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Life Cycle Inventory of Wrought Aluminum Products for Various Usages

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Objective

- The environmental load of wrought aluminum products depends upon the *raw materials mix and process routes* among different kinds of products and alloys.
- Therefore, an LCI study was conducted for the purpose of constructing a database needed for the accurate LCA of various rolled/extruded aluminum products.

Product System

Sheet products

Product	Alloy & Temper	Dimension	Remarks
Can body stock (3004)	3004-H19	0.3mmt- 1,200-1,500mmw	
Can end stock (5182)	5182-H19	0.25mmt- 1,500-1,655mmw	coated
Can end stock (5182)	5182-H19	0.25mmt- 1,655mmw	non-coated
Foil stock (1000s)	1N30-H14	0.28-0.35mmt- 1,000-1,500mmw	
PS plate (1000s)	1050-H18	0.24mmt- 1,030mmw	
Sheet for construction (1000s)	1100s-H14	2.0mmt- 1,000 × 2,000mm	
Fin stock (1000s)	1000s-H26	0.115mmt-700-1,200mmw	with surface treatment
Common alloy sheet (5052)	5052-H32	2.0mmt-1,000 × 2,000mm	

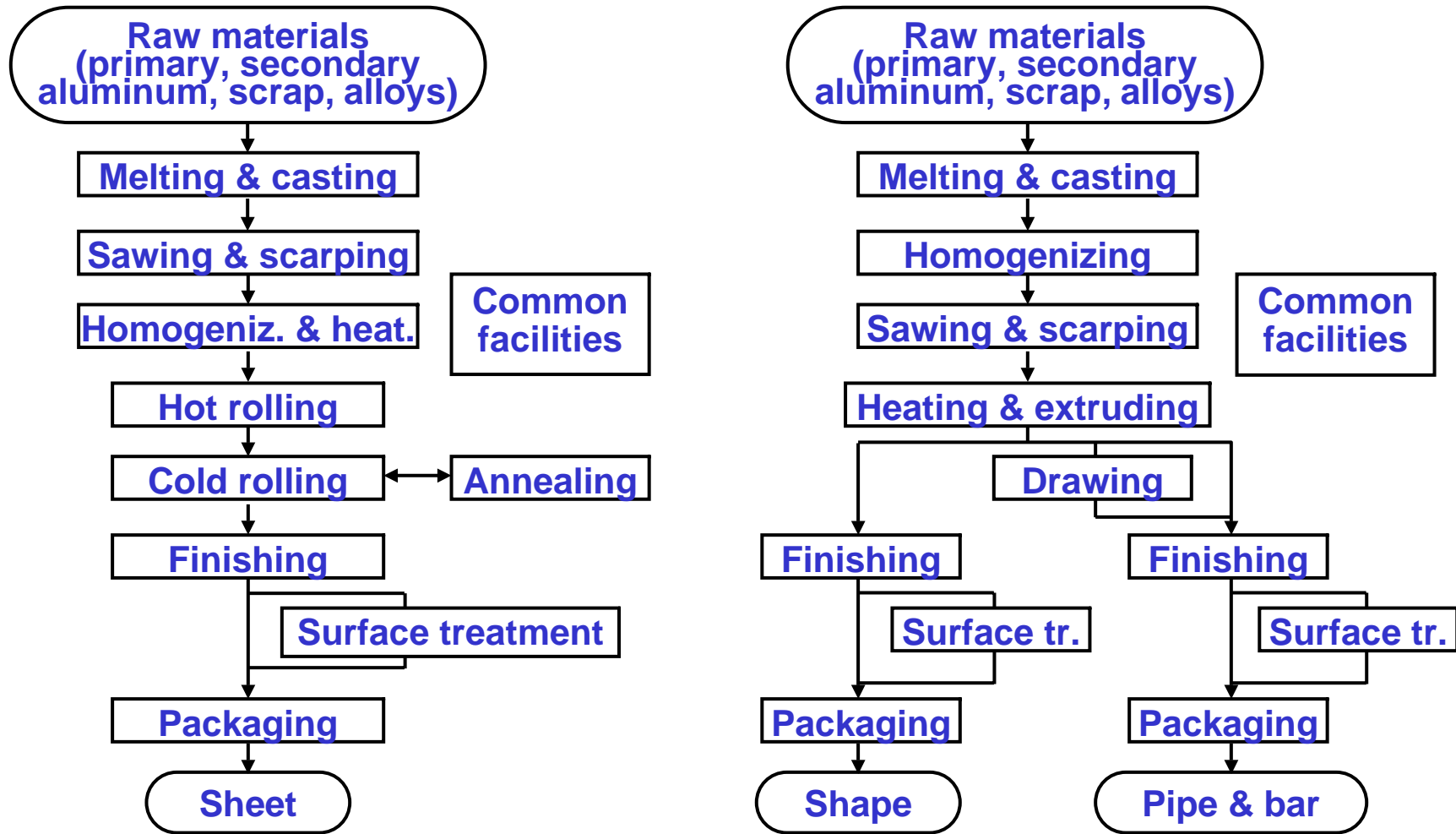
Product System

Extruded products

Product	Alloy & Temper	Dimension	Remarks
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Shape (for heat exchanger)	1000s-H112	approx. 100 mmw	direct extrusion for multi-hole evaporator
Large shape (6063)	6063-T5	Billet dia. 11-16 inch	direct extrusion
Small shape (6063)	6063-T5	Billet dia. 7-8 inch	direct extrusion
Bar (2000s)	2017-T4	Billet dia. 12inch Bar size 60mm	indirect extrusion
Pipe (5000s)	5056-H34	Billet dia. 7-9inch Pipe size 50mm	indirect extrusion -drawing
Shape for rim (7000s)	7N01-O	Billet dia. 8-10inch	Direct extrusion

Data Collection

~ Process flow ~



Data Collection

~ Time period & data coverage ~

- Foreground data:
 - collected from seven major aluminum companies in Japan
 - 100 % of energy consumption and over 99% of the accumulated weight of raw materials and auxiliary materials were covered.
- Time period:
 - Overall process data on sheet, pipe, bar and shape products, in 1996FY.
 - Raw materials mix, process yield, energy consumption were re-collected on various kinds of product, in 1998FY.
 - For can body stock, data were reviewed based on the start in operation of new slab making process directly from UBC scrap in 2001.
- Data coverage:
 - 60-80 % for sheet products.
 - 70 % for extruded products.

Data Collection

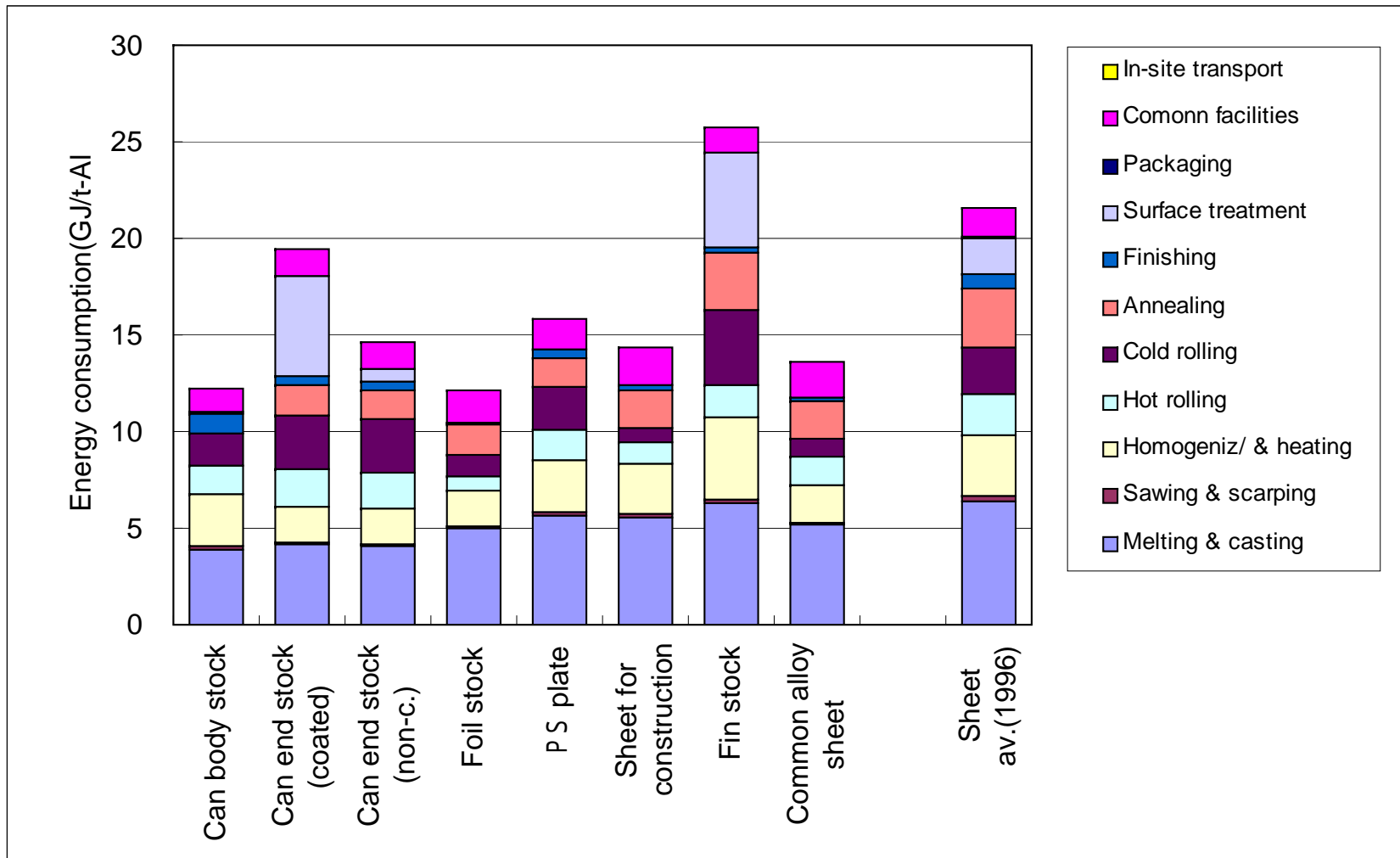
~ Related & background data ~

- For primary aluminum, the inventory was calculated based on the amount imported to Japan in 1998[1] by JAA.
- For secondary aluminum, inventory data on scrap melting in major aluminum companies in Japan were collected.
- For raw materials, auxiliary materials and energy, various database and literatures were referred to establish the inventory data necessary for the calculation of LCI.
- CO₂ emission was calculated with the emission factor by Ministry for Environment in Japan.

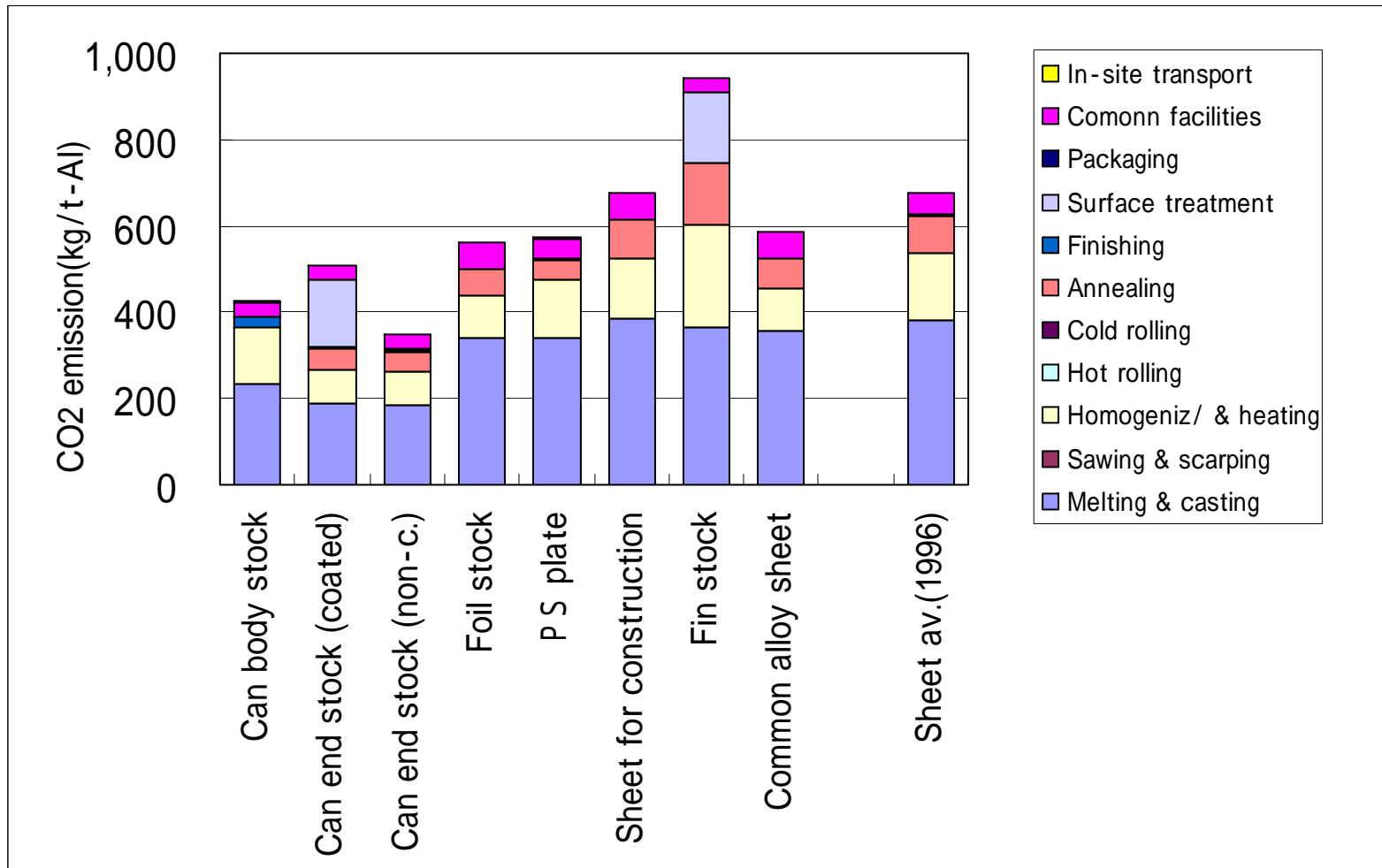
Calculation of Inventory

- Functional unit:
 - 1,000 kg of wrought aluminum products.
- Data processing:
 - Inventory data for each kind of product were accumulated along the process flow.
 - Weighted average of the manufacturers concerned was taken for the inventory of each kind of product based on the amount produced in each manufacturer.
- Allocation:
 - For common facilities and internal transportation, the environmental loads were allocated among kind of products based on the mass processed in hot rolling or hot extrusion process.

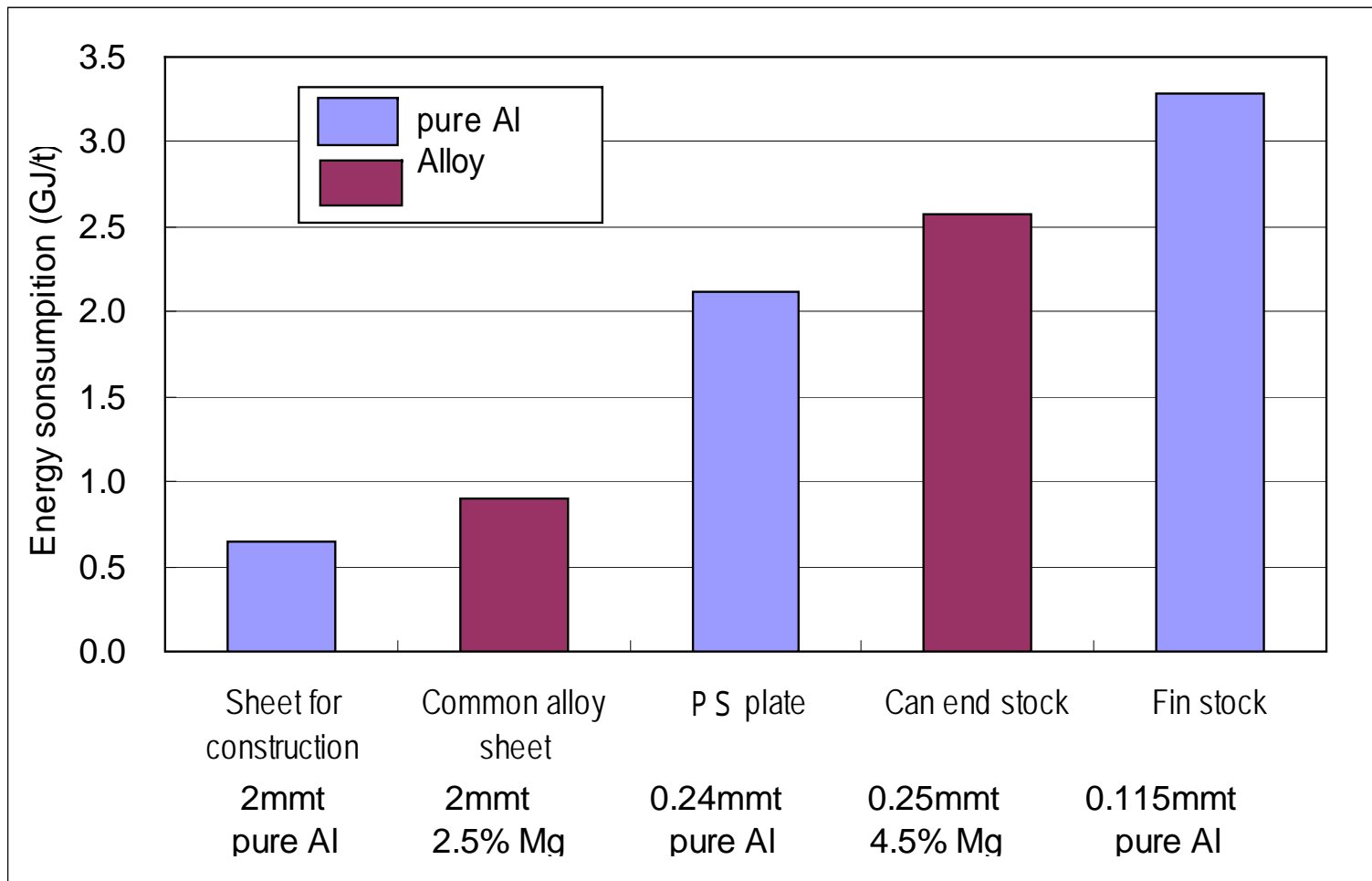
Energy consumption in the manufacturing sheet products



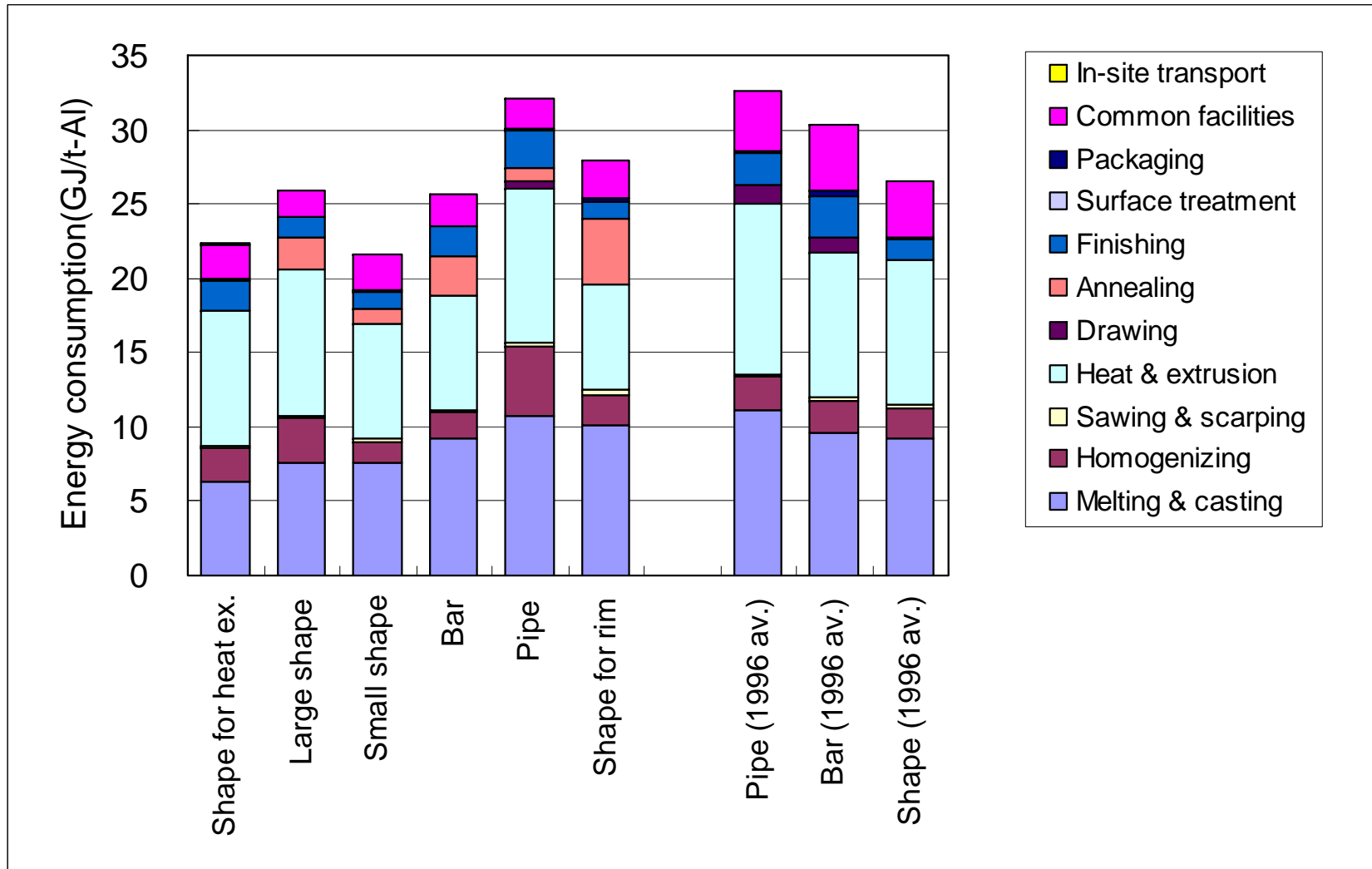
CO₂ emission in the manufacturing sheet products



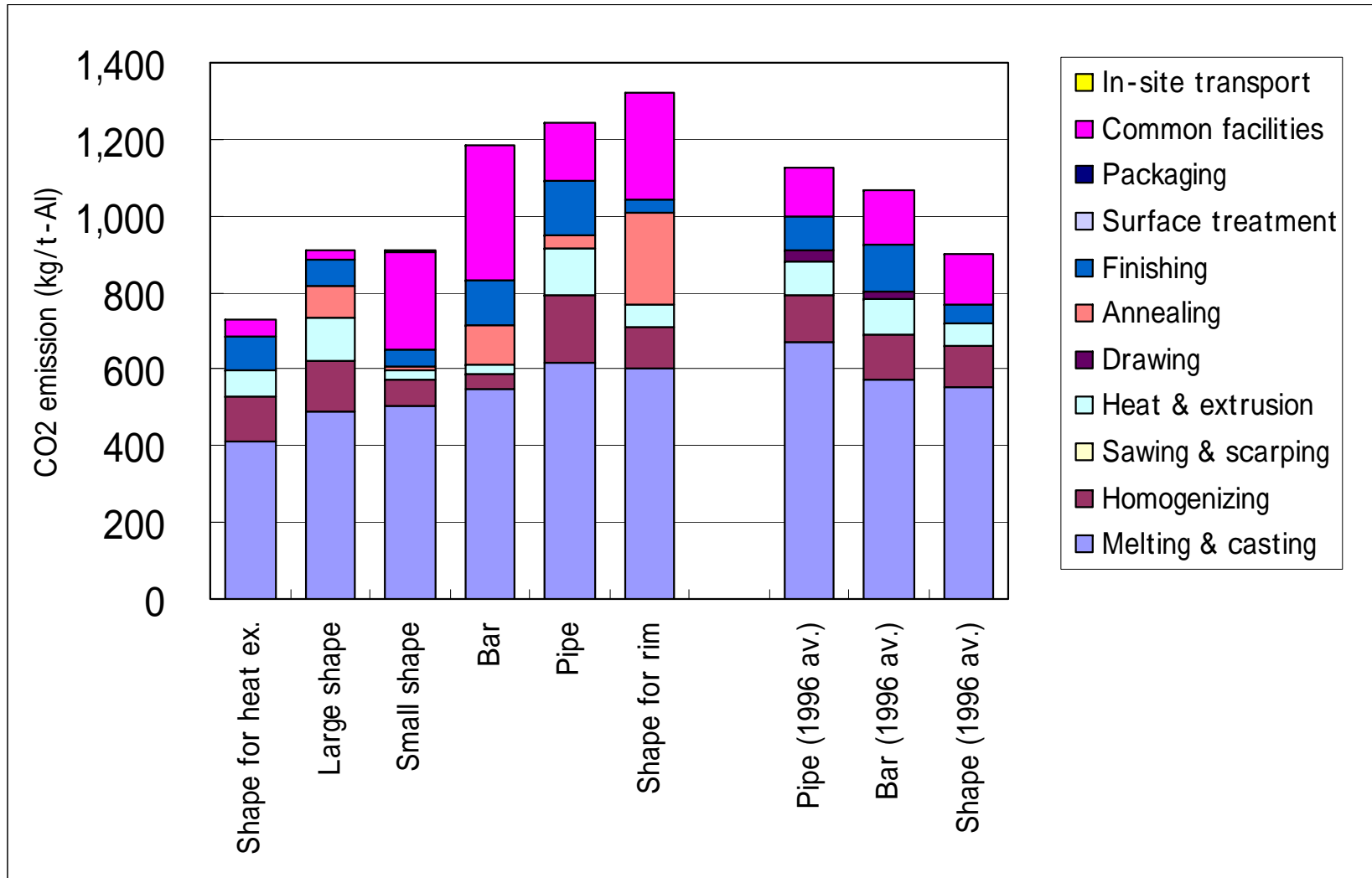
Effect of thickness and chemical composition on energy of cold rolling



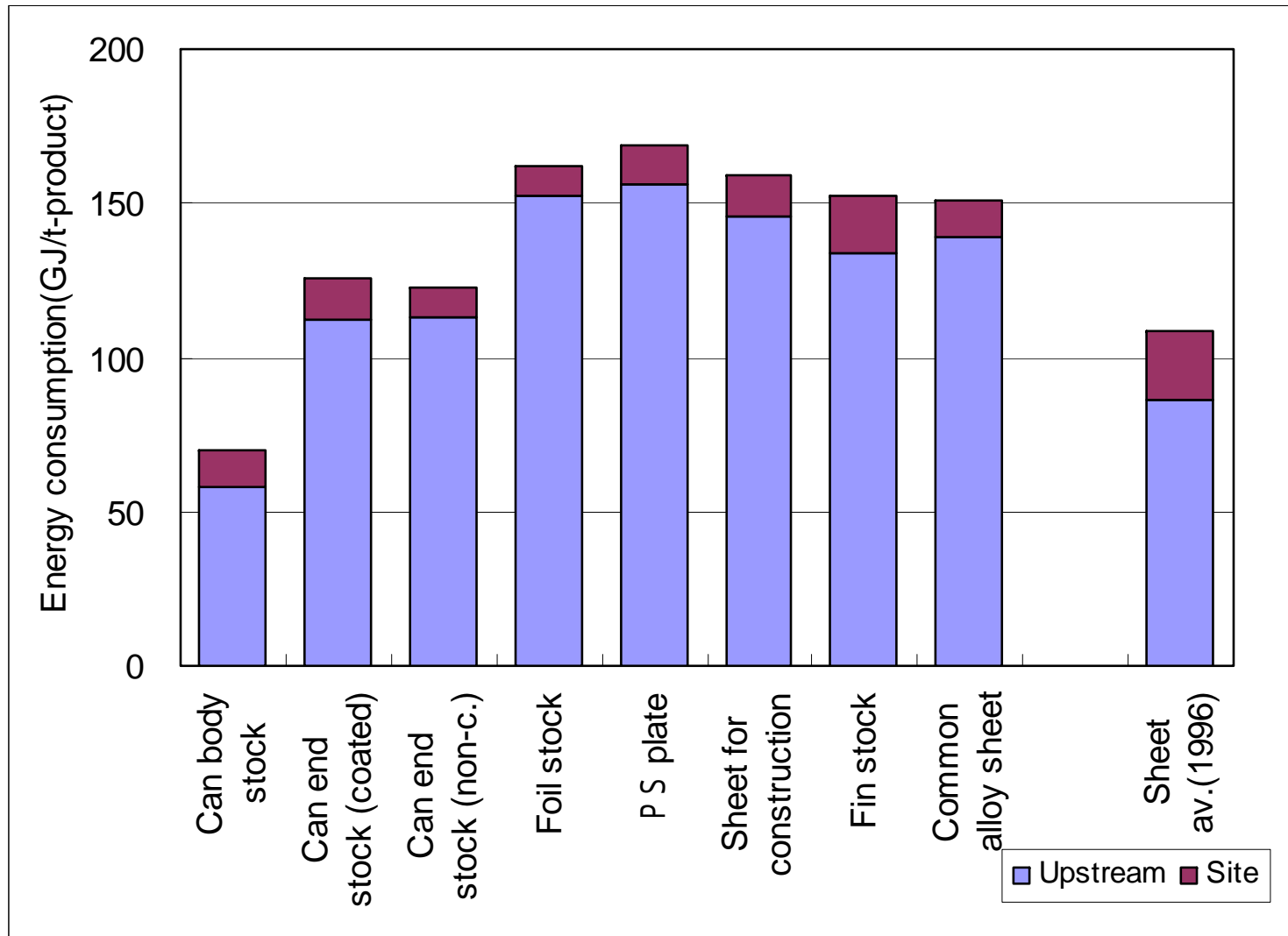
Energy consumption in the manufacturing extruded products



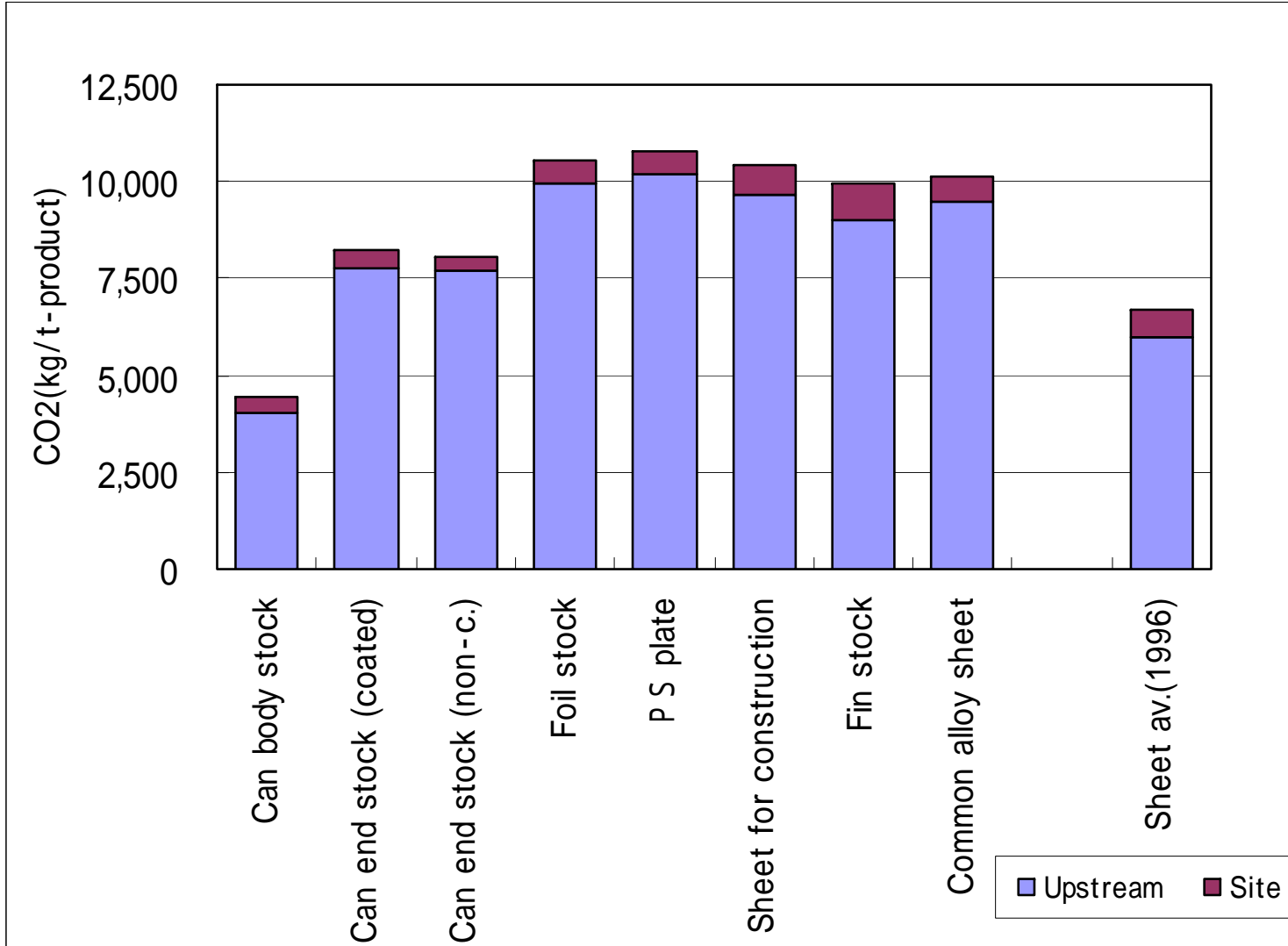
CO₂ emission in the manufacturing extruded products



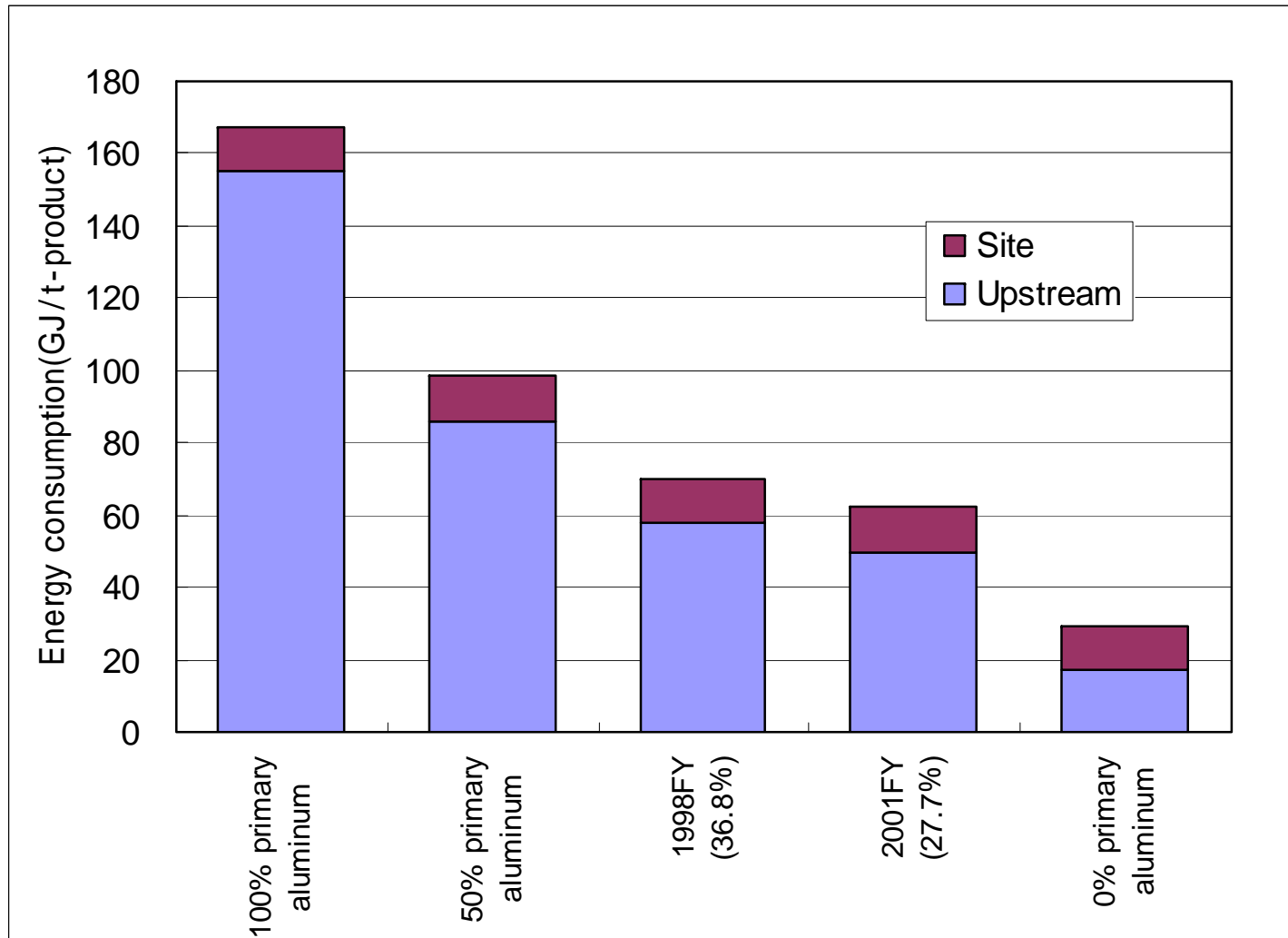
Life cycle energy consumption in the manufacturing sheet products



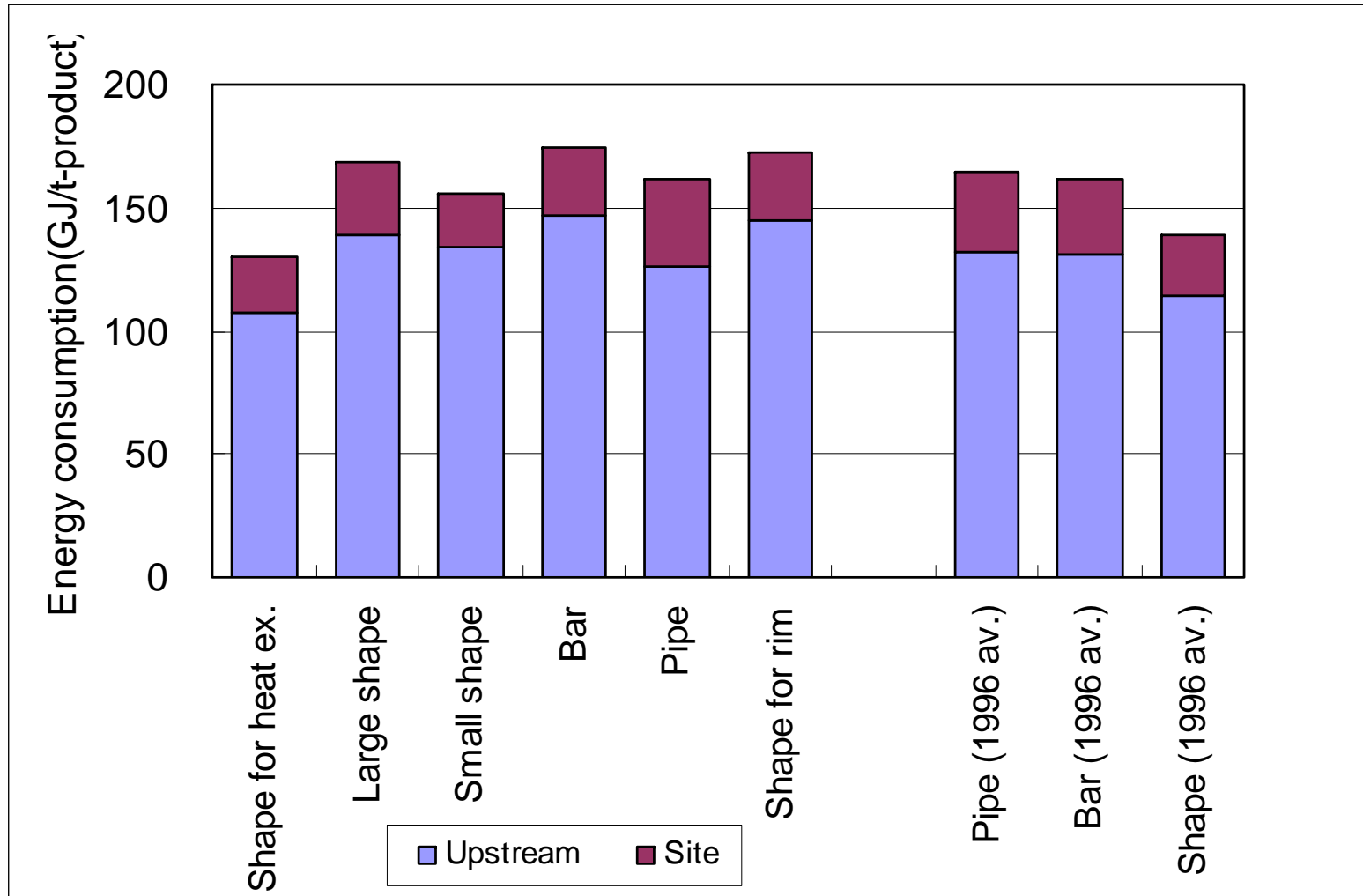
Life cycle CO₂ emission in the manufacturing sheet products



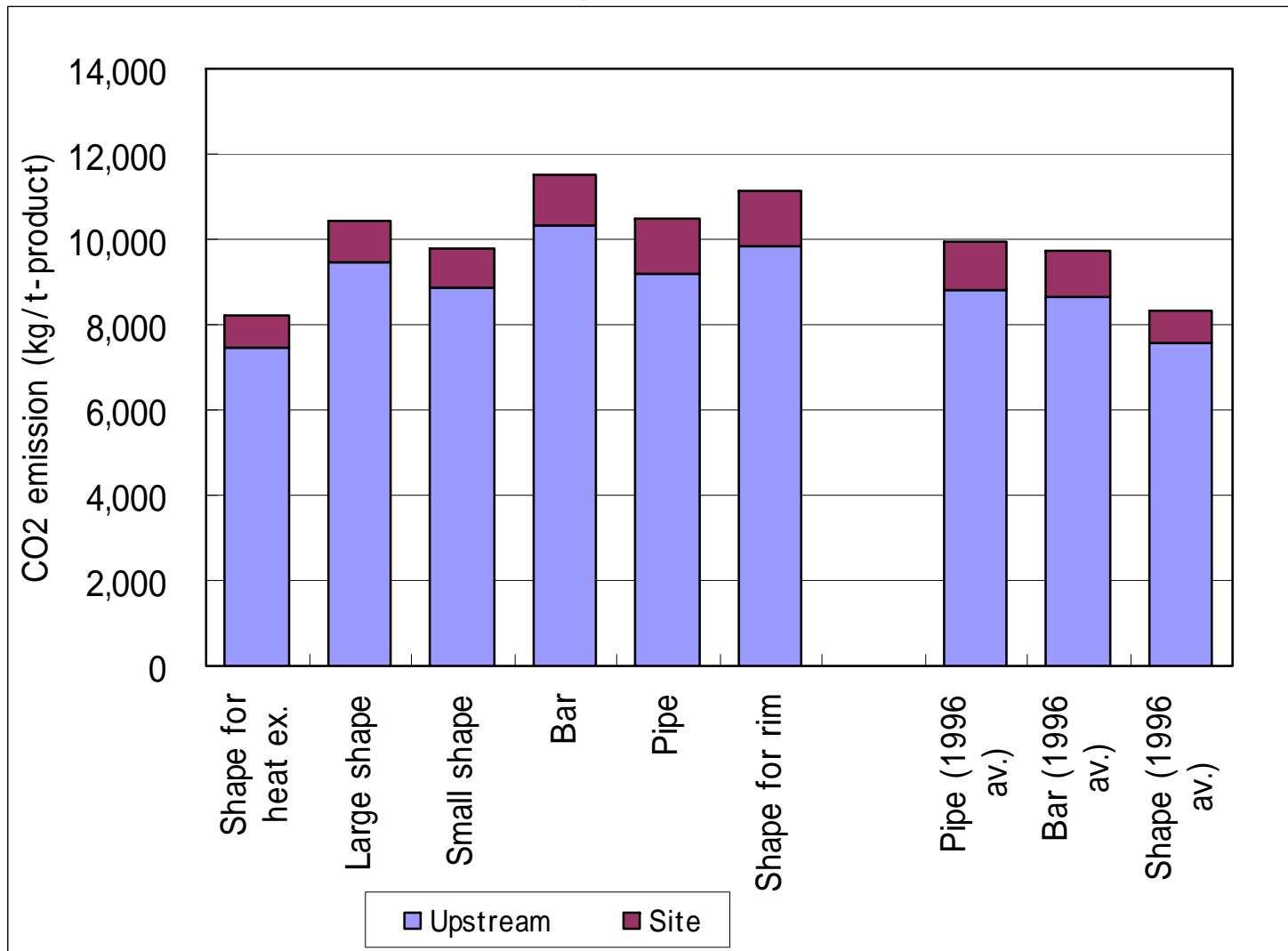
Effect of raw materials mix of can body stock on life cycle energy



Life cycle energy consumption in the manufacturing extruded products



Life cycle CO₂ emission in the manufacturing extruded products



Conclusions

- Differences in life cycle inventory due to the differences in raw materials, thickness, shape of the cross section and other conditions were analyzed.
- Although the amount of energy consumption varied among different processes, the study confirmed that the raw materials mix had far more significant effects on the total inventory of the product than other factors.
- Thus, for conducting an LCA of aluminum products, recycling should be considered adequately and treated accordingly.