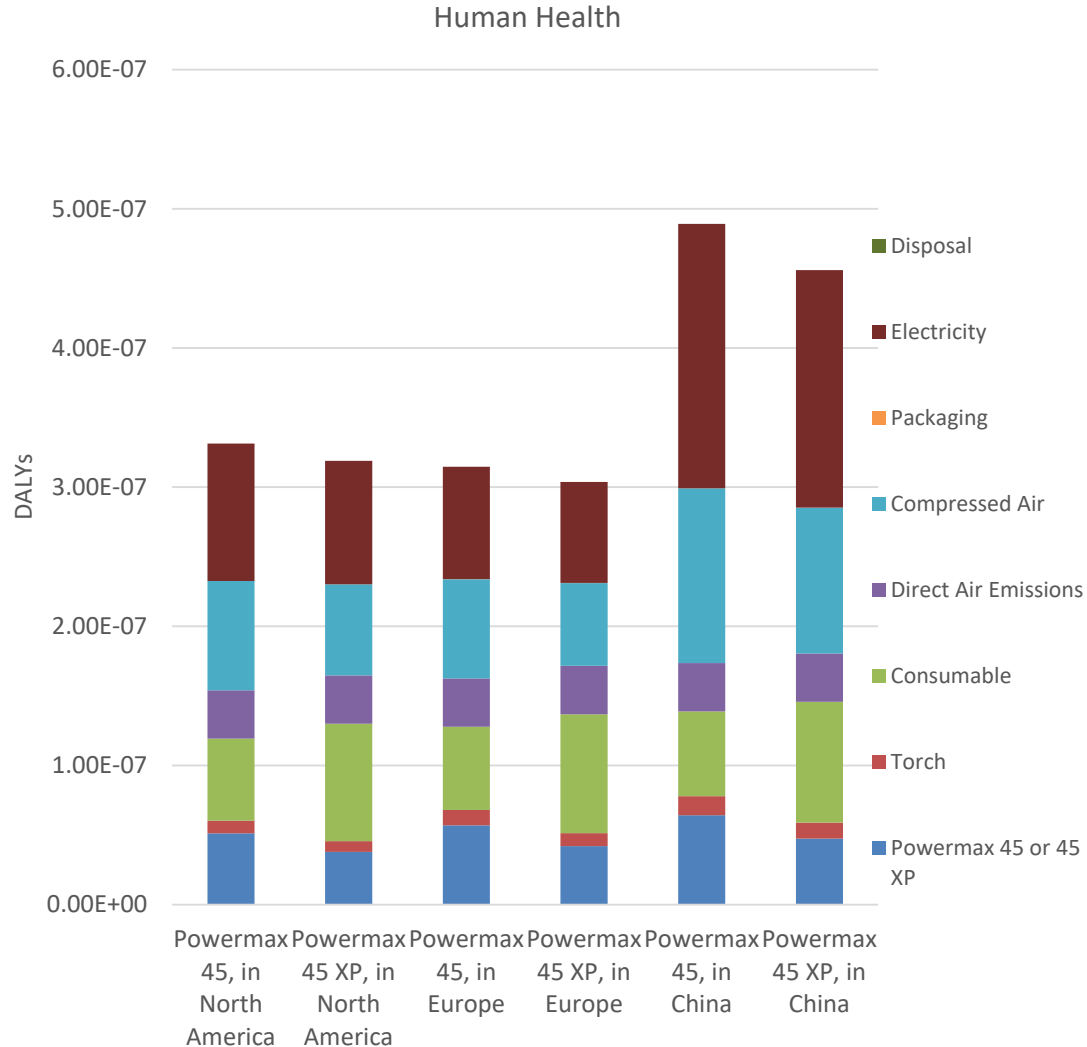
Comparative Analysis

Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, without scrap



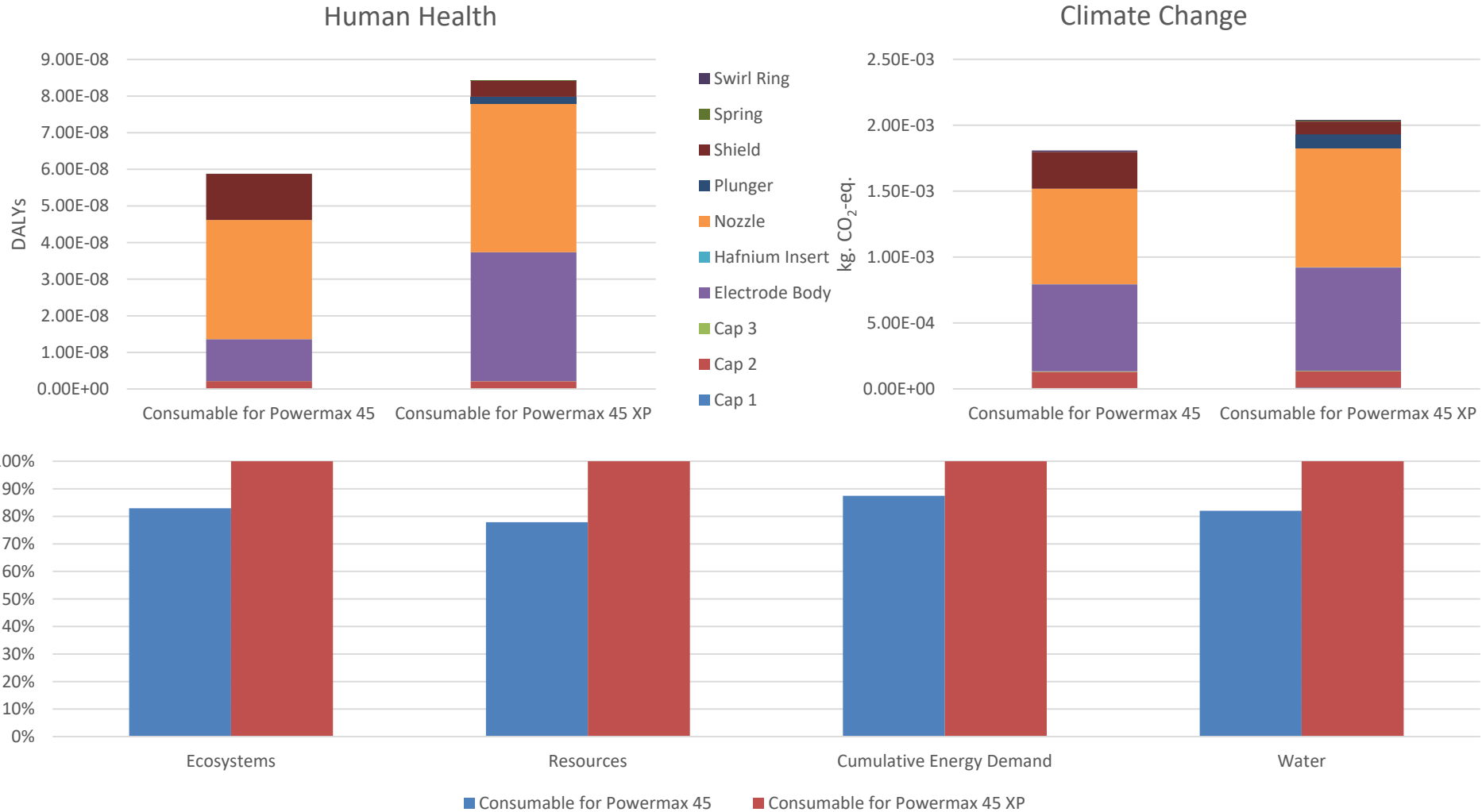
Comparative Analysis

Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, without scrap



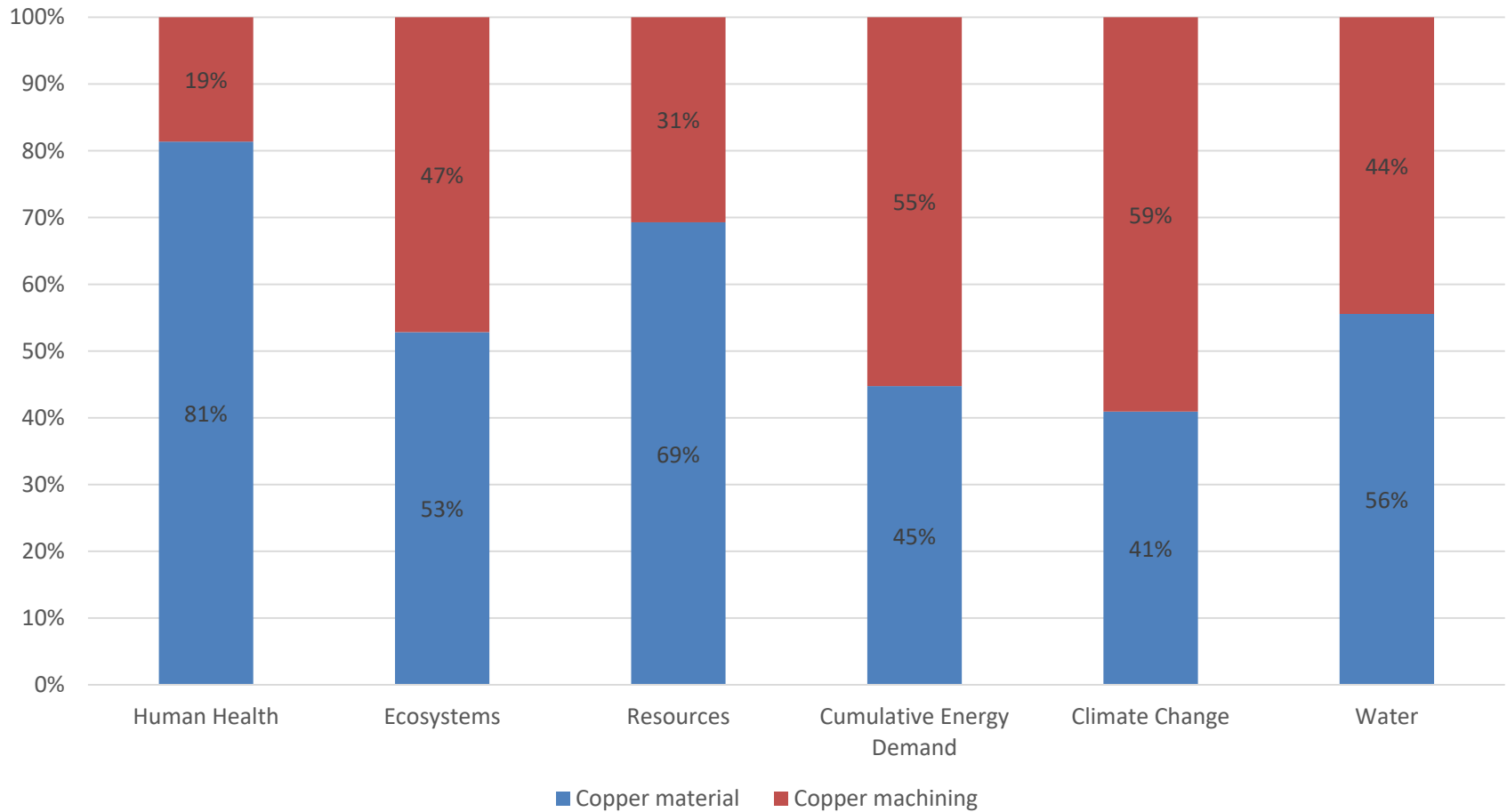
Comparative Analysis

Consumable Powermax 45 vs. 45 XP, per foot of cut, cradle-to-grave, in North America



Contribution Analysis

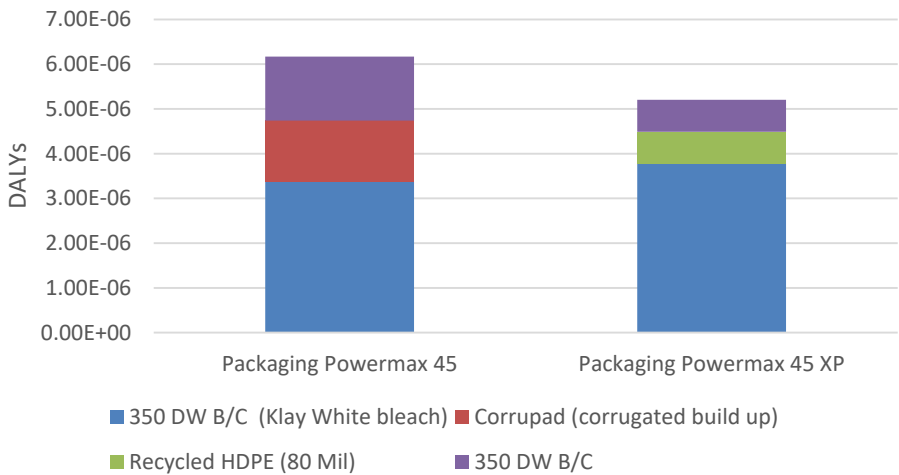
1 lb of copper, cradle-to-gate, (used in nozzle and electrode body, among other components)



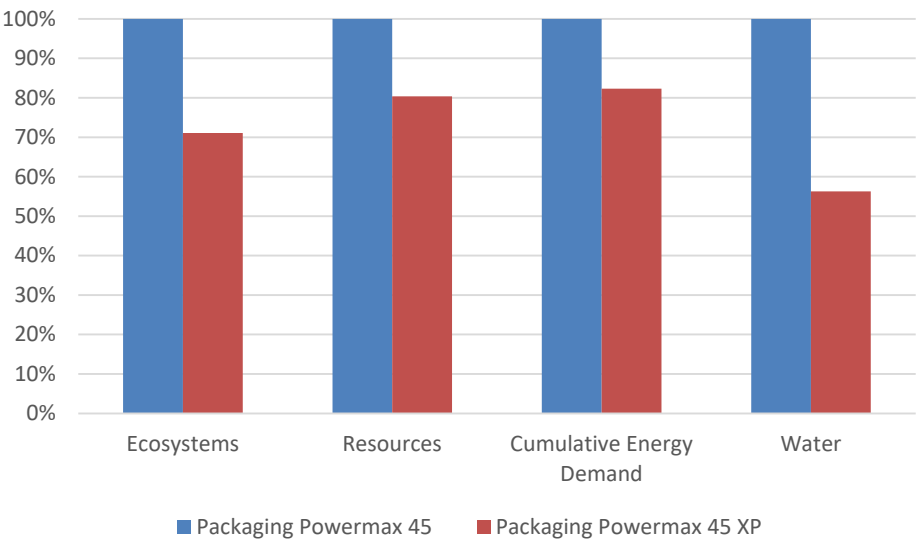
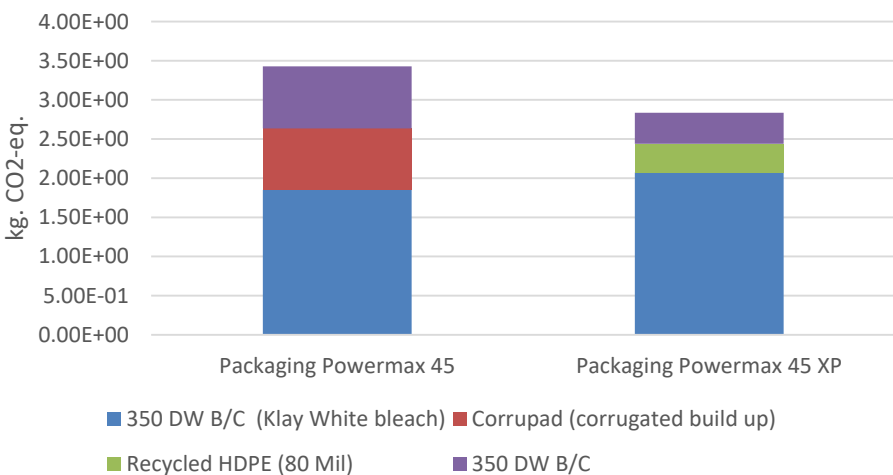
Comparative Analysis

Packaging, cradle-to-grave, in North America

Human Health



Climate Change



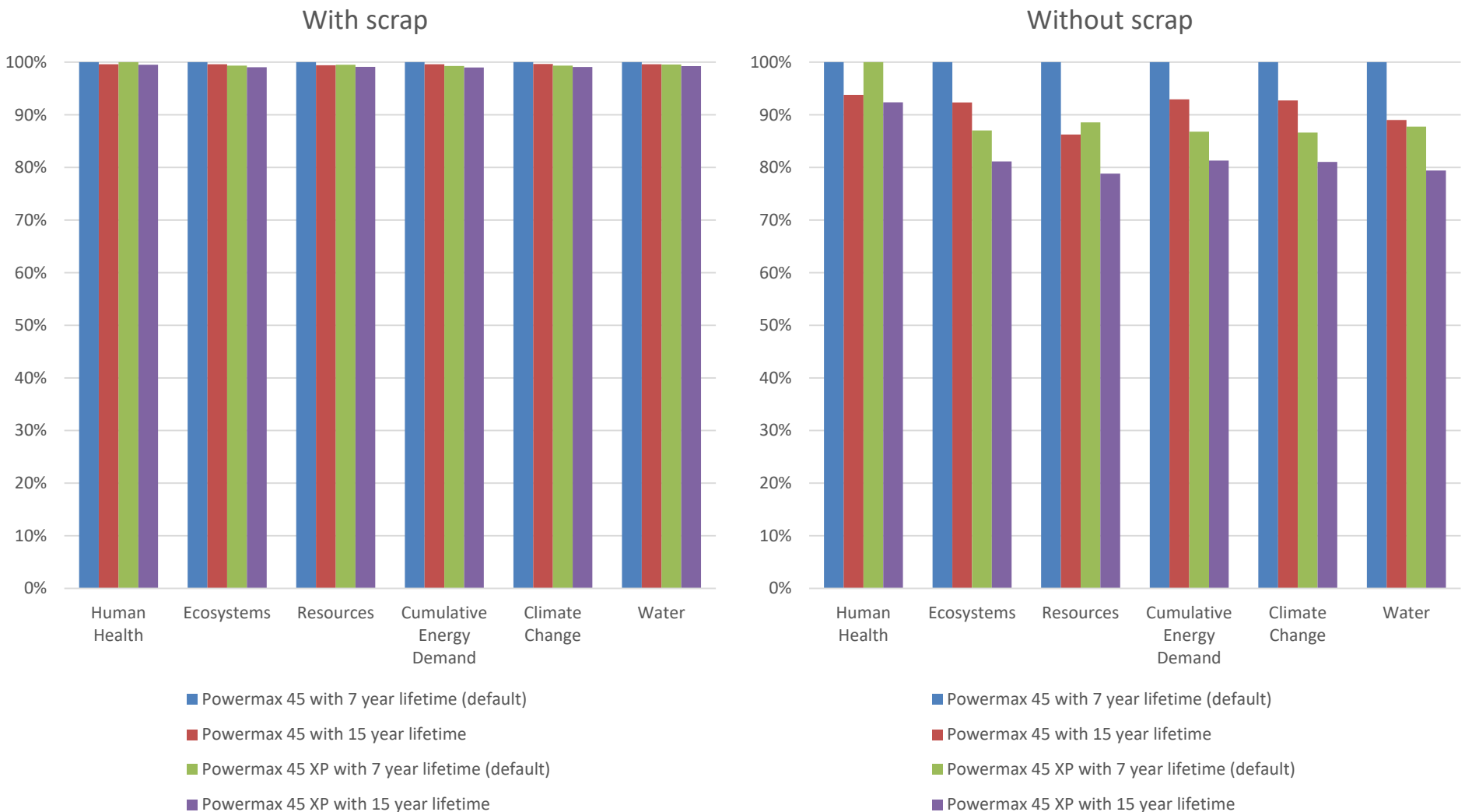
Material	Powermax 45	Powermax 45 XP
350 DW B/C (Klay White bleach) (Lbs)	2.9	3.25
Corrupad (corrugated build up) (Lbs)	1.5	N/A
Recycled HDPE (80 Mil) (Lbs)	N/A	1.15
350 DW B/C (Lbs)	1.5	0.75
TOTAL WEIGHT (Lbs)	5.9	5.15

How sensitive are the results?

SENSITIVITY ANALYSES

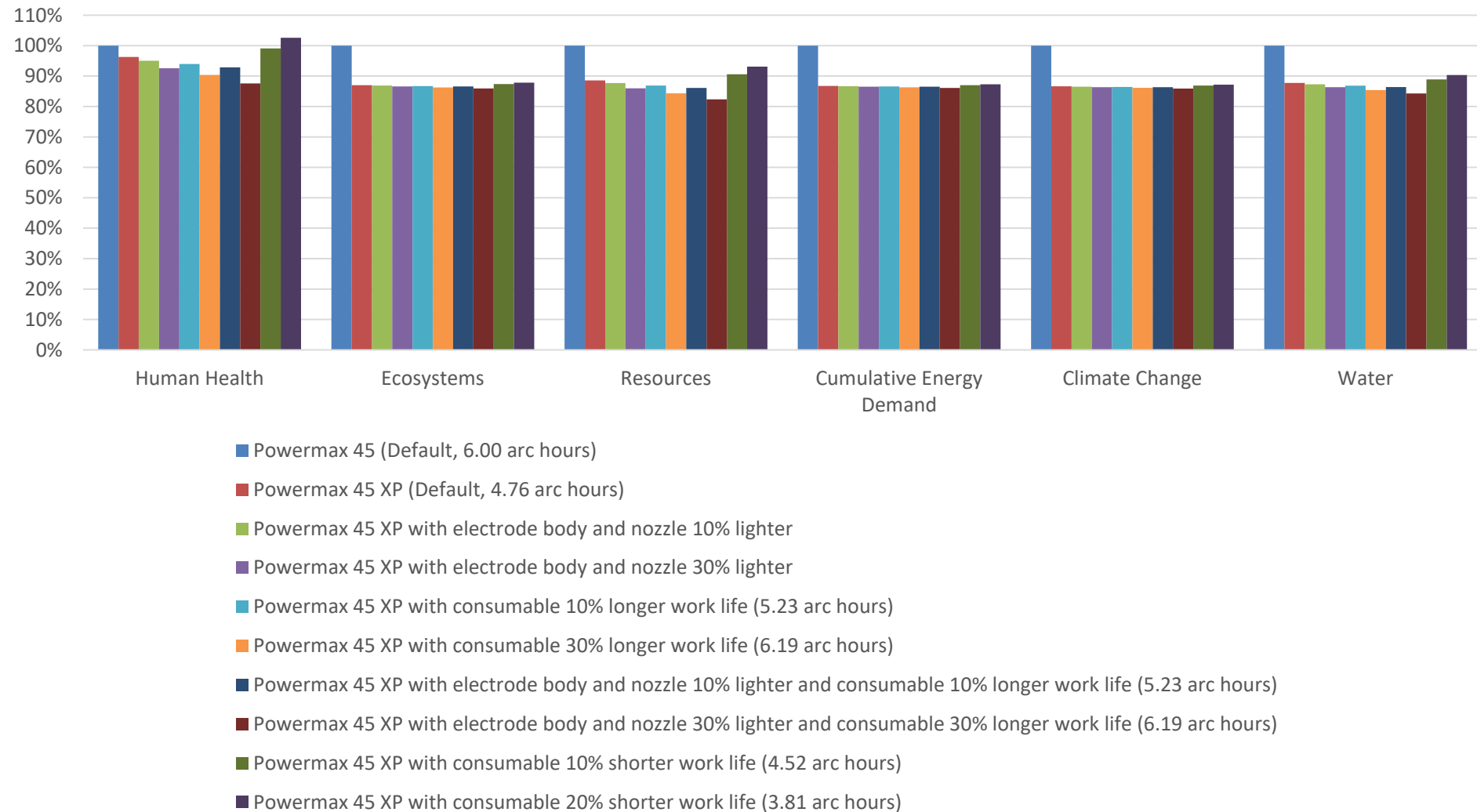
Sensitivity Analysis

Lifetime, per foot of cut, cradle-to-grave, in North America



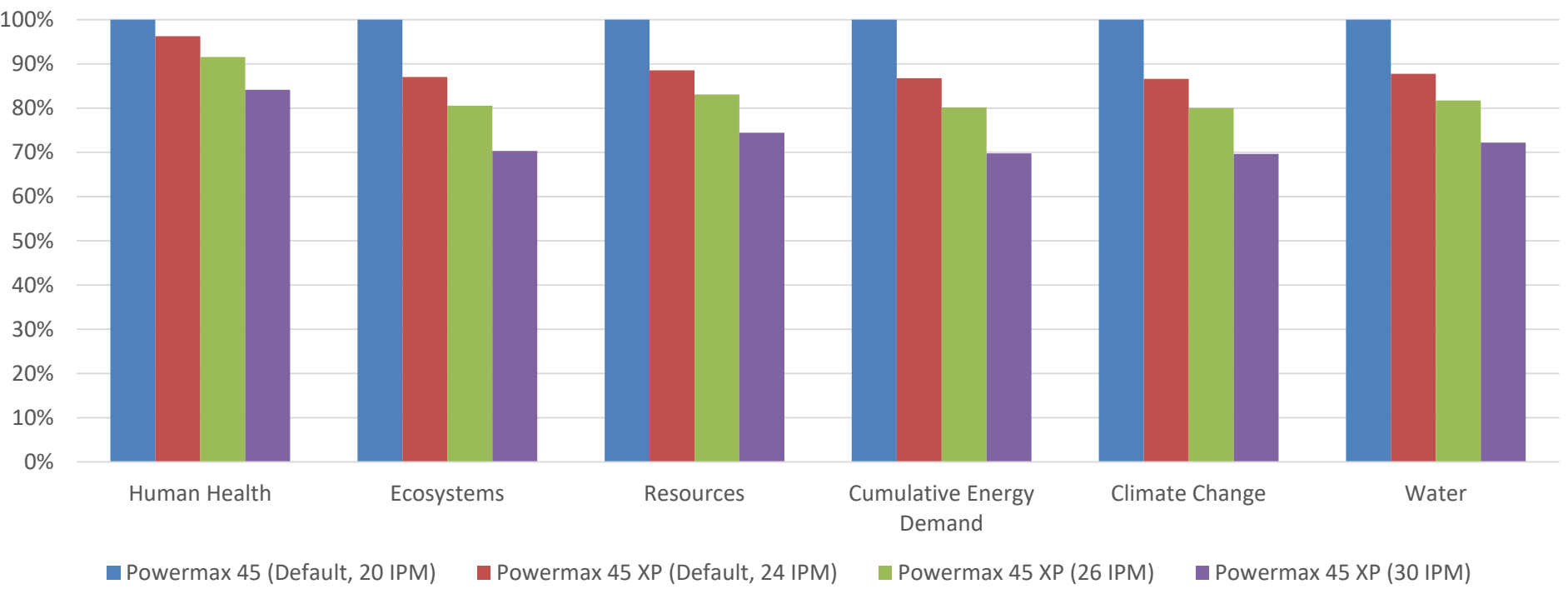
Sensitivity Analysis

Powermax comparison testing consumable weight and lifetime, per foot of cut, cradle-to-grave, in North America, without scrap



Sensitivity Analysis

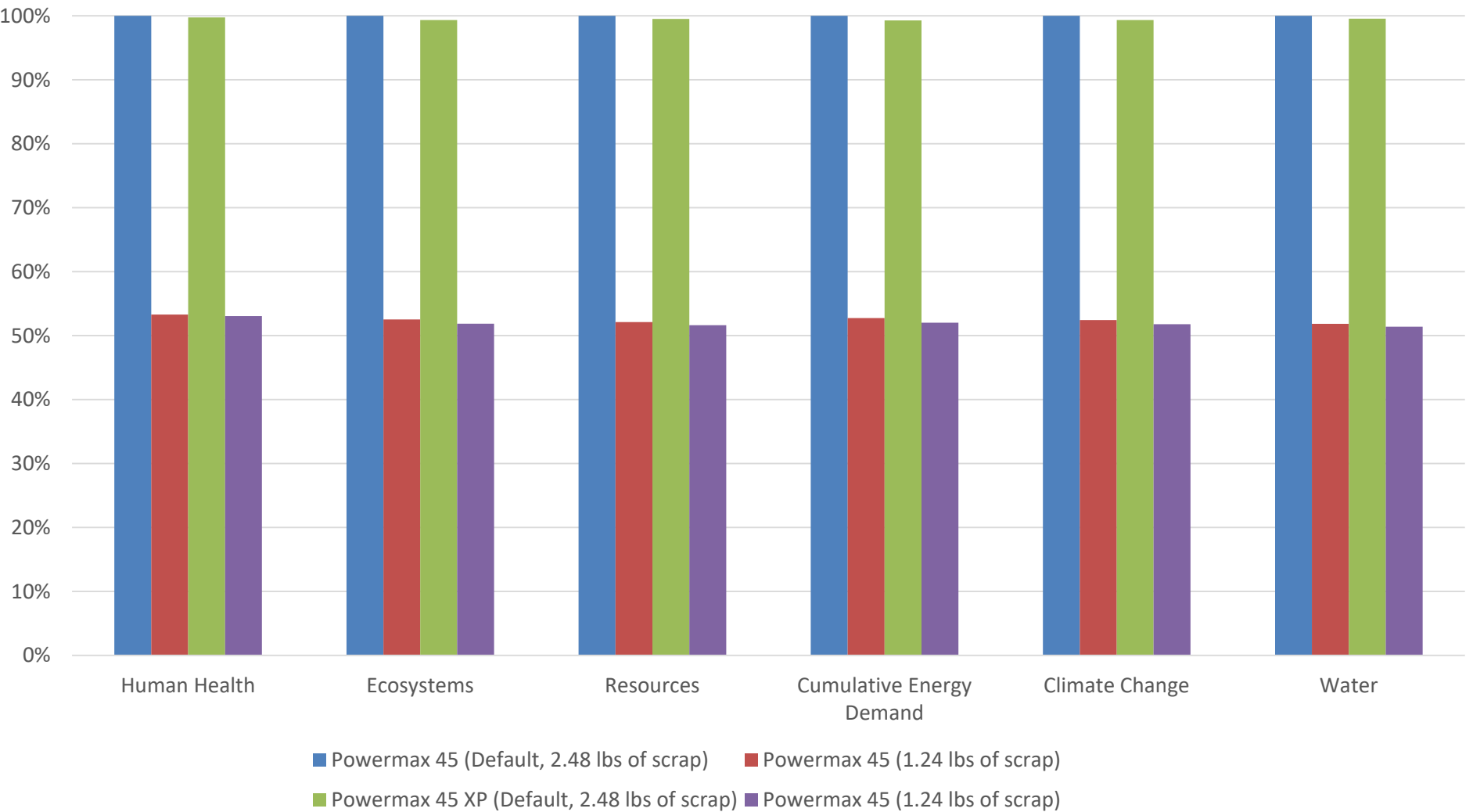
Speed, per foot of cut, cradle-to-grave, in North America, without scrap



Activity	Powermax 45 (Default, 20 IPM)	Powermax 45 XP (Default, 24 IPM)	Powermax 45 XP (26 IPM)	Powermax 45 XP (30 IPM)
Electricity (kWh/foot)	0.0688	0.0618	0.0570	0.0494
Compressed Air (Cu.Ft./foot)	3.20	2.67	2.46	2.13
Lifetime (Feet of cut)	30,520	36,624	39,676	45,780

Sensitivity Analysis

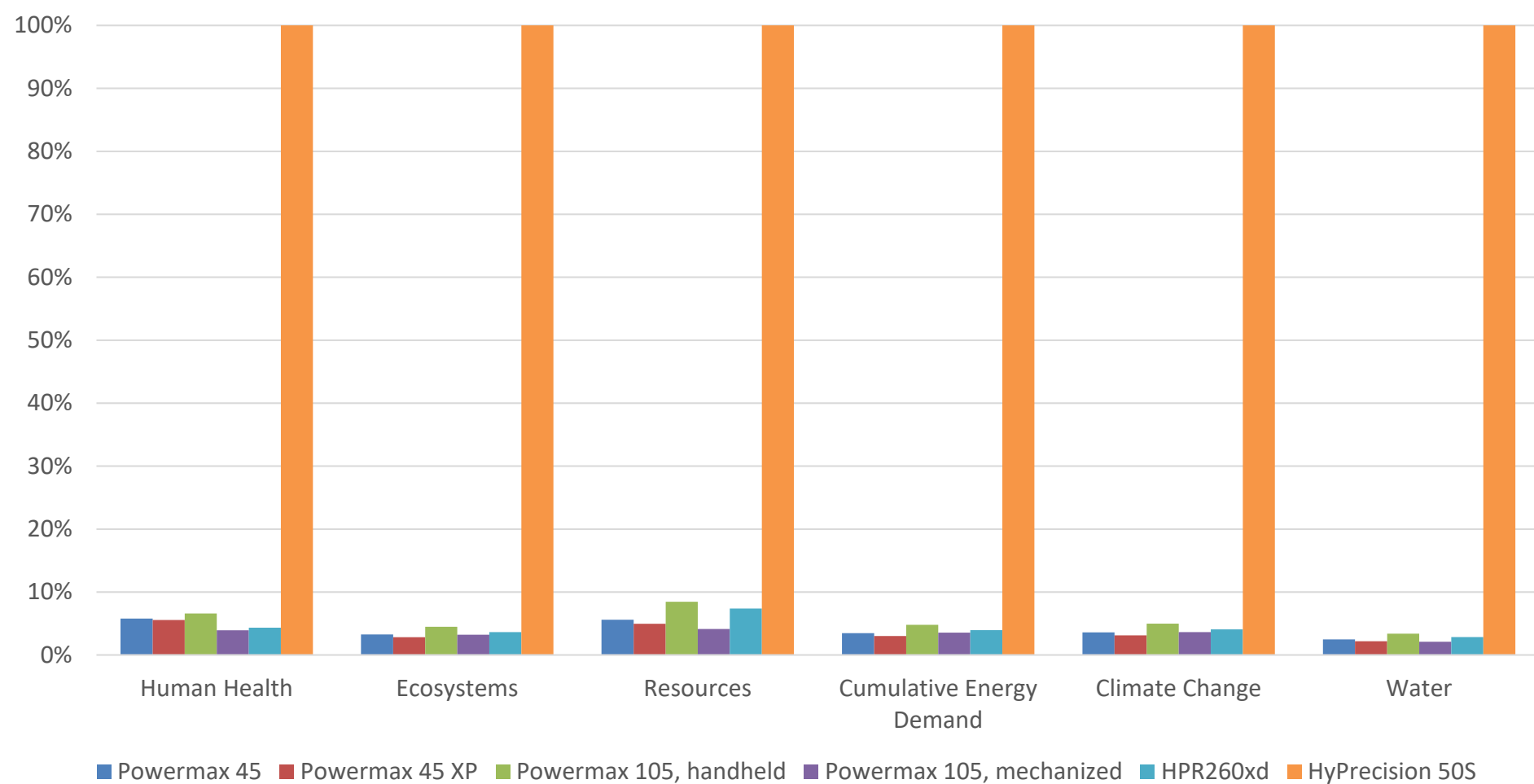
Scrap Amount, per foot of cut, cradle-to-grave, in North America,



BIGGER PICTURE

Comparison with other tools

Per foot of cut, cradle-to-grave, in North America, without scrap



NOTE: Cutting ½" mild steel for Powermax 45, 45 XP and HyPrecision 50S, while ¾" for Powermax 105 and HPR260xd.
In addition, different speeds were used for each based on each tools purpose.

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Comparison with other tools

Per foot of cut, cradle-to-grave, in North America, without scrap

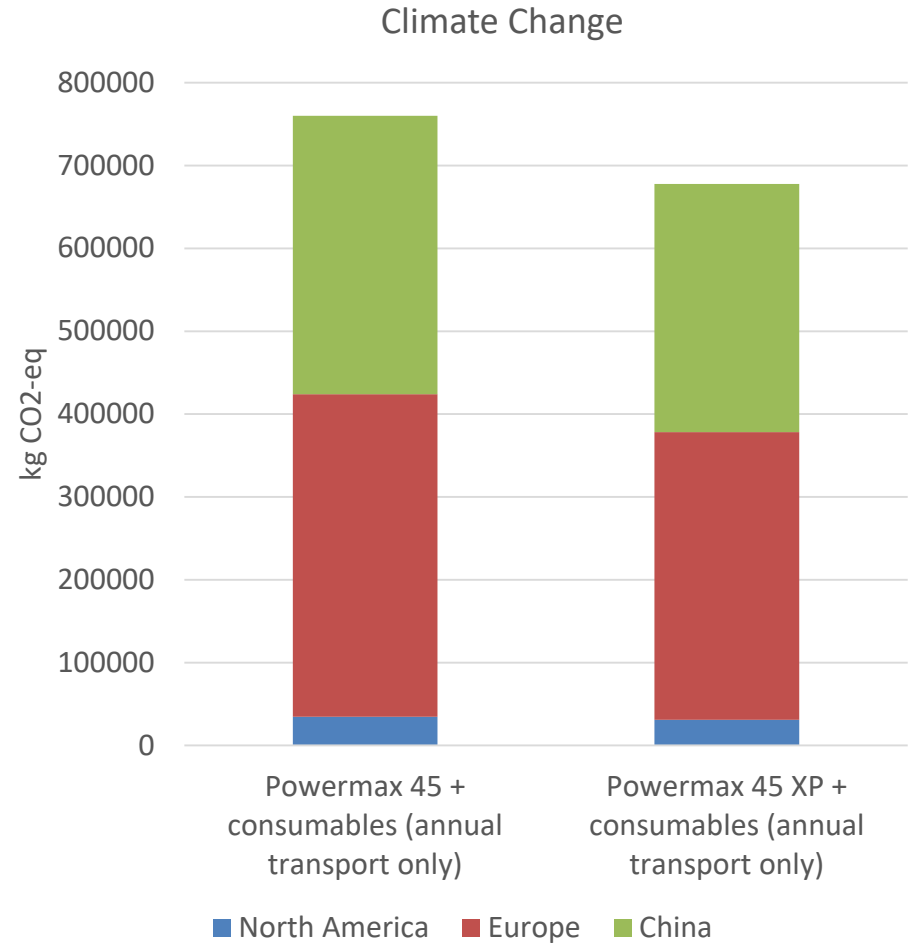
Impact Category	Powermax 45	Powermax 45 XP	Powermax 105, handheld	Powermax 105, mechanized	HPR260xd	WaterJet
Human Health (DALY)	3.31E-07	3.19E-07	3.77E-07	2.25E-07	7.27E-06	5.73E-06
Ecosystems (species.yr)	9.03E-10	7.86E-10	1.24E-09	8.94E-10	2.64E-08	2.78E-08
Resources (\$)	7.24E-03	6.41E-03	1.09E-02	5.34E-03	2.54E-01	1.29E-01
Cumulative Energy Demand (MJ)	1.56E+00	1.35E+00	2.15E+00	1.59E+00	4.21E+01	4.49E+01
Climate Change (kg CO2-eq)	9.42E-02	8.16E-02	1.31E-01	9.54E-02	2.86E+00	2.63E+00
Water (m3)	7.86E-04	6.90E-04	1.07E-03	6.69E-04	3.16E-02	3.17E-02

NOTE: Cutting ½” mild steel for Powermax 45, 45 XP and HyPrecision 50S, while ¾” for Powermax 105 and HPR260xd. In addition, different speeds were used for each based on each tools purpose.

Annual Transportation Impact Difference

	System Weight per year (Lbs)	Consumable Weight per Year (Lbs)	TOTAL Weight per Year (Lbs)
Powermax 45	544,000	10,237	554,237
Powermax 45 XP	476,000	18,299	494,299

	North America	Europe/ South America	China/ APAC
Sales by Region	64%	26%	10%



NOTE: Assuming the same sales for Powermax 45 and Powermax 45 XP, as well as consumable components.

Key Findings & Observations

Powermax 45

With scrap, the majority of cradle-to-grave environmental impacts are coming:

- Scrap (91 – 96%)*
- Electricity (1 – 4%)*
- Compressed air (1 – 2%)*
- The Powermax, torch, consumables, air emissions and packaging are not significant contributors when scrap is included.

Without scrap:

- Electricity (26 – 56%)*
- Compressed air (23 – 40%)*
- Powermax 45 (11 – 24%)*
- Consumables (1 – 19%)*
- The torch, air emissions and packaging are not significant contributors, except in the human health category where the air emissions result in 7 – 11% of the impacts.

The majority of the Powermax 45 impacts are coming from:

- Inductors & Transformers
- PCBs
- Capacitors

* Across all impact categories and distribution locations

Key Findings & Observations

Powermax 45 XP

With scrap, the majority of cradle-to-grave environmental impacts are coming:

- Scrap (91 – 97%)*
- Electricity (1 – 4%)*
- Compressed air (1 – 2%)*
- The Powermax, torch, consumables, air emissions and packaging are not significant contributors when scrap is included.

Without scrap:

- Electricity (24 – 58%)*
- Compressed air (20 – 38%)*
- Powermax 45 XP (9 – 19%)*
- Consumables (2 – 4%)*
- The torch, air emissions and packaging are not significant contributors, except in the human health category where the air emissions result in 8 – 11% of the impacts.

The majority of the Powermax 45 impacts are coming from:

- Inductors & Transformers
- PCBs
- Capacitors

* Across all impact categories and distribution locations

Key Findings & Observations

Comparison of Powermax 45 vs. Powermax 45 XP

With scrap:

- The Powermax 45 XP has slightly fewer impacts* than the Powermax 45.

Without scrap:

- The Powermax 45 XP has 11%* fewer electricity impacts, 20% fewer compressed air impacts and around 20%* fewer Powermax component impacts than the Powermax 45:
 - 4% less in human health
 - 13% less in ecosystems
 - 11% in resources
 - 13% in cumulative energy demand
 - 13% less in climate change
 - 12% in water

Percent differences for North America. Similar for Europe and China.

* Across all impact categories and distribution locations

Summary of Key Findings

- The majority of the cradle-to-grave impacts of the Powermax 45 and Powermax 45 XP come from the scrap, electricity and compressed air.
- The inductors & transformers, PCBs and capacitors drive the Powermax 45 and Powermax 45 XP impacts.
- While the Powermax 45 XP has made improvements in energy efficiency (electricity and compressed air usage) and speed of cutting compared to the Powermax 45, the increased weight and shorter life of the Powermax 45 XP consumables increase the impact of the consumables over the previous generation. However, the effect is smaller than, and is far outweighed by, the beneficial impacts of the energy efficiency and speed. Furthermore, there are benefits to the Powermax 45 XP consumable that go beyond the LCA, including commonality, ease of use for end user, and patent.

Next Steps & Recommendations

- Innovate around scrap reduction.
- Research ways to reduce electricity and compressed air during the use phase.
- Investigate ways to increase the speed and to extend the life of the Powermax 45 XP.
- Encourage on-site renewable energy generation.