Semi-Fab LCA

Technical Toolkit

Choose
Aluminum

Goal and Scope of Study

Goal:

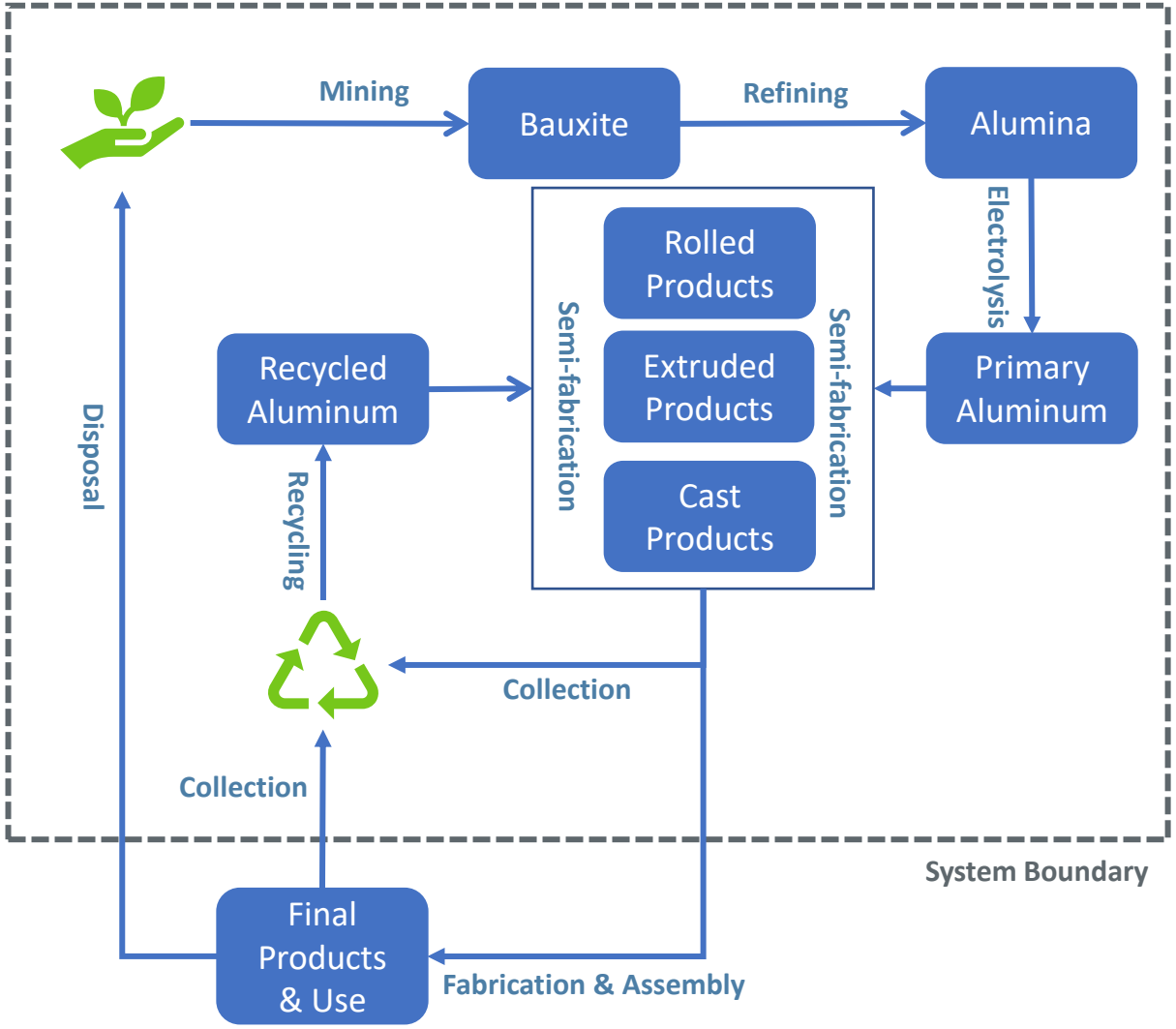
- Provide up-to-date information to serve the demand of LCA data in downstream market and help the industry and stakeholders better understand the potential environmental impact of aluminum products.

Scope:

- Product systems include primary aluminum, recycled aluminum, and semi-fabricated aluminum (extruded, rolled and casted).
- The products serve as raw materials or intermediate products. The functional unit is 1,000 kg.

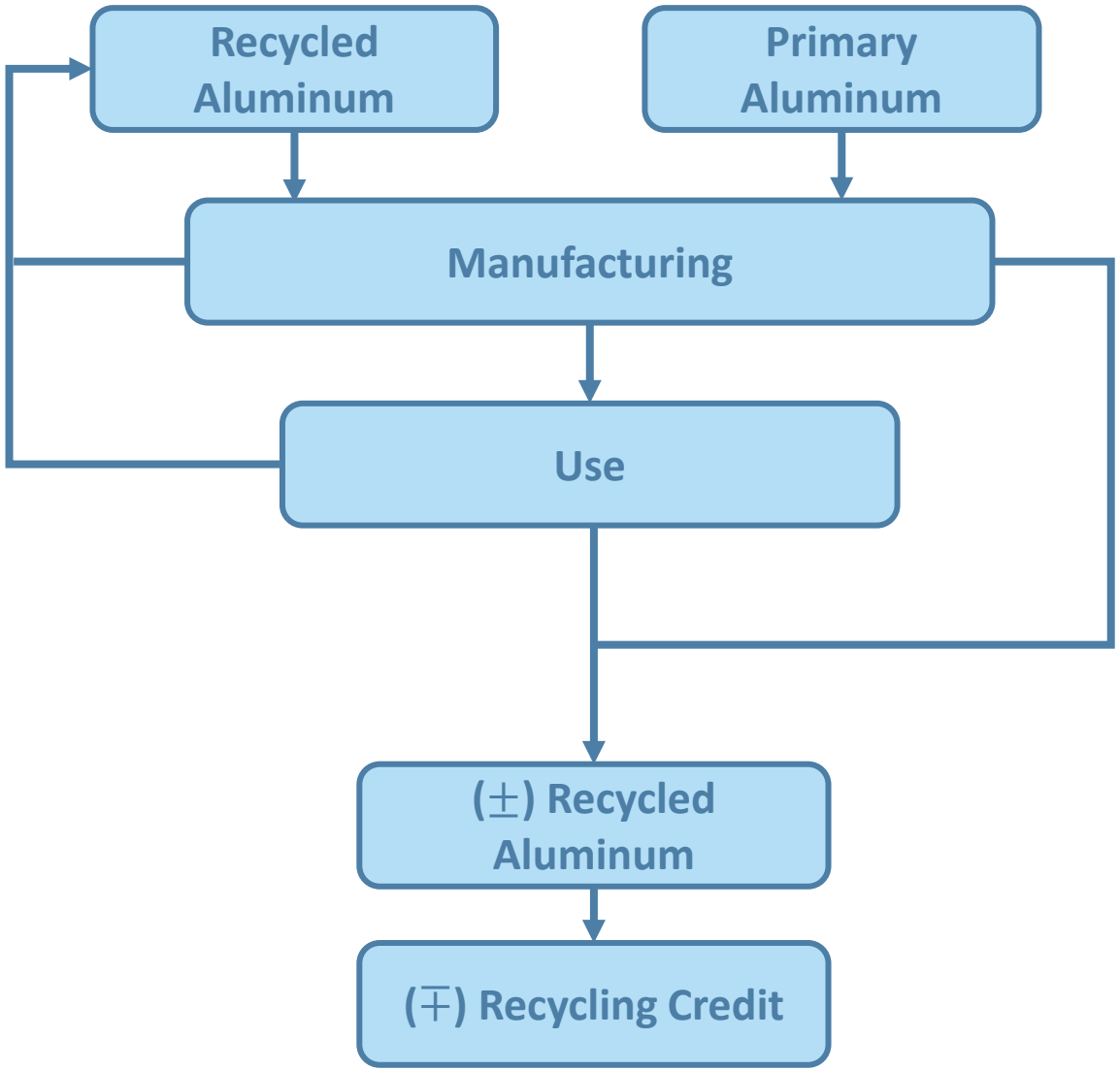
Understanding Jargon

- Cradle-to-gate refers to a partial product life cycle from raw material extraction (cradle) to the completion of the manufacturing process(es)
- Cradle-to-grave is a full product life cycle from raw material extraction to product manufacturing, use and end-of-life recycling or disposal
- Some cradle-to-grave LCAs exclude the use phase due to uncertainty and complexity



Allocation Method for Recycling

- A “net scrap substitution method” is used for recycling allocation.
- This is a hybrid method of a “cut-off approach” and a “substitution approach”.
- The method is also known as a “Module D approach”.
- From a cradle-to-gate perspective, it is a cut-off approach. From a cradle-to-grave perspective, it is a substitution approach.



Primary Aluminum Environmental Footprint

Environmental footprint of 1000 kg primary aluminum (cradle-to-gate, North American production mix)

Inventory parameter	Unit	Bauxite mining	Alumina refining	Electrolysis	Cast house	Total
Primary energy demand	GJ	0.61	32.87	99.93	1.91	135.32
Global warming potential	kg CO2e	48.49	2801.58	5489.62	115.62	8455.31
Acidification potential	kg SO2e	0.24	10.96	25.54	0.25	36.99
Eutrophication potential	kg Ne	0.01	0.47	0.33	0.01	0.82
Smog formation potential	kg O3e	2.81	184.31	81.35	5.40	273.87

Recycled Aluminum Environmental Footprint

Environmental footprint of 1000 kg recycled aluminum (cradle-to-gate, 100% scrap)

Assessment Parameter	Unit	Scrap Processing, Melting and Casting	Dross & Salt Cake Recycling	Primary Ingot	Total
Primary energy demand	GJ	9.14	0.04	0.00	9.18
Global warming potential	kg CO2e	524.59	2.13	0.00	526.71
Acidification potential	kg SO2e	0.86	0.00	0.00	0.87
Eutrophication potential	kg Ne	0.04	0.00	0.00	0.04
Smog formation potential	kg O3e	15.56	0.08	0.00	15.64

Cradle-to-Gate Environmental Footprint

Cradle-to-gate environmental footprint of 1000 kg semi-fabricated aluminum

Assessment Parameter	Extrusion	Sheet	Foil	Die Cast	Automotive Extrusion	Automotive Sheet
Primary energy demand (GJ)	102.38	66.72	78.87	48.76	78.97	126.14
Global warming potential (kg CO2 e.)	6213.222	3978.32	4653.41	2898.98	4739.43	7744.79
Acidification potential (kg SO2 e.)	23.77	13.81	15.39	9.66	17.04	31.68
Eutrophication potential (kg N e.)	0.64	0.39	0.46	0.28	0.49	0.79
Smog formation potential (kg O3 e.)	225.73	140.21	159.59	96.23	169.01	287.04

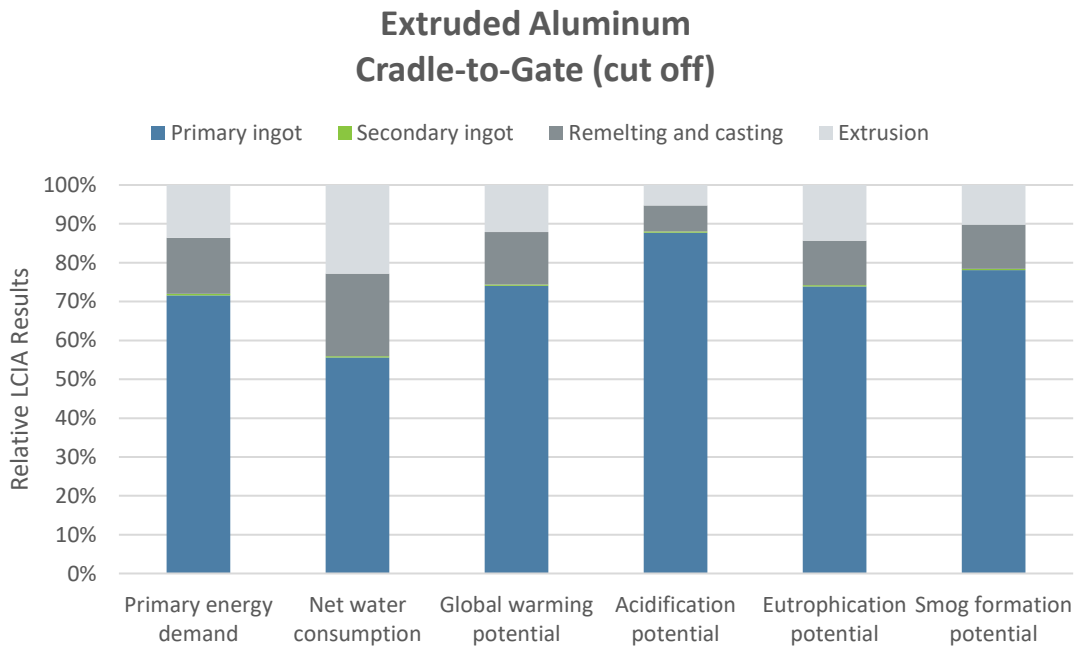
Cradle-to-Grave Environmental Footprint

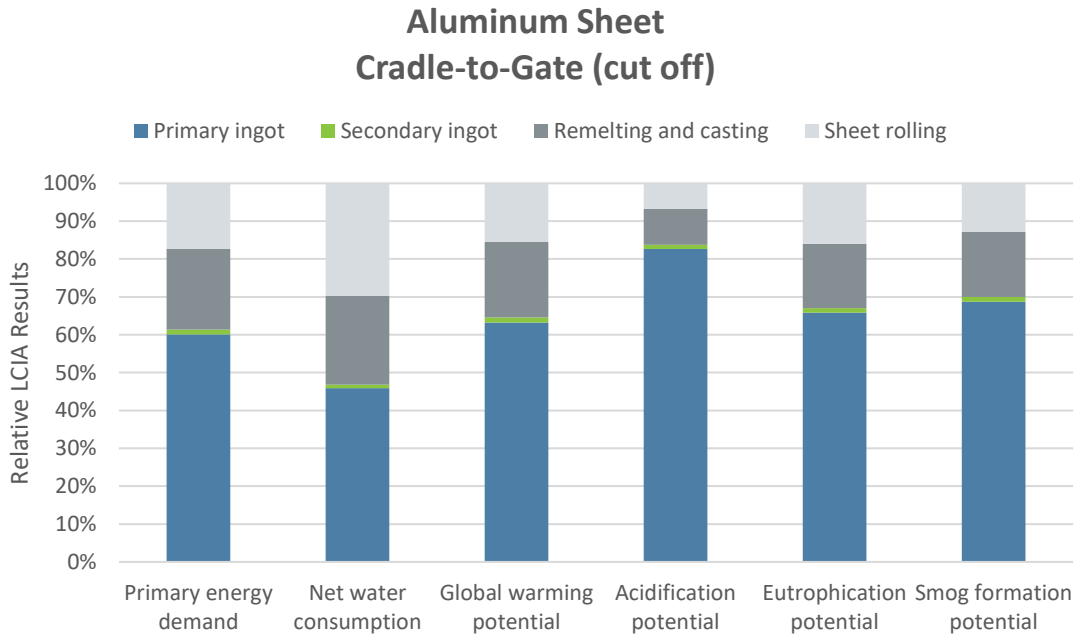
Cradle-to-grave environmental footprint of 1000 kg semi-fabricated aluminum

Assessment Parameter	Extrusion	Sheet	Foil	Die Cast	Automotive Extrusion	Automotive Sheet
Primary energy demand (GJ)	46.28	49.79	57.30	29.25	45.93	**35.96**
Global warming potential (kg CO2 e.)	2667.42	2903.98	3286.18	1666.76	2649.77	**2044.85**
Acidification potential (kg SO2 e.)	6.99	8.741	8.94	3.82	7.16	**4.69**
Eutrophication potential (kg N e.)	0.27	0.28	0.32	0.16	0.27	**0.19**
Smog formation potential (kg O3 e.)	**88.04**	**98.75**	**106.75**	**48.38**	**87.98**	**65.54**

Energy Key Driver of Cradle-to-Gate Footprint

The environmental footprint of aluminum products is driven by primary aluminum content, which is in-turn driven by the high energy demand for smelting.





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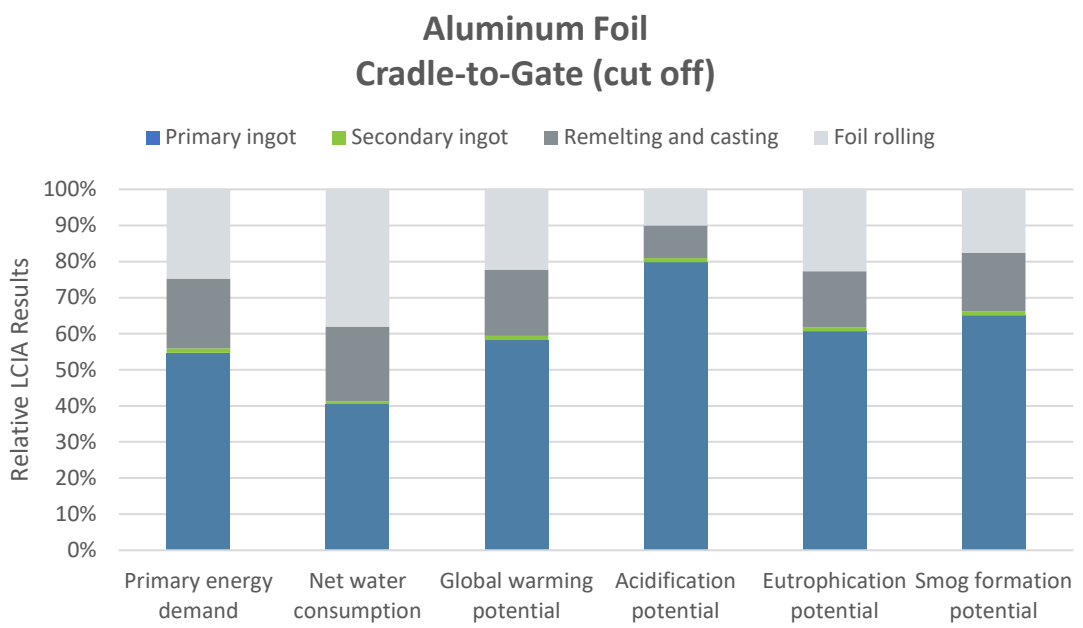
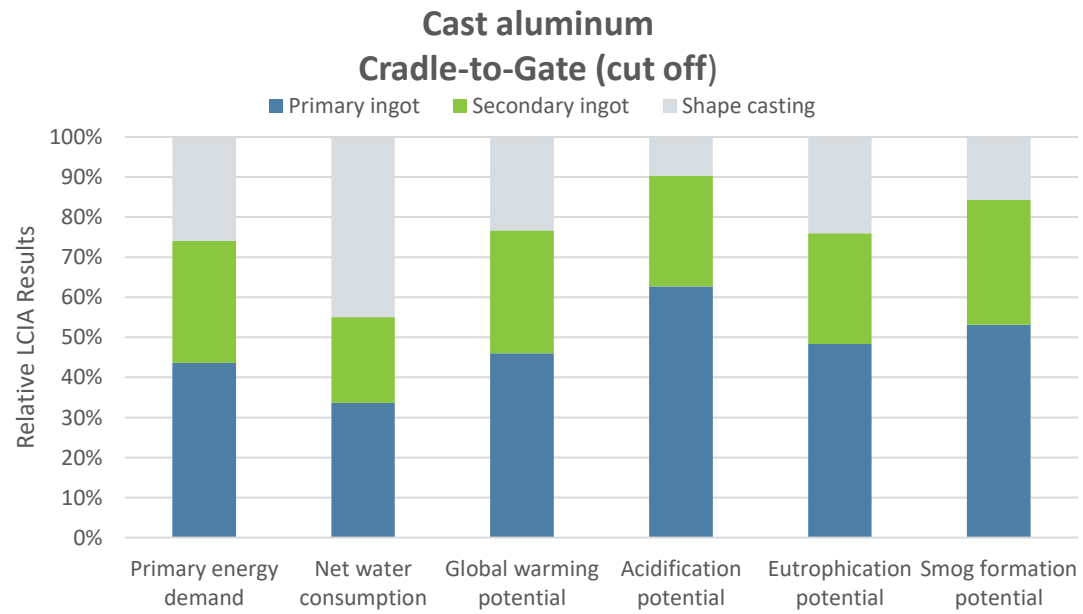
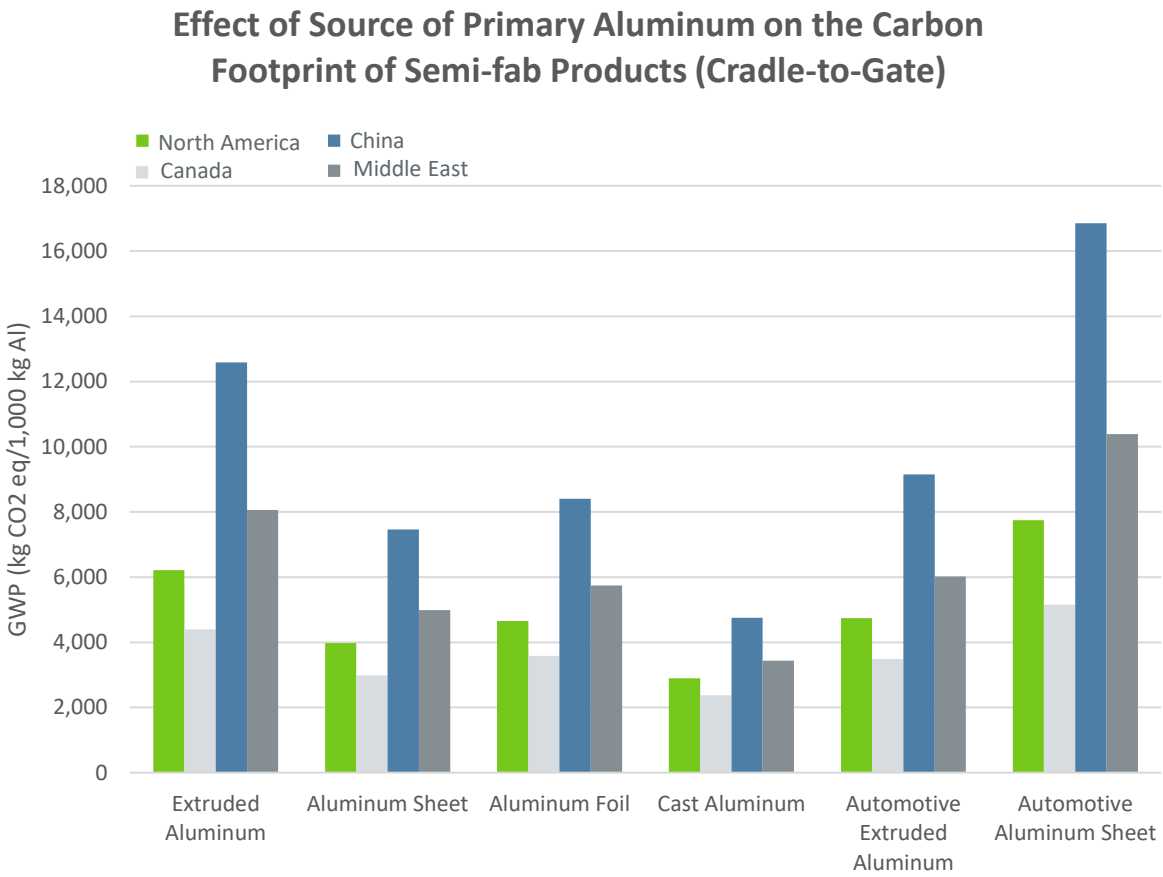




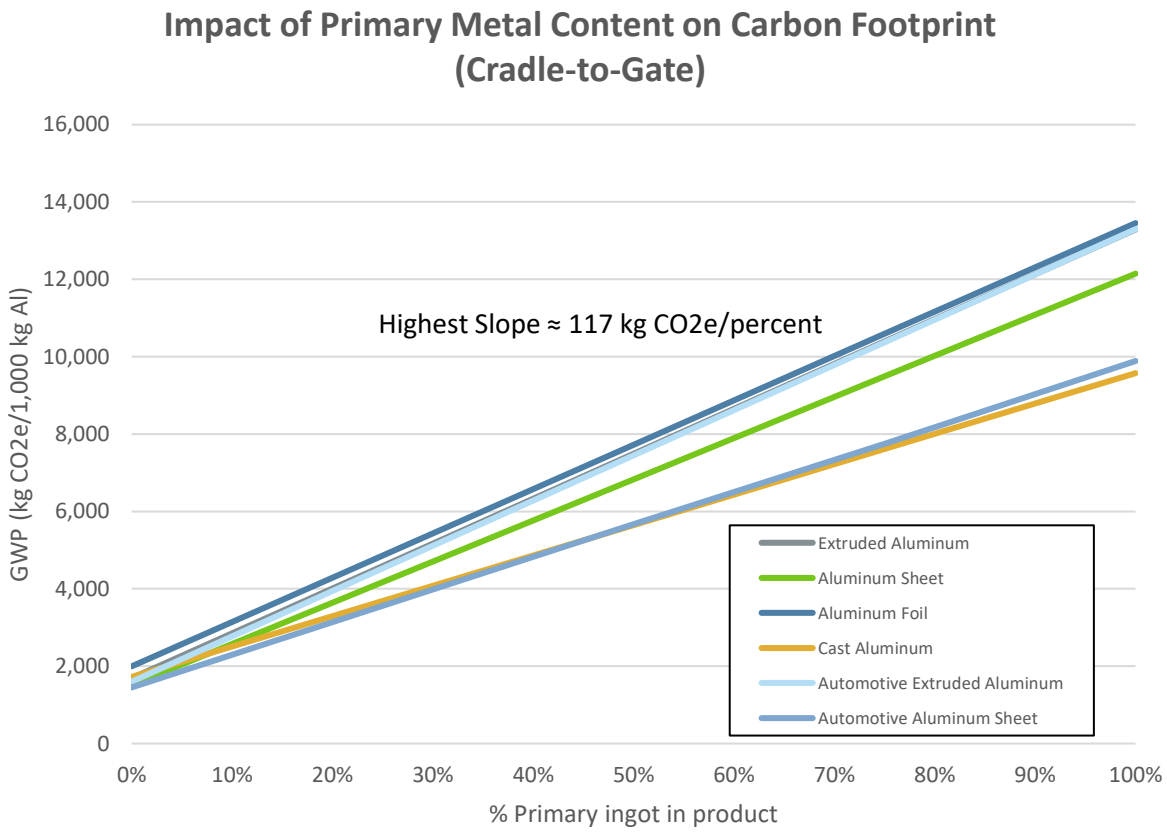
Sourcing Low Footprint of Primary Aluminum Can Lower the Overall Cradle-to-Gate Footprint

Not all primary aluminum is created equal. Aluminum smelted with renewable energy electricity can significantly reduce cradle-to-gate footprint of the products.



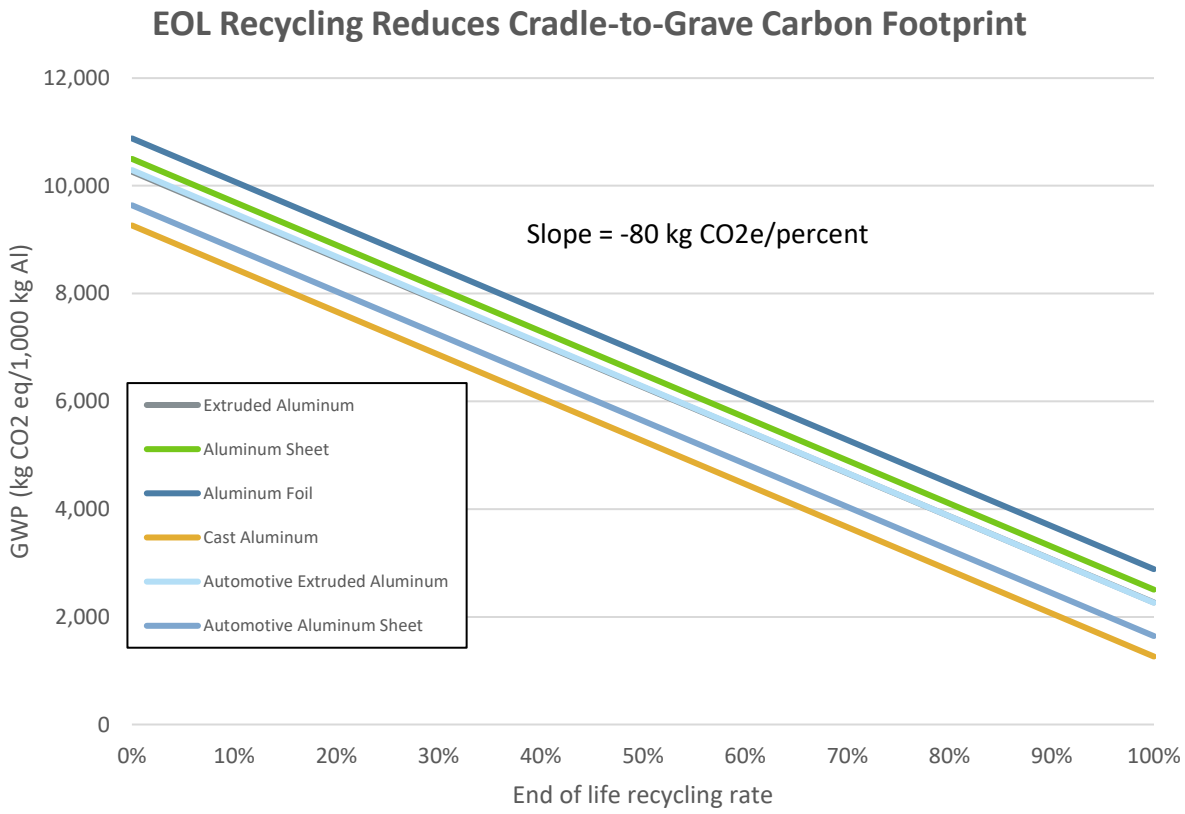
Increased Recycled Content Can Reduce Overall Cradle-to-Gate Footprint

Reducing the use of primary aluminum and increasing the use of recycled aluminum can significantly reduce the cradle-to-gate footprint of products; A one percent reduction of primary aluminum can lead to as much as a 117 kg CO2e carbon footprint reduction for 1000 kg semi-finished products.



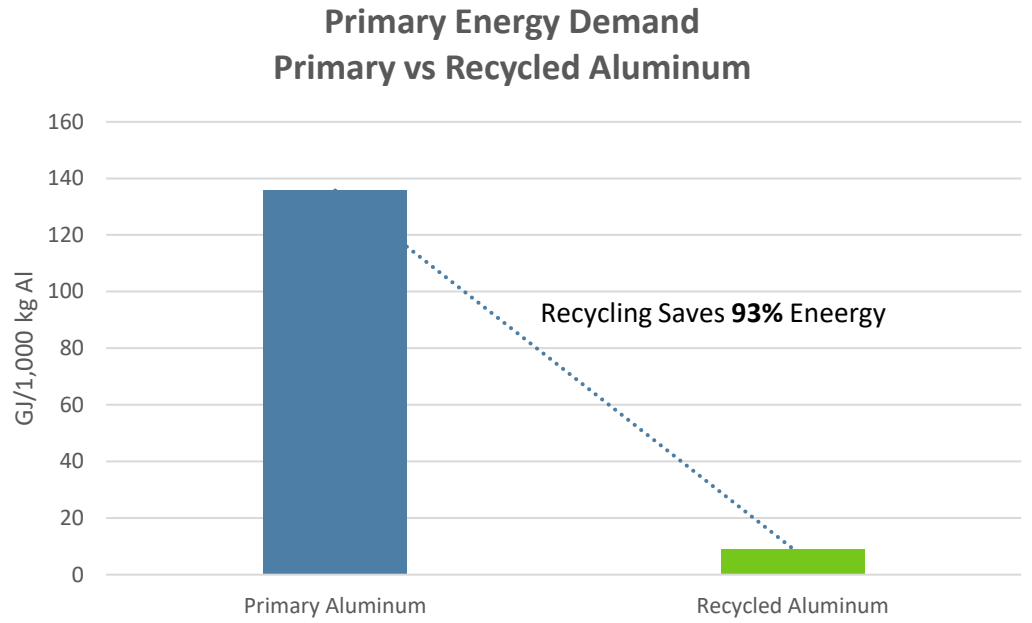
EOL Recycling Reduces Cradle-to-Grave Footprint

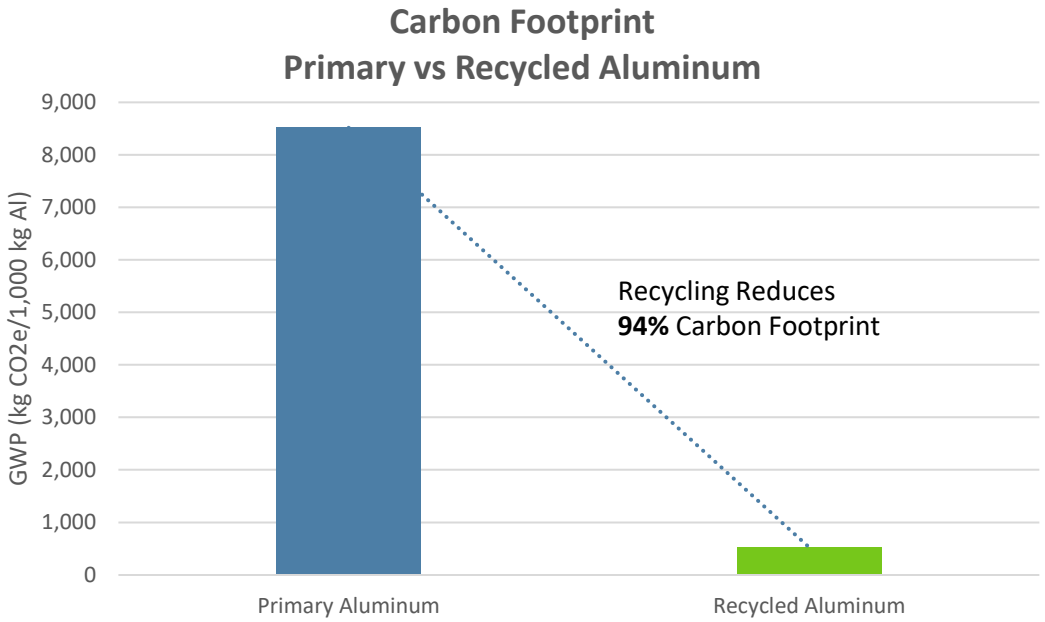
End-of-life recycling is key for reducing the full life cycle environmental footprint of products; A one percent increase in EOL recycling rate can reduce the cradle-to-grave footprint of 1000 kg aluminum products by 80 kg CO2e.



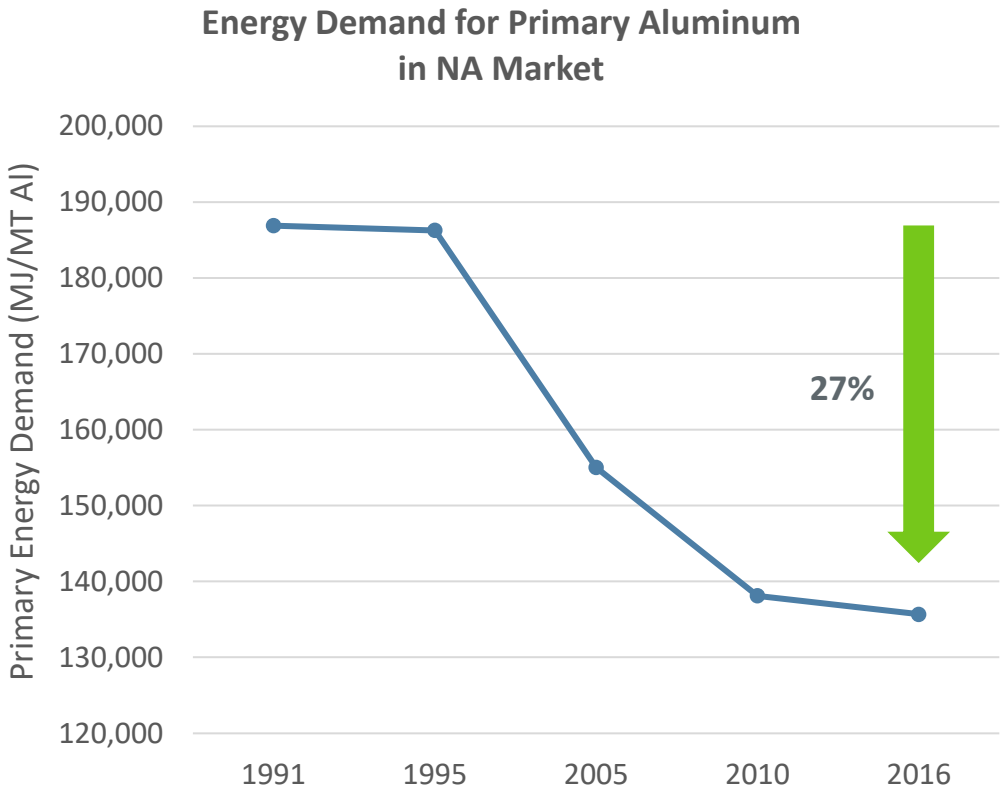
The Environmental Benefit of Aluminum Recycling for Raw Material Production

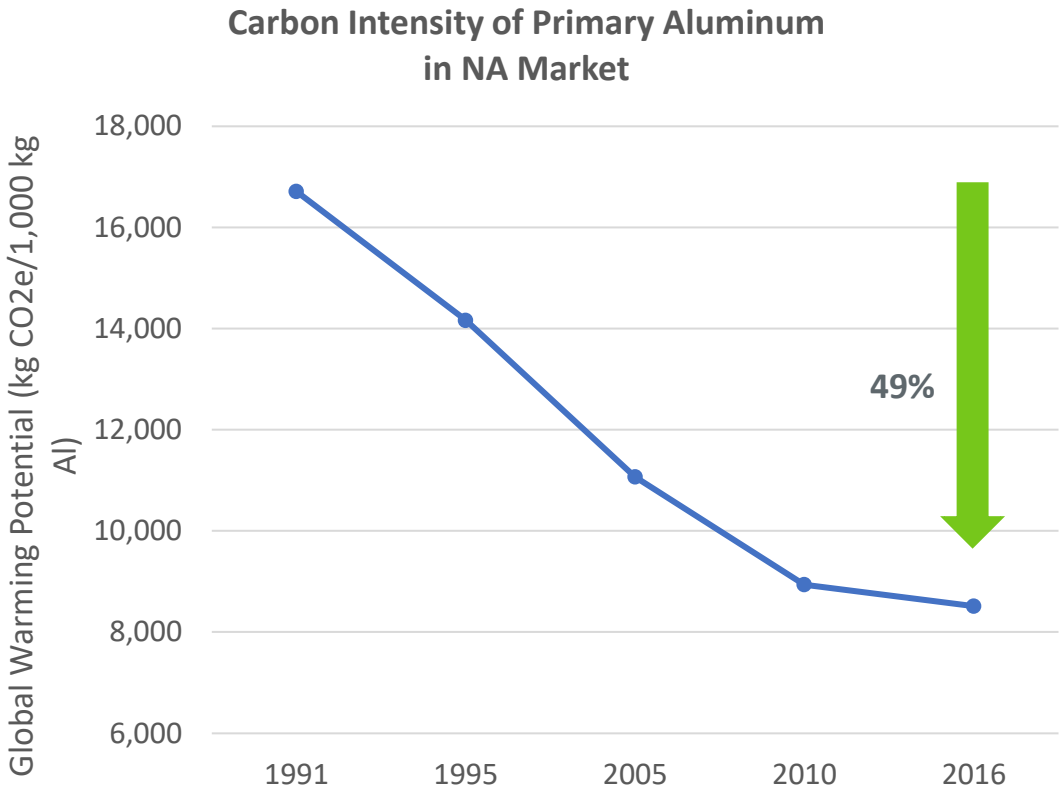
Recycling saves 93 percent of energy; recycling reduces 94 percent of carbon footprint.



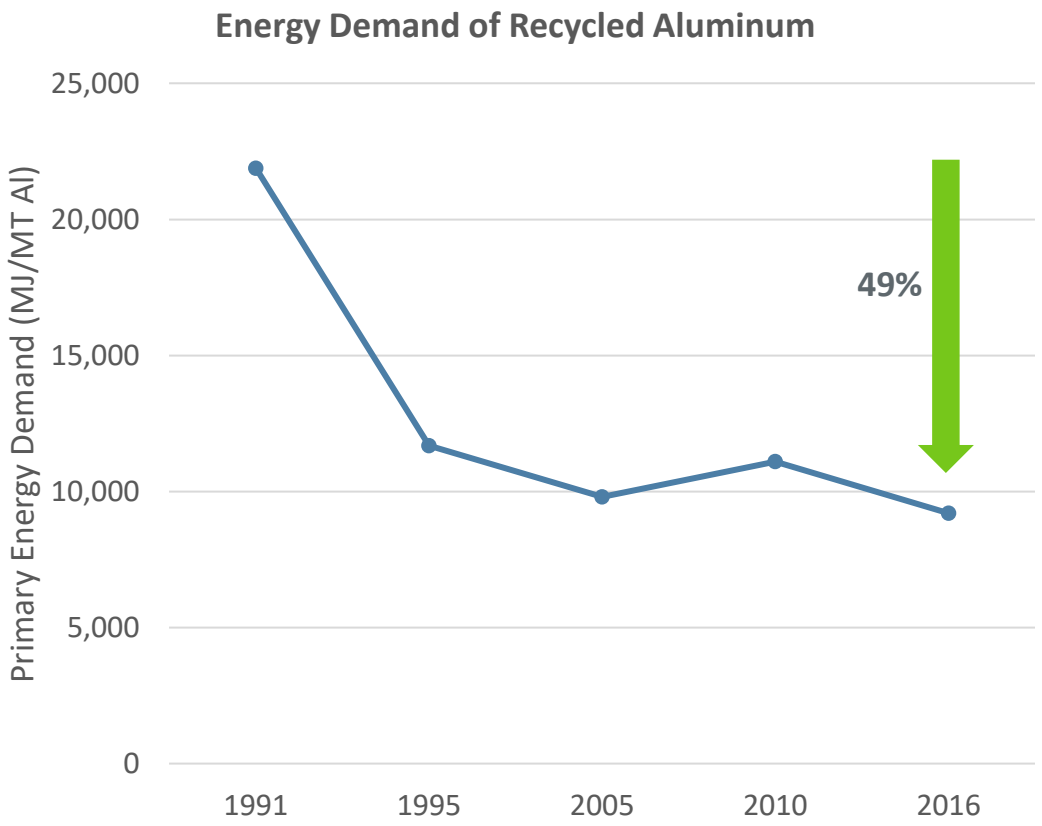


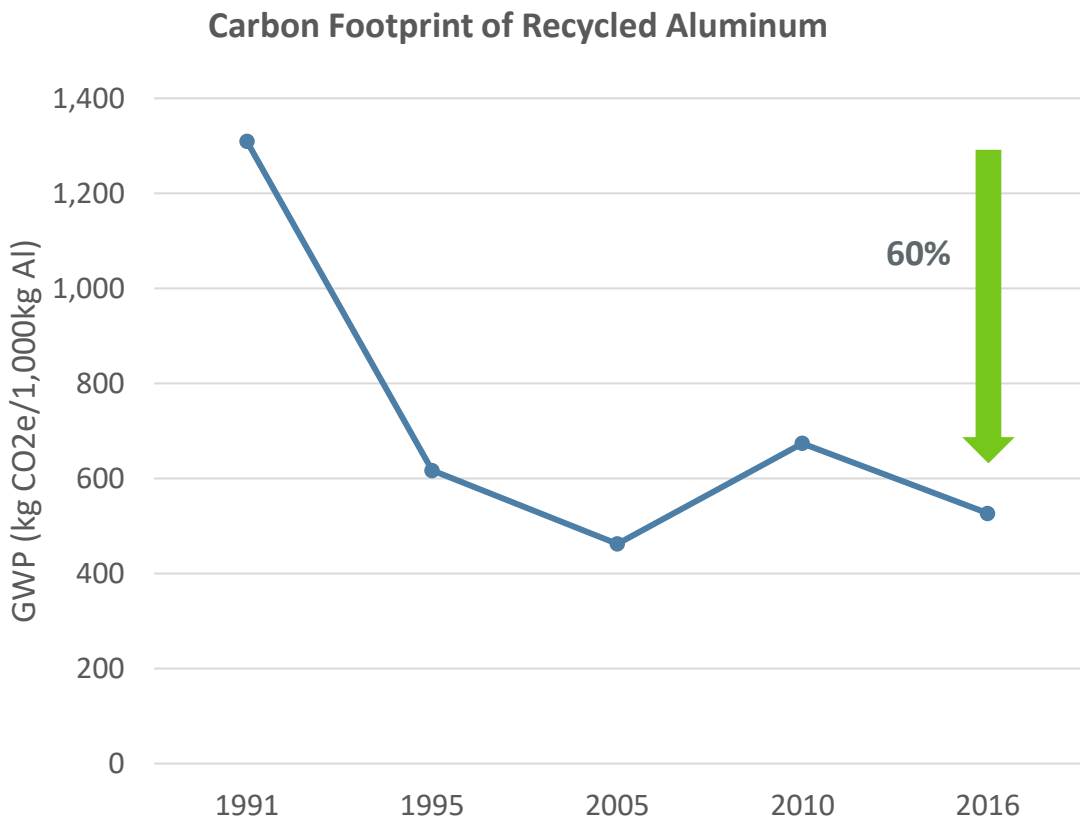
Trends in Primary Aluminum



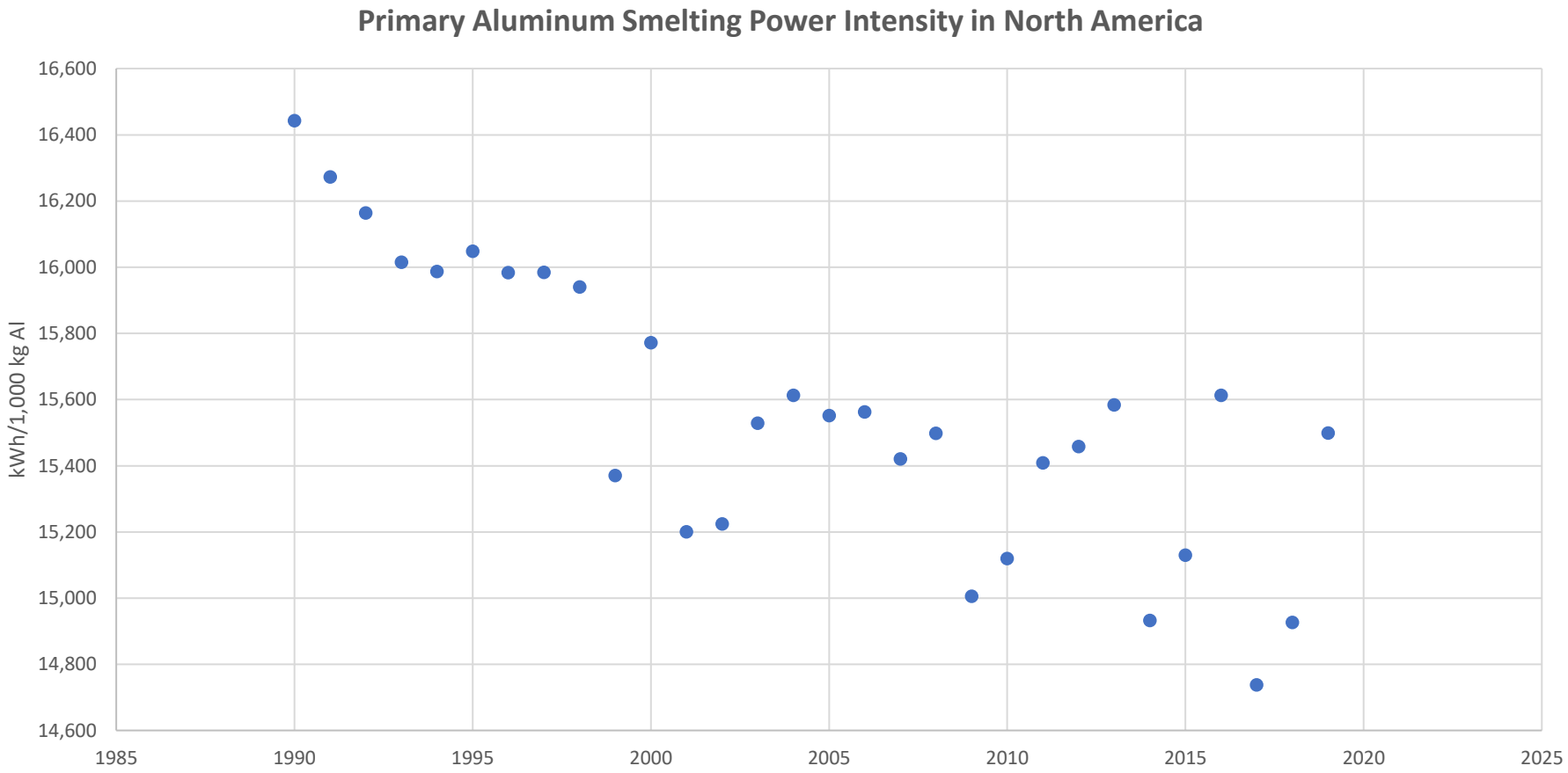


Trends in Recycled Aluminum

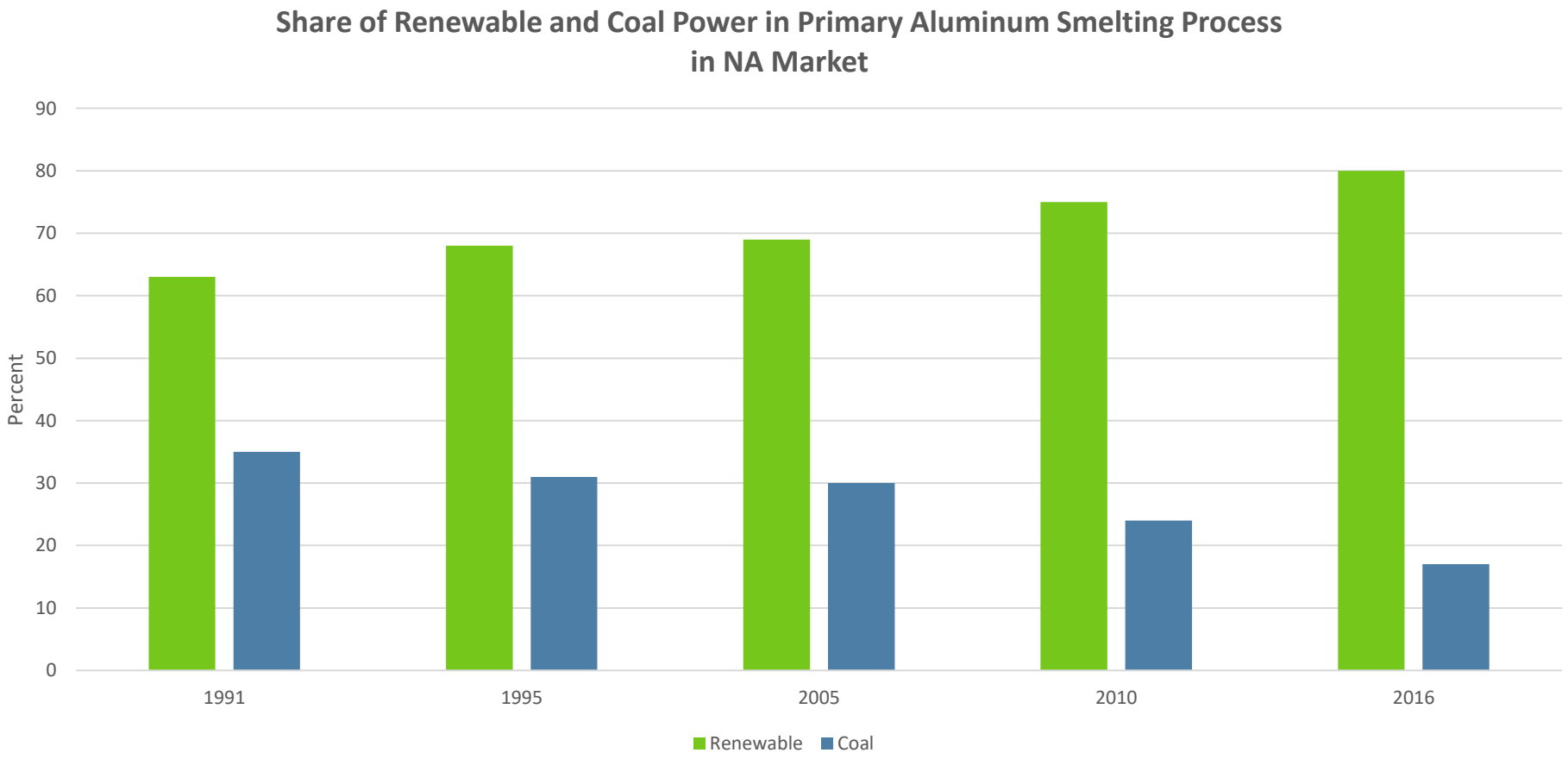




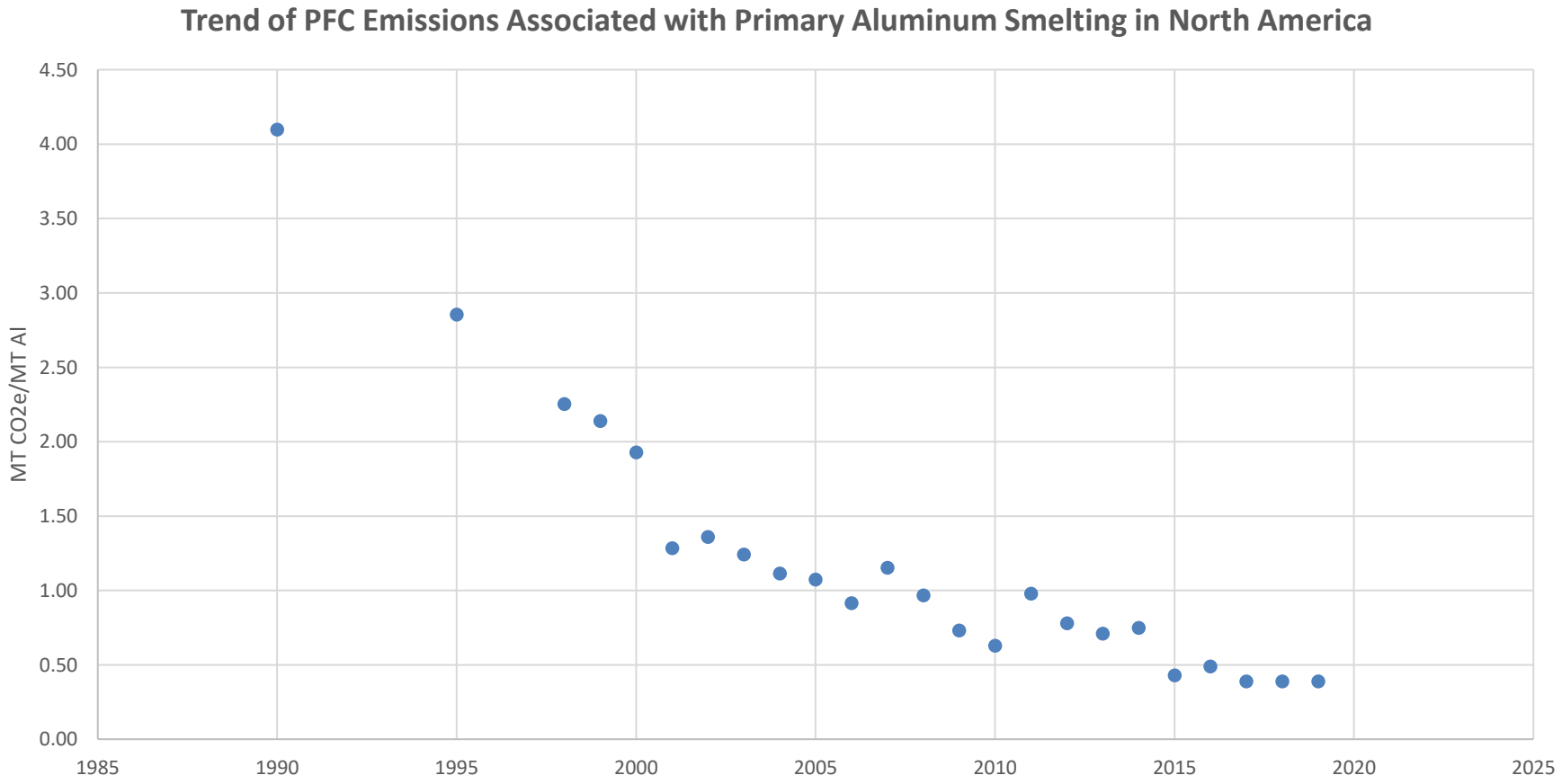
Trends in Primary Aluminum Smelting Electricity Consumption



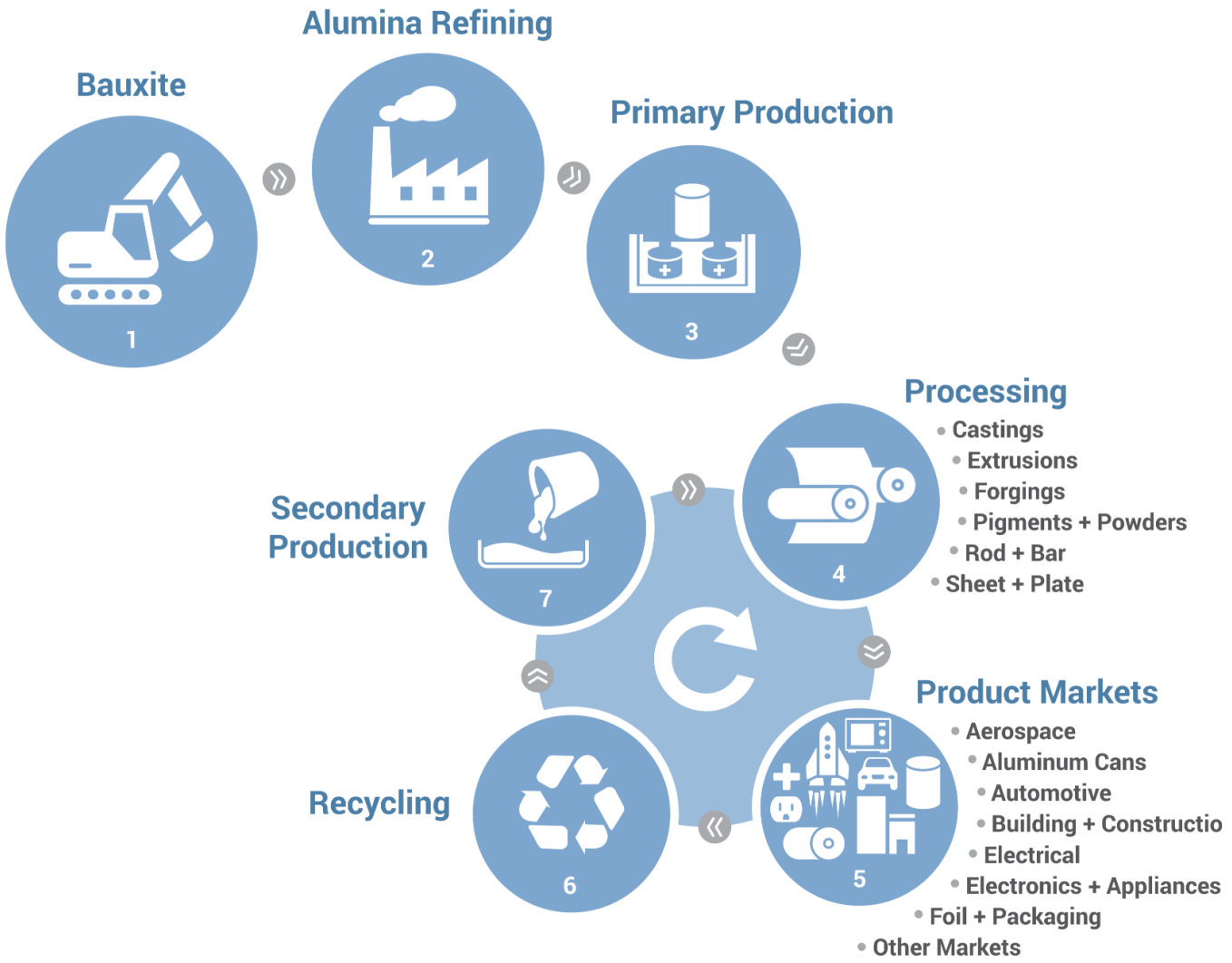
Trends in Primary Aluminum Smelting Power Mix



Trends in PFC Emissions During the Primary Aluminum Smelting Process



Full Life Cycle LCA is Critical



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