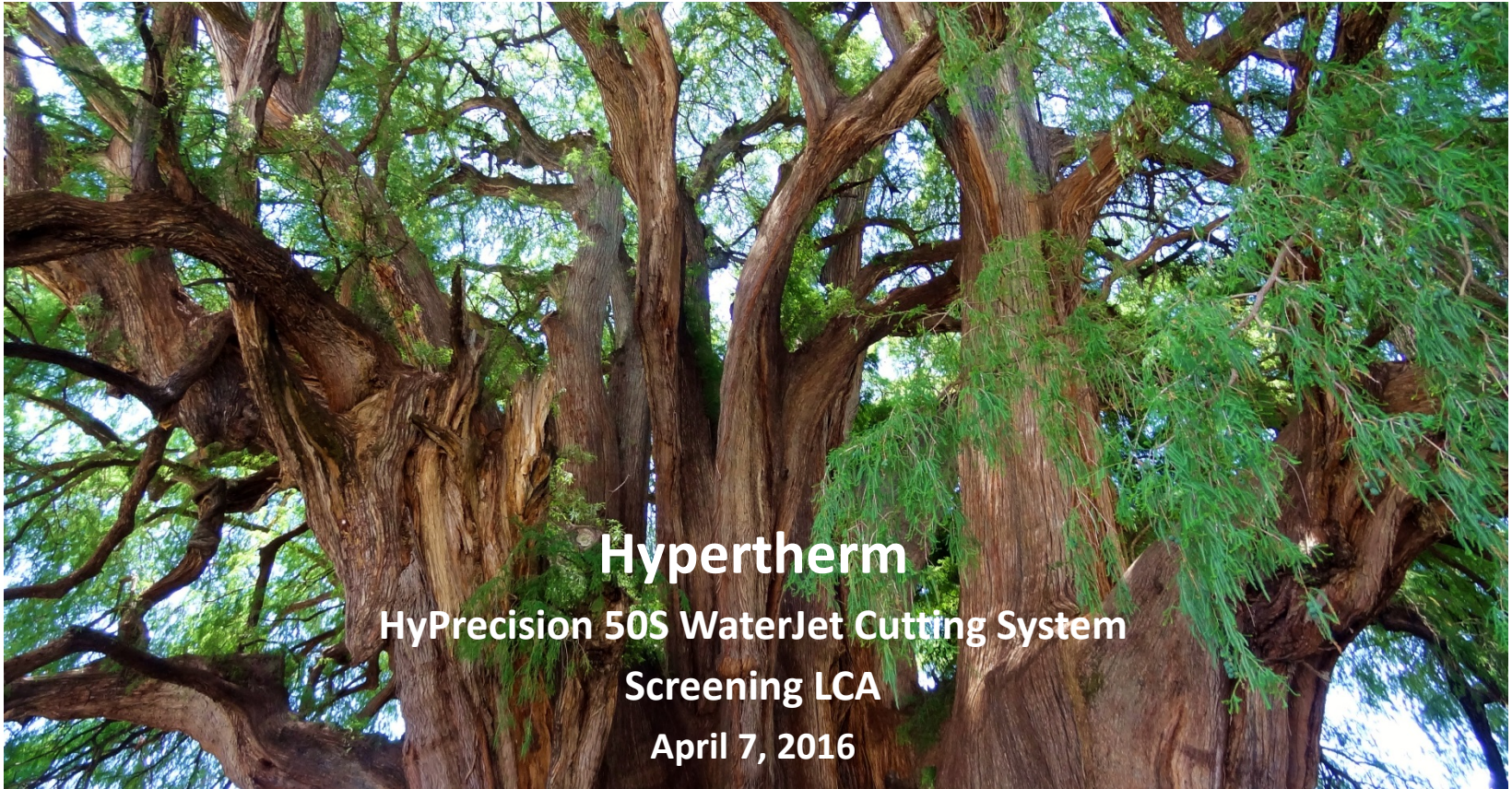


# EARTHSHIFT

Experts in Product Stewardship



**Hypertherm**

**HyPrecision 50S WaterJet Cutting System**

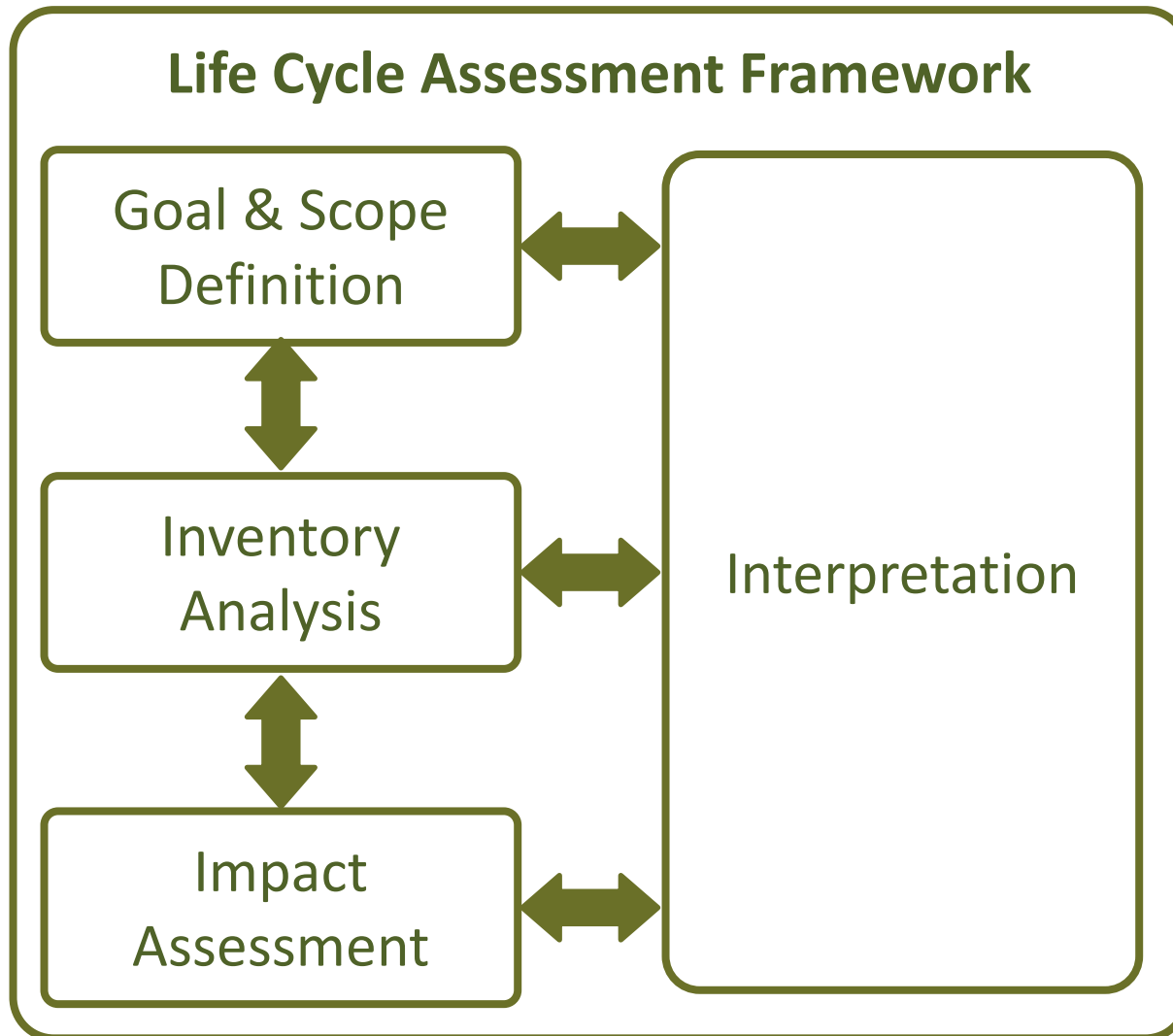
**Screening LCA**

**April 7, 2016**

*Shelly Martin*

*Shelly@earthshiftsustainability.com*

# The Steps of an LCA

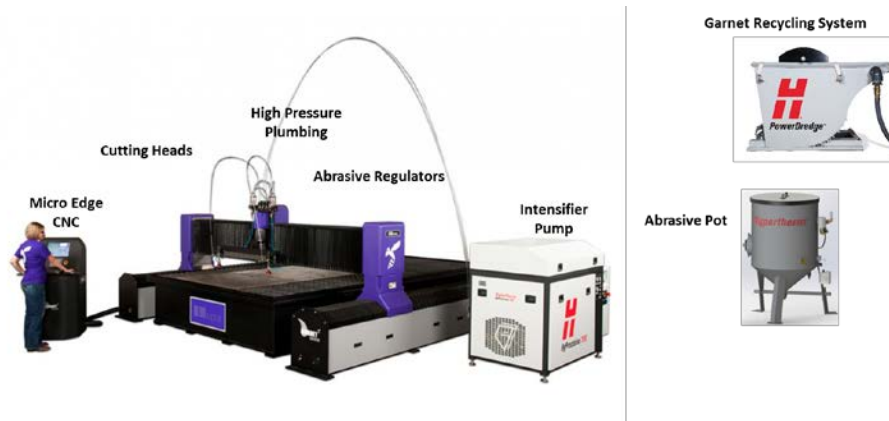


What is the goal of the study? What does the study entail?

## **GOAL AND SCOPE**

# Goal & Scope

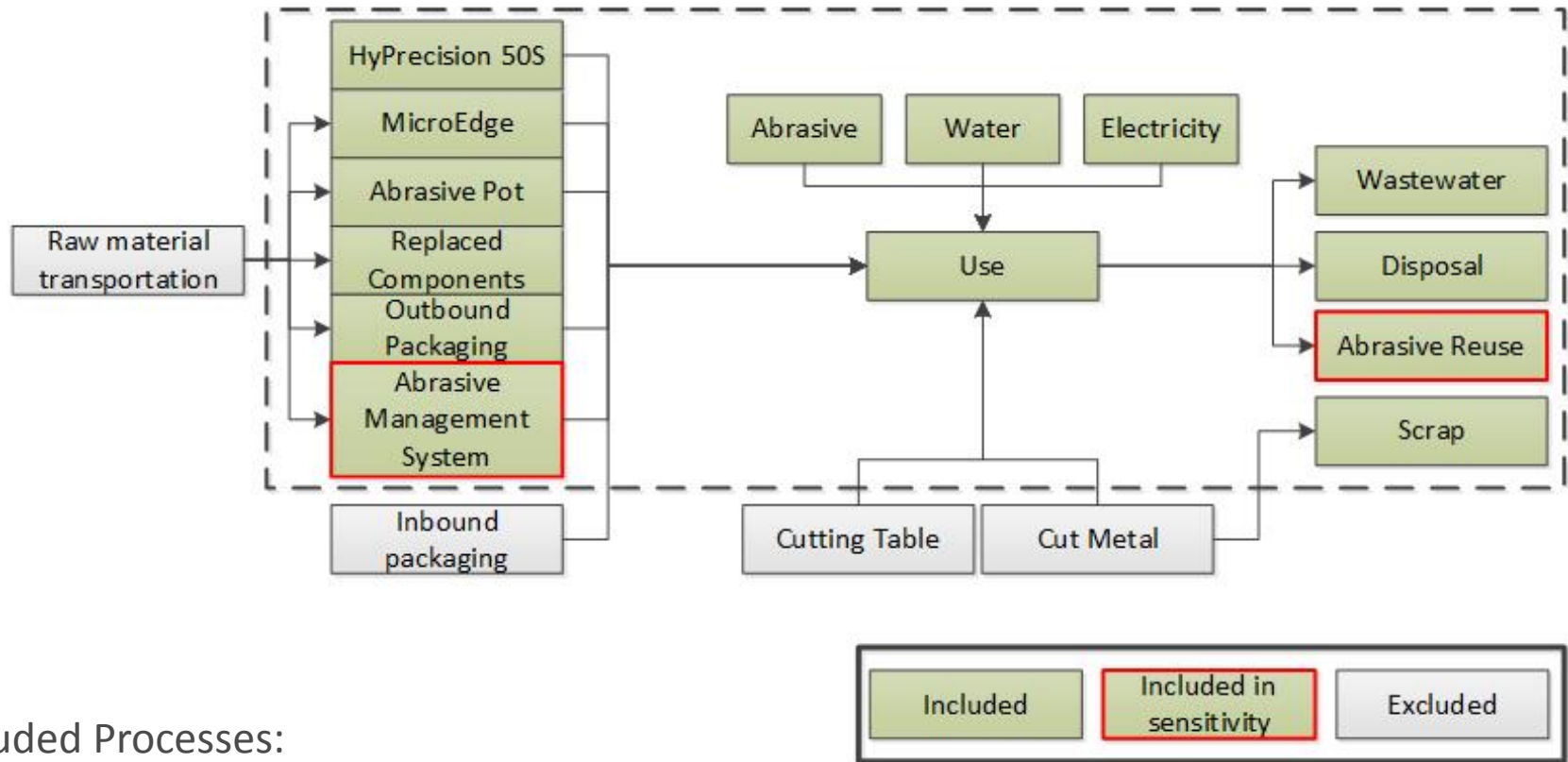
- **Intended applications**
  - Cradle-to-grave screening LCA of the HyPrecision 50S WaterJet Cutting System.
- **Reasons for carrying out the study**
  - To help drive product innovation, meet customer demands for information, and identify where the biggest impacts are occurring throughout the life cycle.
- **Target audience**
  - The initial audience will be internal to Hypertherm: the Sustainability team, the WaterJet engineering team, the consumables team, the marketing team, the manufacturing team, the operations and facilities team.
- **Functional units**
  - Cutting one foot of  $\frac{3}{4}$ " thick mild steel at a feed rate of 3.63 inches per minute.





# System Boundaries

## HyPrecision 50S WaterJet Cutting System



### Excluded Processes:

- Infrastructure (e.g. buildings and plant equipment);
- Human activities (e.g. employee travel to and from work);
- R&D (i.e. the laboratory and inputs related to the development of the technologies);
- Services (e.g. the use of purchased marketing, consultancy services, business travelling).

What data was used? What assumptions were made?

# LIFE CYCLE INVENTORY

# Life Cycle Inventory

- **Primary data** (Provided by Hypertherm)
  - Material and energy data.
  - Distribution.
  - Packaging.
  - Use phase.
  - Disposal.
- **Secondary data** (Used literature, US-EI<sup>1</sup> and Ecoinvent 2.2<sup>2</sup>)
  - LCI data for raw materials, energy production, transport and disposal.

<sup>1</sup> See [www.earthshiftsustainability.com/services/software/datasmart-life-cycle-inventory](http://www.earthshiftsustainability.com/services/software/datasmart-life-cycle-inventory) for more information about US-EI.

<sup>2</sup> See [www.Ecoinvent.ch](http://www.Ecoinvent.ch) for more information about Ecoinvent 2.2.

# HyPrecision 50S Components

Component	Amount	Unit	Component	Amount	Unit
11733 Shift Valve	21	lbs	Electrical Enclosure Assy	178	lbs
11805 Control Manifold Assy	24	lbs	HP Attenuator, 1L	198	lbs
11978 50 HP Motor	651	lbs	HP Plumbing	20	lbs
13115 Manifold	21	lbs	Hydraulic Hoses	45	lbs
14533 Heat Exchanger	10	lbs	Intensifier	188	lbs
14603 Frame	526	lbs	LP Filters and Manifold	15	lbs
14615 Hydraulic Tank Assy	151	lbs	LP Plumbing	35	lbs
50HP Pump	118	lbs	S Series Cover	86	lbs
All Panels	102	lbs	Outbound Packaging (Skid & Film)	285	lbs
Bleed-down Valve Assy	5	lbs	Tools Shipped with Pump	54	lbs
Boost Pump and 1/2 HP Motor	21	lbs	Micro Edge CNC	42	lbs
			Abrasive Pot	404	lbs



# Abrasive Management System (Used in Sensitivity)

Component	Amount	Unit
Power Dredge	995	lbs
EcoSift Hopper	500	lbs
EcoSift	2500	lbs
Electricity	0.32	kWh/foot of cut
Compressed Air	3.99	CF/foot of cut
Water	2.4	Gallons/foot of cut

# Use Phase

	Lifetime Feet of Cut
HyPrecision 50S System and Abrasive Management System	453,750*
*A lifetime of 25,000 hours: Assuming an 8 year life at 35% uptime. Tested with 20,000 to 30,000 hours OR 363,000 to 544,500 feet.	

	Per Foot of Cut \$ Amount	Per Foot of Cut Amount
Electricity	\$0.16	2.1 kWh
Water Usage	\$0.06	3.2 gallons
Abrasive	\$0.79	4.0 lbs

# Assumptions

## Raw materials & manufacturing

- Hypertherm supply chain is equivalent to “average” supply chain within our LCI dataset.
- Hypertherm processing is similar to “average” processing of a similar type within our dataset.
- No additional production emissions captured.
- Abrasive packaged in paper bags and shipped on pallets. In the U.S., distributed 1500 miles by truck (15%) and 10,000 miles by ocean freighter and then 750 miles by truck (85%). In Europe, distributed 10,000 miles by ocean freighter and 1,000 miles by truck. Abrasive transported to landfill 50 miles by truck.

## Distribution

- 85% of shipments within the U.S. by truck (assuming 1/3 to each coast and central).
- 15% of shipments to Europe (1% by air, 14% by ocean and truck).

# Assumptions

## Use

- Included replaced components.
- Cutting table is excluded.
- 3.72 lbs of scrap is produced per foot of cut (same as HPR260xd).
- Cut metal is excluded.

## End of Life/Disposal

- All machine components are recycled.
- 100% of abrasive is landfilled, transported 50 miles by truck. Tested 50% of abrasive is reused with Abrasive Management System, other 50% landfilled.
- Outbound packaging is landfilled.

# Impact Assessment Method

Damage Category	Units	From	Comments
Human health	DALY	ReCiPe Endpoint (H)	Accounts for years lived disabled as well as life cut short
Climate change	kg CO <sub>2</sub> 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	Economic units	ReCiPe Endpoint (H)	Puts a future value on resources which will be unavailable since we are using them today
Water	m <sup>3</sup>	ReCiPe Midpoint (H)	Counts the amount of water consumed. <b>Does not show impact. Used for benchmarking only.</b>
CED	MJ	Cumulative Energy Demand	Adds up different categories of energy

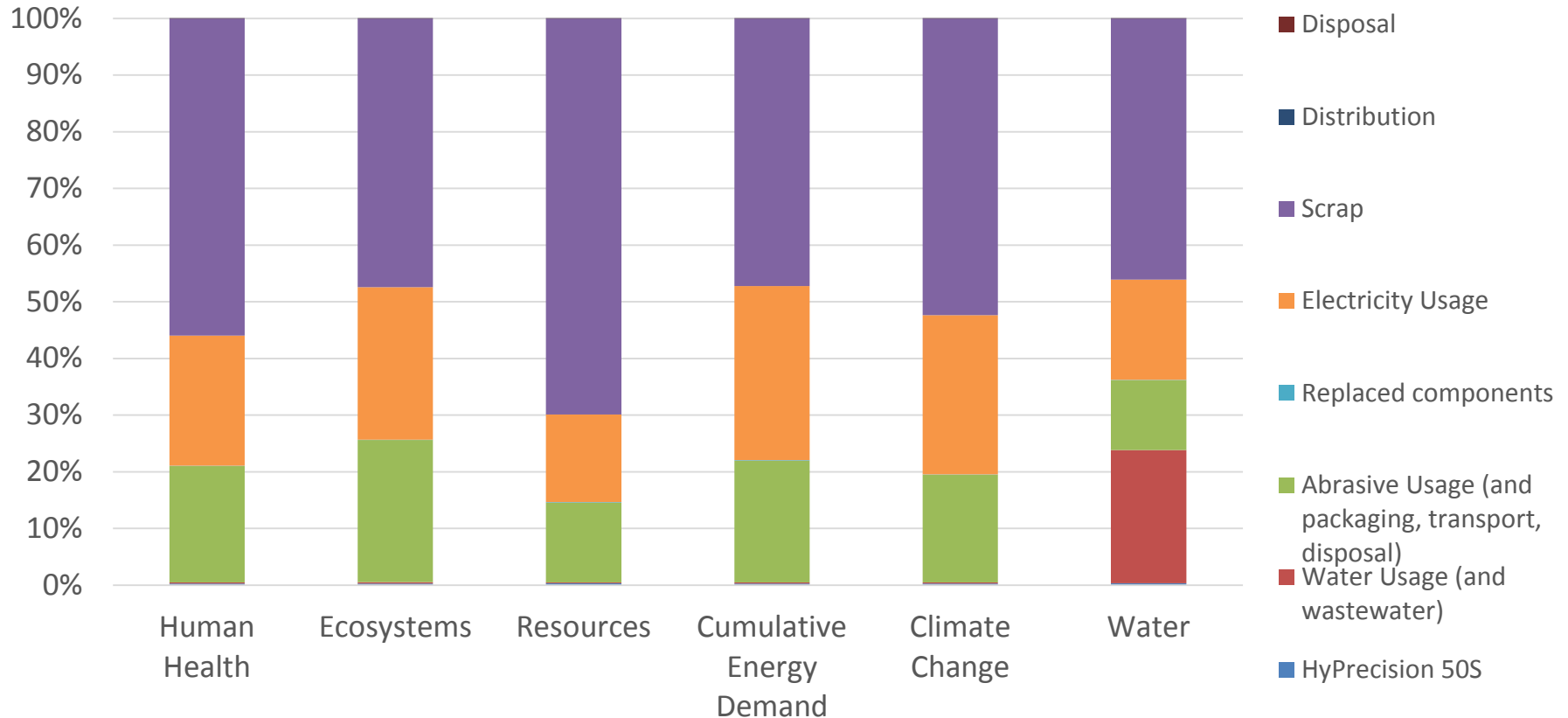
What are the environmental hotspots?

# CONTRIBUTION & COMPARATIVE ANALYSIS



# Contribution Analysis

HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, with scrap (3.72 lbs/foot cut)



The majority of the impacts come from the scrap (46% - 56%), electricity (15% - 31%) and abrasive (12% - 25%) usage. ~50% of the abrasive impacts come from transportation.

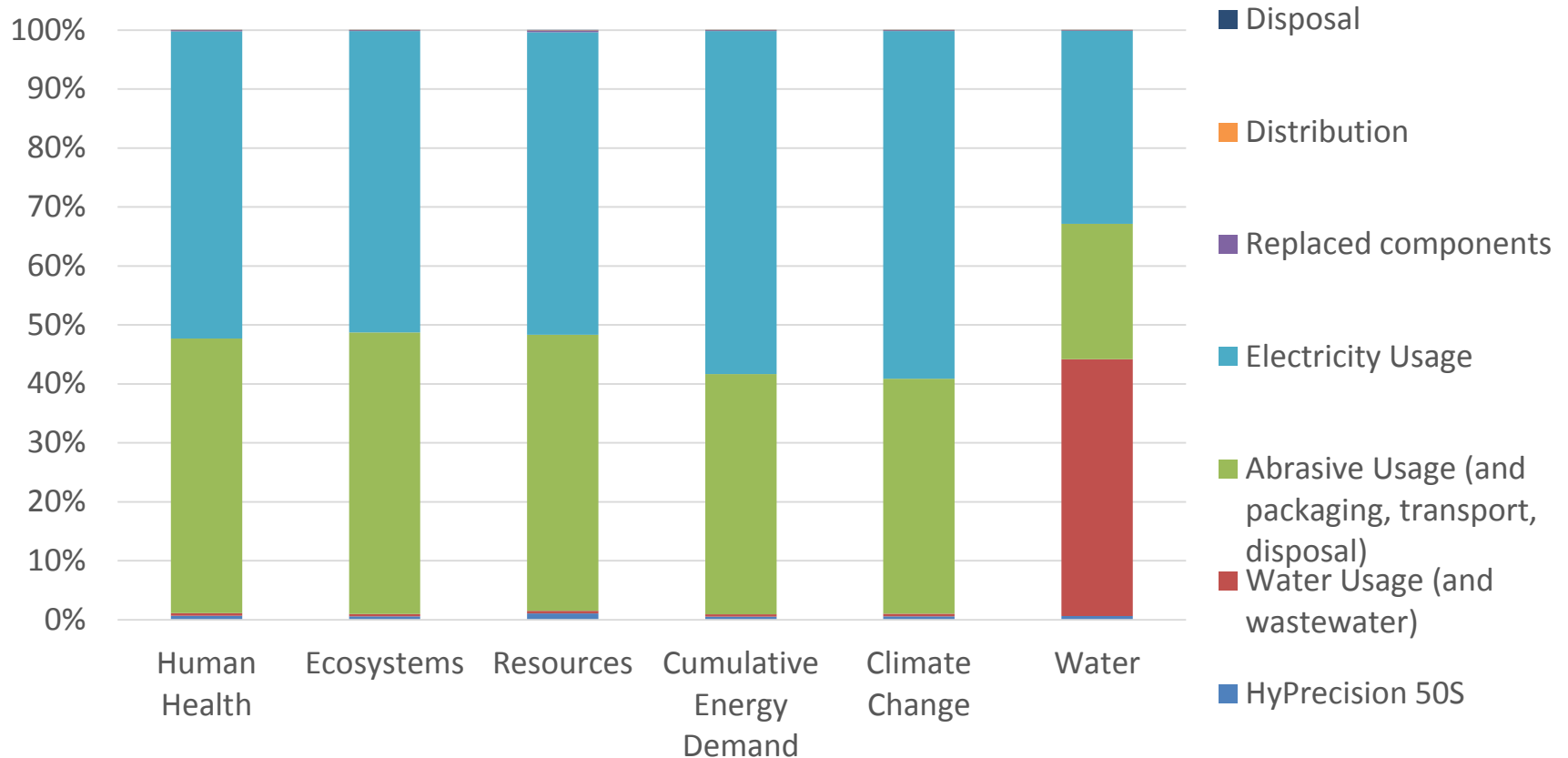
# Contribution Analysis

HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, with scrap (3.72 lbs/foot cut)

Impact Category	TOTAL	HyPrecision 50S	Water Usage	Abrasive Usage	Electricity Usage	Replaced components	Scrap	Distribution	Disposal
Human Health (DALY)	1.30E-05	3.82E-08	2.55E-08	2.67E-06	2.99E-06	9.35E-09	7.27E-06	1.68E-09	4.12E-11
Ecosystems (species.yr)	5.28E-08	1.58E-10	1.11E-10	1.33E-08	1.42E-08	3.30E-11	2.50E-08	6.66E-12	1.48E-13
Resources (\$)	4.29E-01	1.40E-03	5.34E-04	6.06E-02	6.64E-02	4.36E-04	3.00E-01	4.09E-05	3.49E-07
Cumulative Energy Demand (MJ)	8.51E+01	2.44E-01	1.58E-01	1.83E+01	2.61E+01	5.85E-02	4.02E+01	1.11E-02	9.50E-05
Climate Change (kg CO2-eq)	5.51E+00	1.53E-02	1.14E-02	1.05E+00	1.55E+00	3.61E-03	2.88E+00	8.01E-04	2.23E-05
Water (m3)	5.88E-02	1.98E-04	1.38E-02	7.27E-03	1.04E-02	3.30E-05	2.71E-02	5.61E-07	8.38E-08

# Contribution Analysis

HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, no scrap



The majority of the impacts come from the electricity and abrasive usage. ~50% of the abrasive impacts come from transportation.

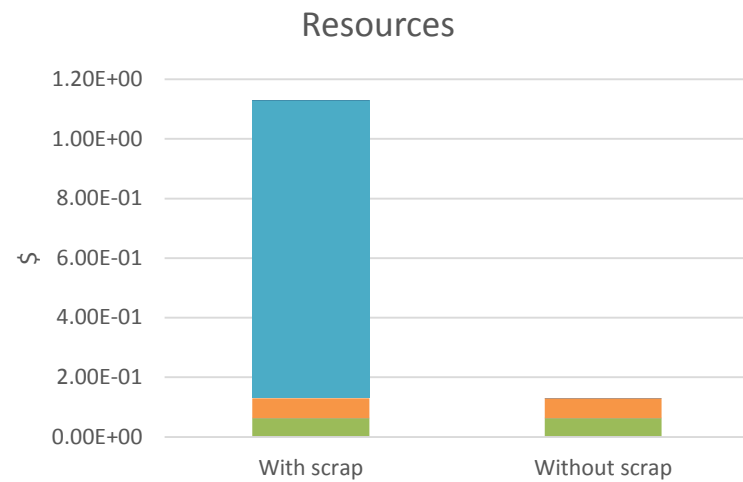
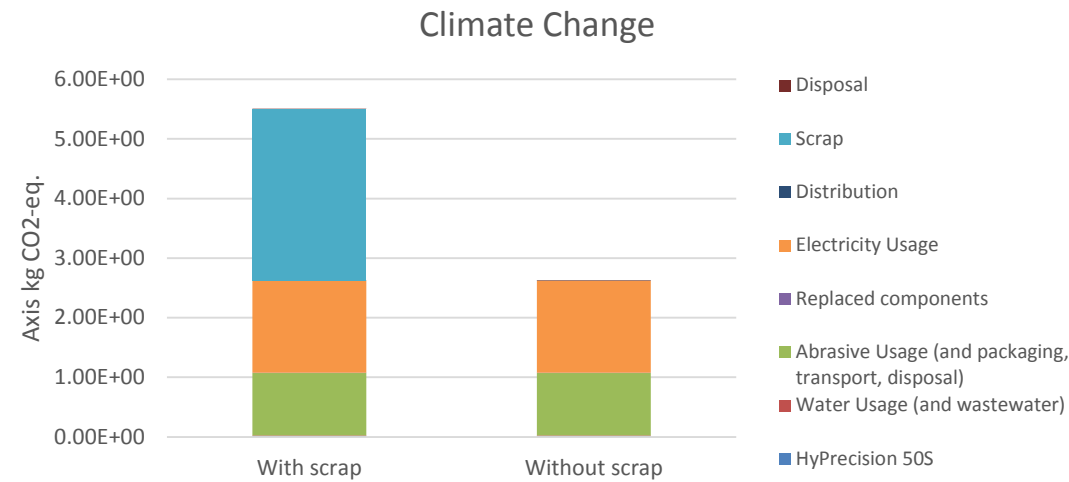
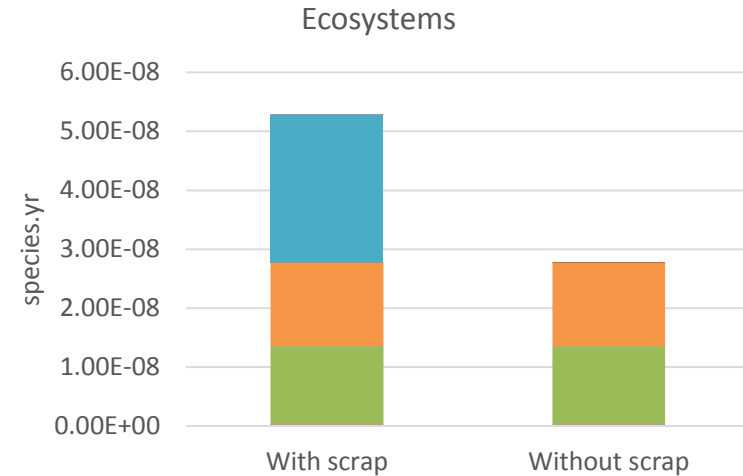
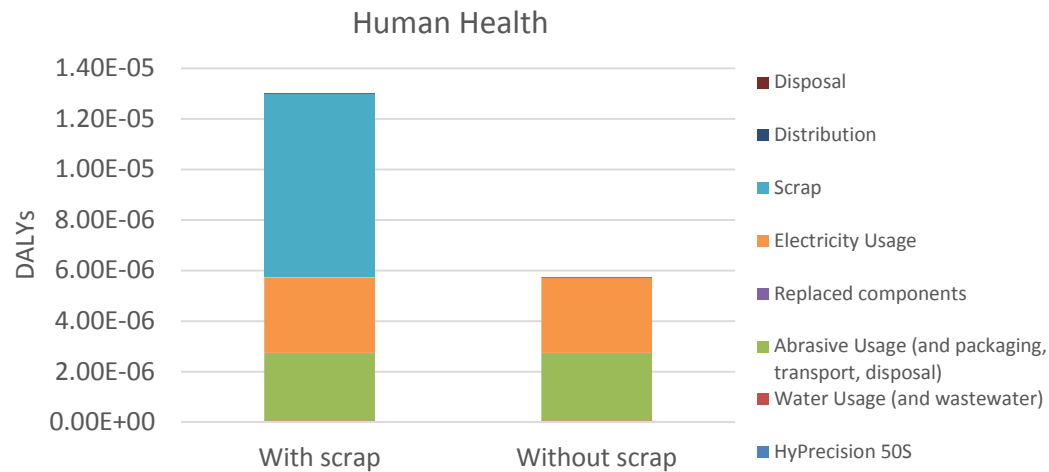
# Contribution Analysis

HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, no scrap

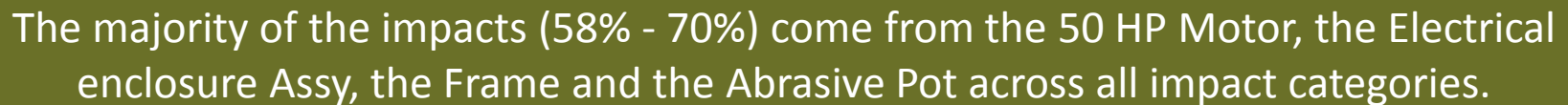
Impact Category	TOTAL	HyPrecision 50S	Water Usage	Abrasive Usage	Electricity Usage	Replaced components	Distribution	Disposal
Human Health (DALY)	5.73E-06	3.82E-08	2.55E-08	2.67E-06	2.99E-06	9.35E-09	1.68E-09	4.12E-11
Ecosystems (species.yr)	2.78E-08	1.58E-10	1.11E-10	1.33E-08	1.42E-08	3.30E-11	6.66E-12	1.48E-13
Resources (\$)	1.29E-01	1.40E-03	5.34E-04	6.06E-02	6.64E-02	4.36E-04	4.09E-05	3.49E-07
Cumulative Energy Demand (MJ)	4.49E+01	2.44E-01	1.58E-01	1.83E+01	2.61E+01	5.85E-02	1.11E-02	9.50E-05
Climate Change (kg CO2-eq)	2.63E+00	1.53E-02	1.14E-02	1.05E+00	1.55E+00	3.61E-03	8.01E-04	2.23E-05
Water (m3)	3.17E-02	1.98E-04	1.38E-02	7.27E-03	1.04E-02	3.30E-05	5.61E-07	8.38E-08

# Comparative Analysis: Scrap vs. no scrap

HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave,



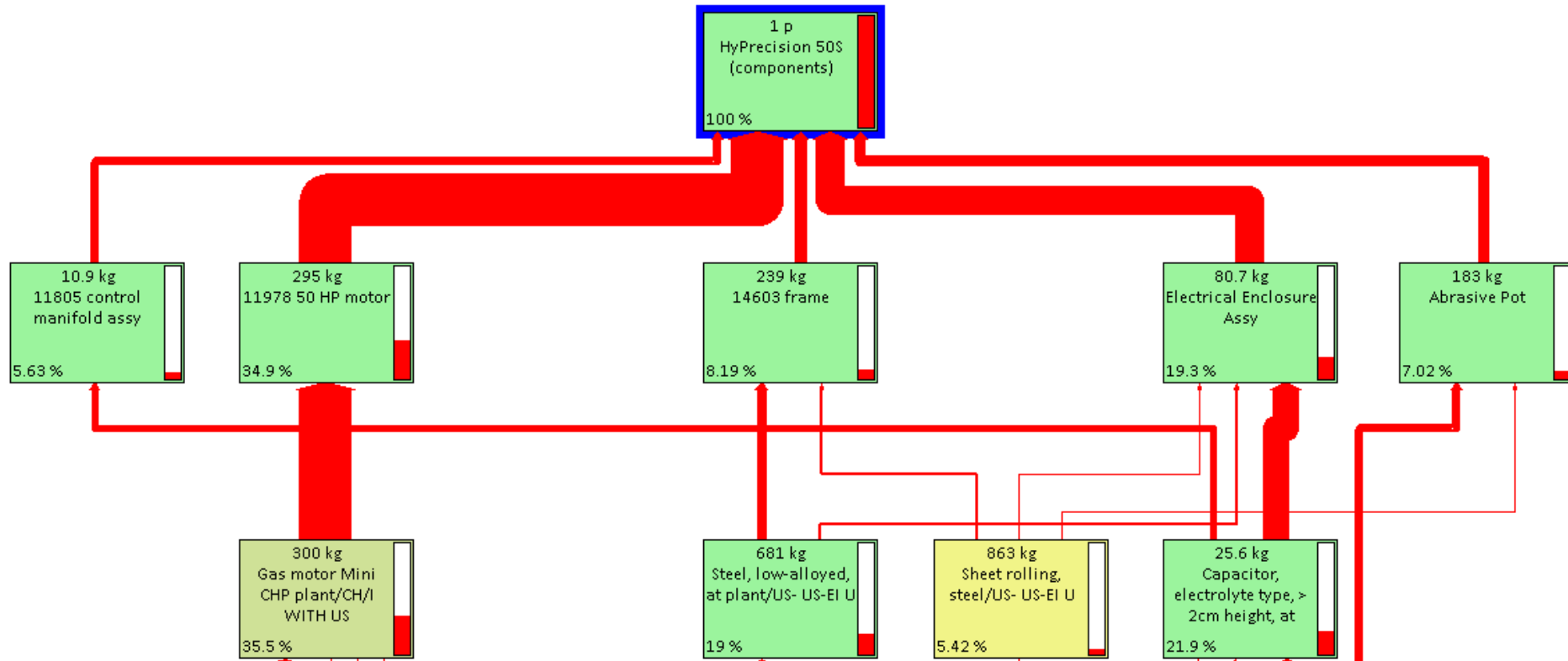
## HyPrecision 50S System Components, cradle-to-gate





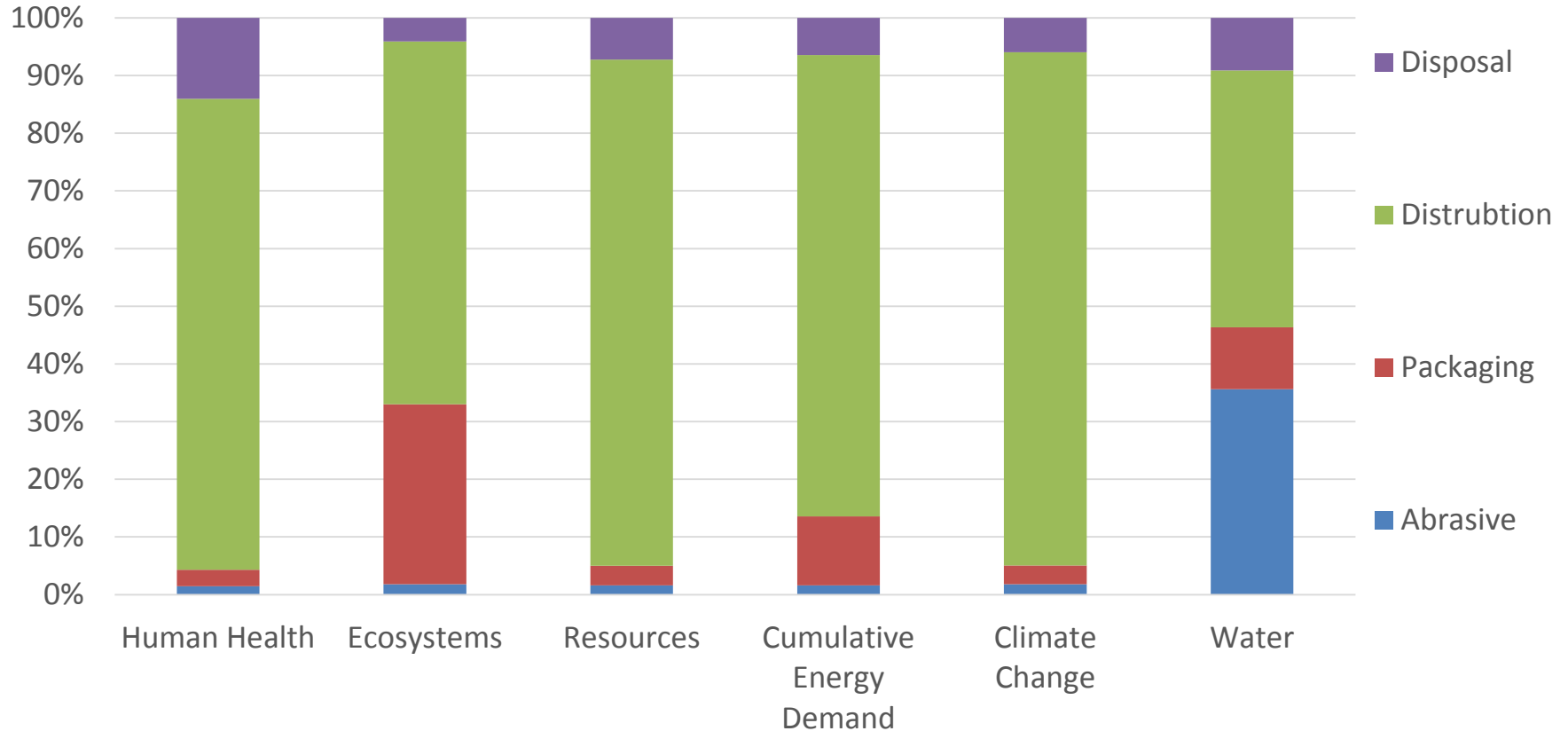
# Network Analysis: Climate Change

## HyPrecision 50S System Components, cradle-to-gate



# Contribution Analysis

## Abrasive ONLY, cradle-to-grave



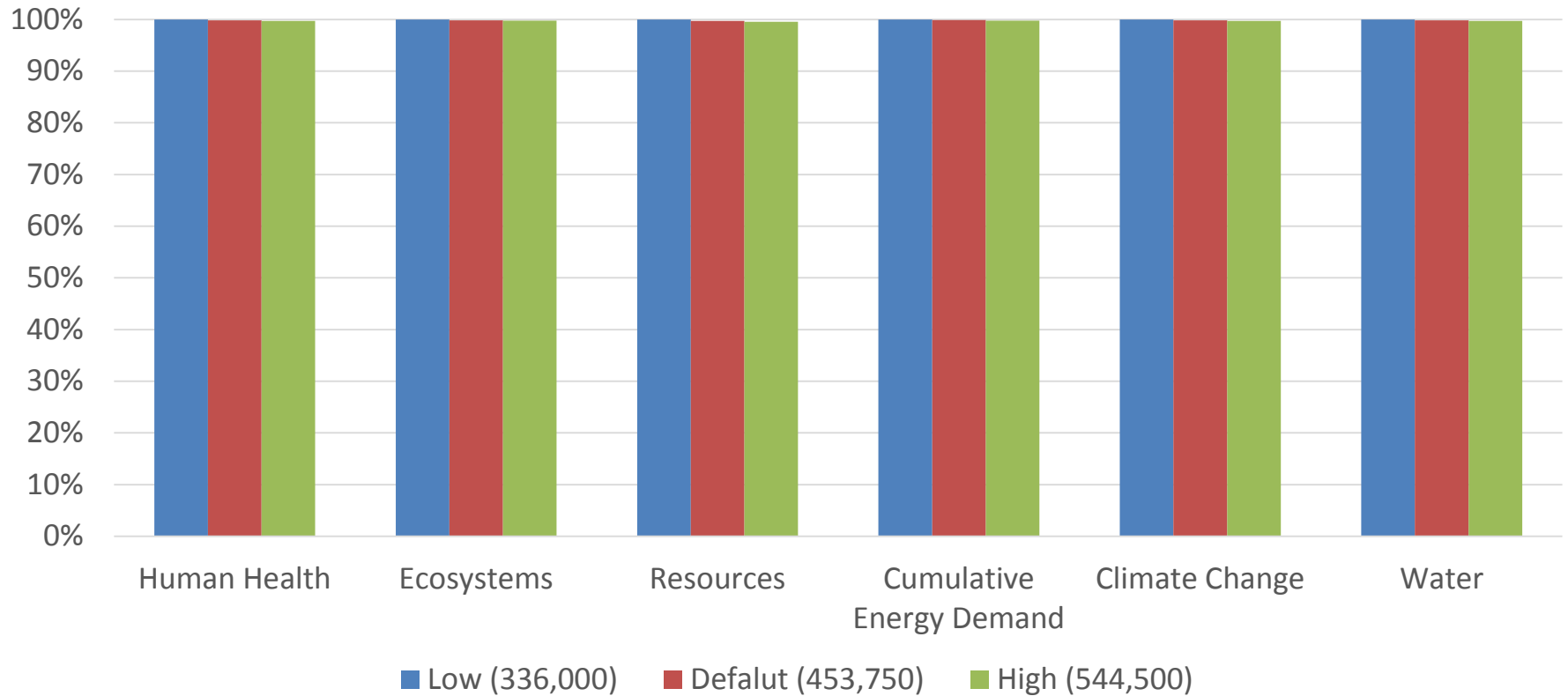
The majority of the abrasive impacts come from the distribution (45% - 85%), while the disposal of the abrasive accounts for 6% - 14% of the impacts across all impact categories.

How sensitive are the results?

# **SENSITIVITY ANALYSES**

# Sensitivity Analysis: Range of Lifetime feet of cut

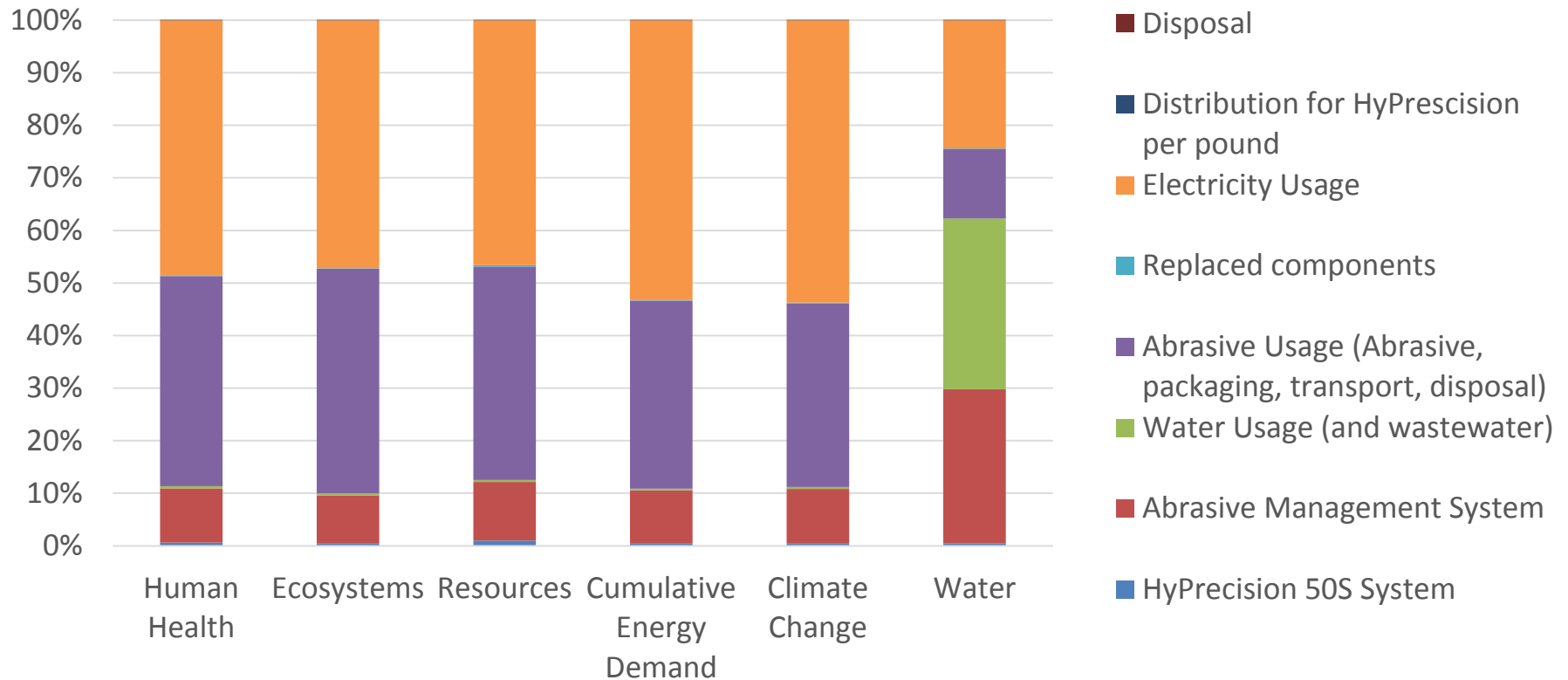
HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, no scrap



The electricity and abrasive usage are such a large contributor to the per foot of cut impacts that shortening or extending the life makes <1% of the impacts.

# Sensitivity Analysis: Abrasive Management System and 50% Abrasive Reuse

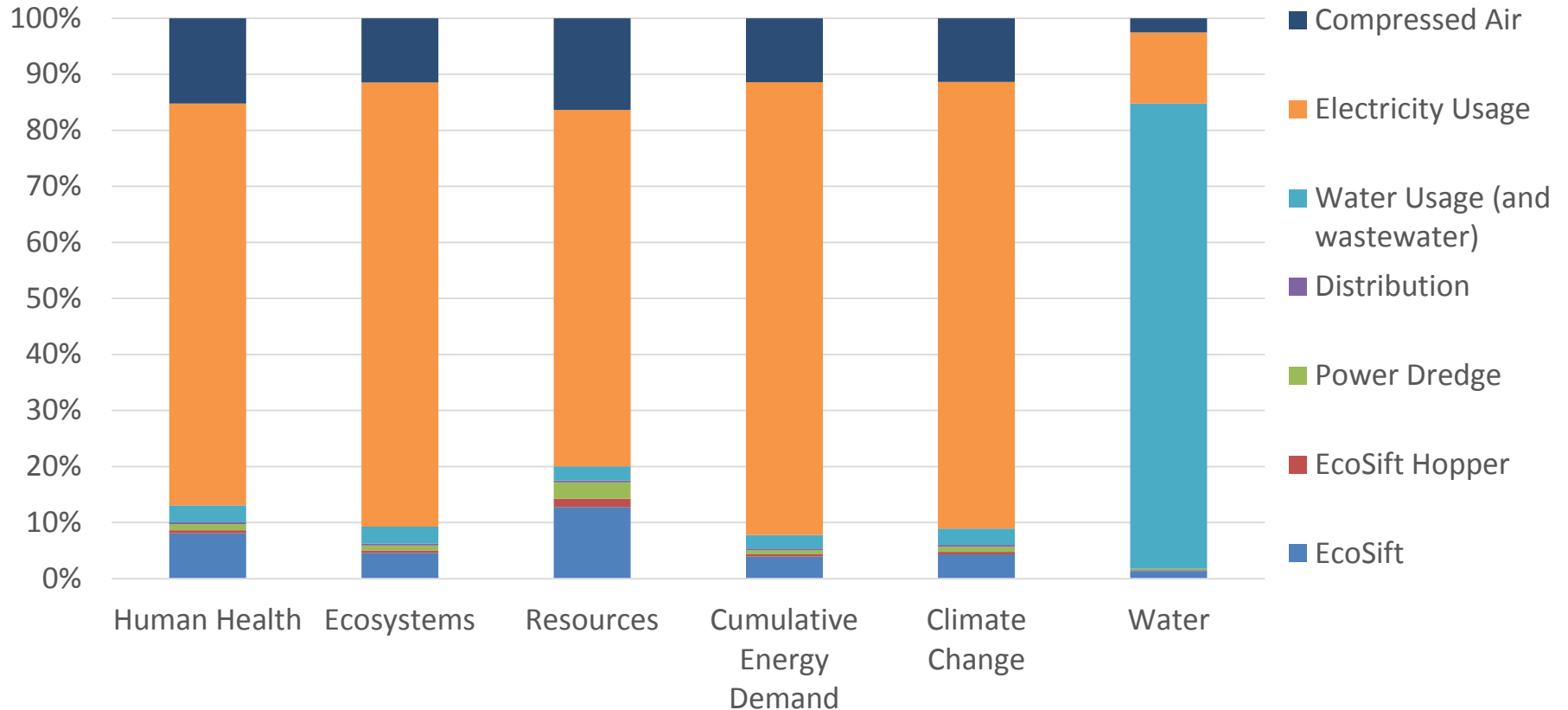
HyPrecision 50S WaterJet Cutting System, per foot of cut, cradle-to-grave, no scrap



The abrasive management system results in 9 – 29% of the impacts per foot of cut, while abrasive usage impacts are reduced by 5% - 10% compared with per foot of cut without the abrasive management system.

# Sensitivity Analysis

## Per Foot of Cut, Abrasive Management System ONLY (AKA EcoSift)



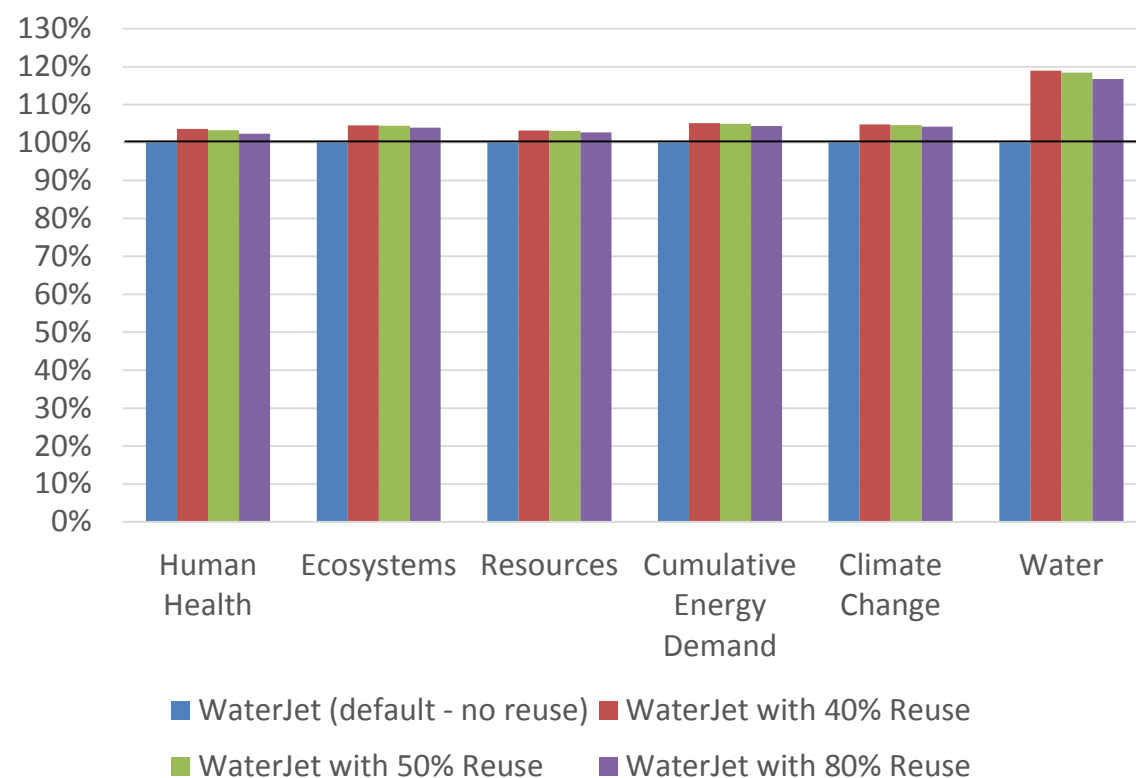
The majority (64% - 81%) of the per foot of cut impacts of just the abrasive management system come from electricity usage in all categories, except water.



# Sensitivity Analysis

## Abrasive Management System and Abrasive Reuse

Per foot of cut, cradle-to-grave, no scrap



Over the lifetime of the WaterJet Cutting System:

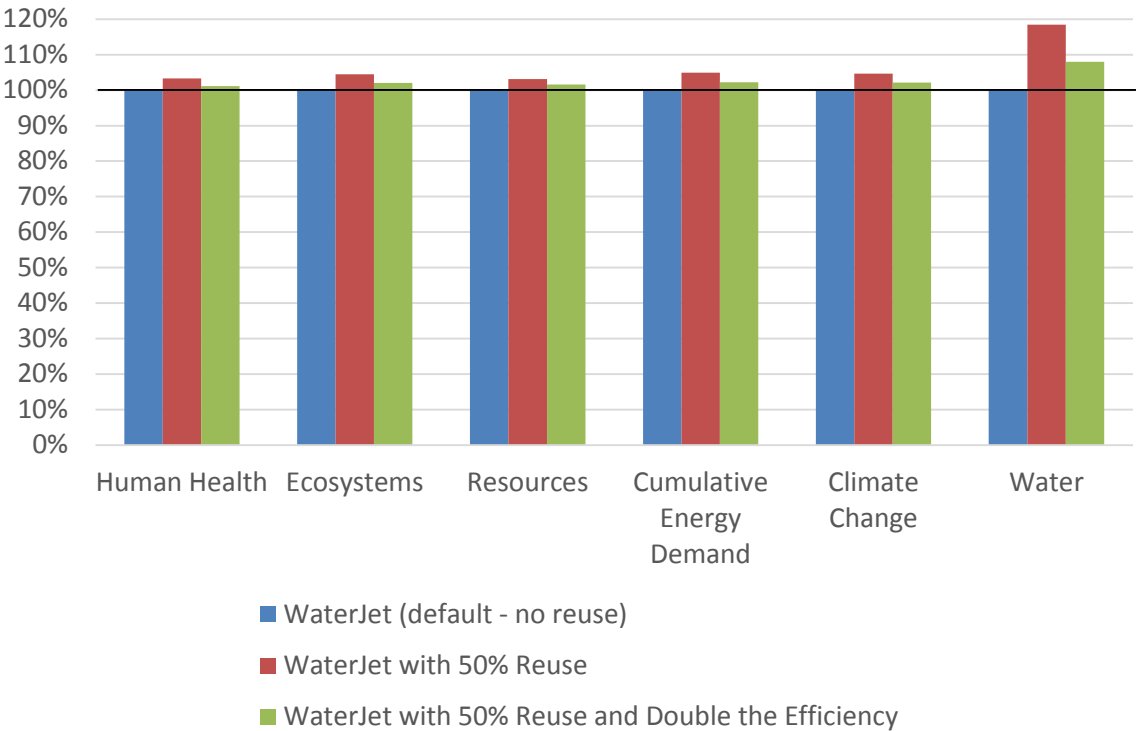
- 1,815,000 pounds of abrasive are consumed and landfilled.
- 454 tons can be diverted from the landfill if the abrasive management system is used at a 50% reuse rate.

Utilizing the Abrasive Management System for Abrasive Reuse increases the impacts by 2% - 19%. However, because of the amount of abrasive used over the life of the system, this should be investigated further.

# Sensitivity Analysis

## Abrasive Management System and Abrasive Reuse, Double the efficiency

Per foot of cut, cradle-to-grave, no scrap









	Default	Double the efficiency
Electricity (kWh/foot of cut)	0.32	0.16
Compressed Air (CF/foot of cut)	3.99	1.995
Water (Gallons/foot of cut)	2.4	1.2

Doubling the efficiency of the Abrasive Management System only increases the overall impacts by 1% - 8%, instead of 2% - 19% with 50% reuse.

**BIGGER PICTURE**

# Comparison against Reference

Over Lifetime of One WaterJet Cutting System, no scrap

Human Health		Ecosystems	Resources
Yearly emissions of  326 cars <sup>1</sup> 		2 acres  of clear cut forest <sup>2</sup> 	2,460  Barrels of oil <sup>3</sup> 
Cumulative Energy Demand		Climate Change	Water
Yearly electricity use  500 homes <sup>4</sup> 		Yearly emissions of  255 cars <sup>5</sup> 	760,000  Five gallon water jugs 

<sup>1</sup> Based on a car's annual mileage of 12,000 miles and 4.87E-5 DALY per mile.

<sup>2</sup> Based on 1.92E-06 species per year lost per meter squared of forest transformation.

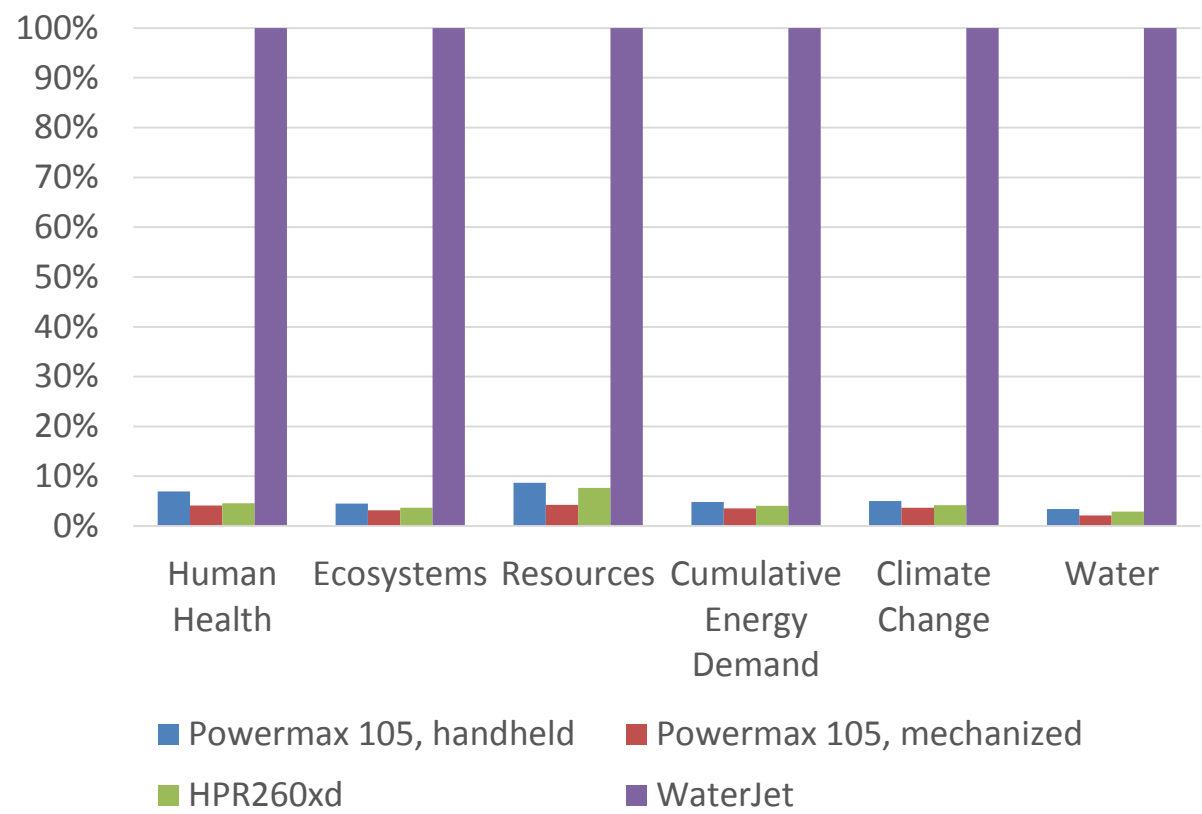
<sup>3</sup> Based on 0.17 \$/kg, oil density of 873 kg/m<sup>3</sup>, 42 gallons per barrel.

<sup>4</sup> Based on average U.S. home consuming 11,280 kWh and 3.6 kWh per MJ.

<sup>5</sup> Based on a car's annual mileage of 12,000 miles and 3.48E-5 kg CO<sub>2</sub> eq. per mile.

# Comparison with other tools

Per foot of cut, cradle-to-grave, 3/4" thick mild steel, no scrap



	Electricity Usage (kWh/foot of cut)
Powermax 105, handheld	0.0913
Powermax 105, mechanized	0.0913
HPR260xd	0.102
WaterJet	2.1

The WaterJet Cutting System results in 1 to 2 magnitude more impacts than the Powermax 105 handheld and mechanized, and the HPR260xd.

# Comparison with other tools

Per foot of cut, cradle-to-grave, 3/4" thick mild steel, no scrap

Impact Category	Powermax 105, handheld	Powermax 105, mechanized	HPR260xd	WaterJet
Human Health (DALY)	3.75E-07	2.20E-07	2.47E-07	5.73E-06
Ecosystems (species.yr)	1.22E-09	8.66E-10	1.00E-09	2.78E-08
Resources (\$)	1.10E-02	5.36E-03	9.66E-03	1.29E-01
Cumulative Energy Demand (MJ)	2.14E+00	1.57E+00	1.78E+00	4.49E+01
Climate Change (kg CO2-eq)	1.30E-01	9.38E-02	1.07E-01	2.63E+00
Water (m3)	1.07E-03	6.66E-04	8.98E-04	3.17E-02



# Key Findings & Observations

- The WaterJet Cutting System per foot of cut impacts come from the scrap (46% - 56%), electricity (15% - 31%) and abrasive (12% - 25%) usage, except in the water category.
  - ~50% of the abrasive impacts come from transportation.
- The majority of the impacts (58% - 70%) of the HyPrecision 50S System come from the 50 HP Motor, the Electrical enclosure Assy, the Frame and the Abrasive Pot.
- When the Abrasive Management System is included, the impacts increase by 2% – 19% per foot of cut.
  - The majority of the per foot of cut Abrasive Management System impacts come from the electricity usage.
  - Doubling the efficiency only increases the overall impacts by 1% - 8%.
  - 454 tons can be diverted from the landfill if the Abrasive Management System recovers 50% of the abrasive.

# Next Steps

- Research ways to reduce HyPrecision 50S WaterJet Cutting System electricity usage.
- Promote on-site renewable energy at consumer sites.
- Understand the use of abrasive and how customers are using, reusing and disposing of it, and revise model as necessary.
- Research ways to reduce Abrasive Management System electricity usage.
- Investigate ways to reduce abrasive usage.
- Encourage purchasing abrasive produced domestically to reduce transportation impacts.