Investigation of utilisation of milling facilities in Ontario to minimize electricity costs

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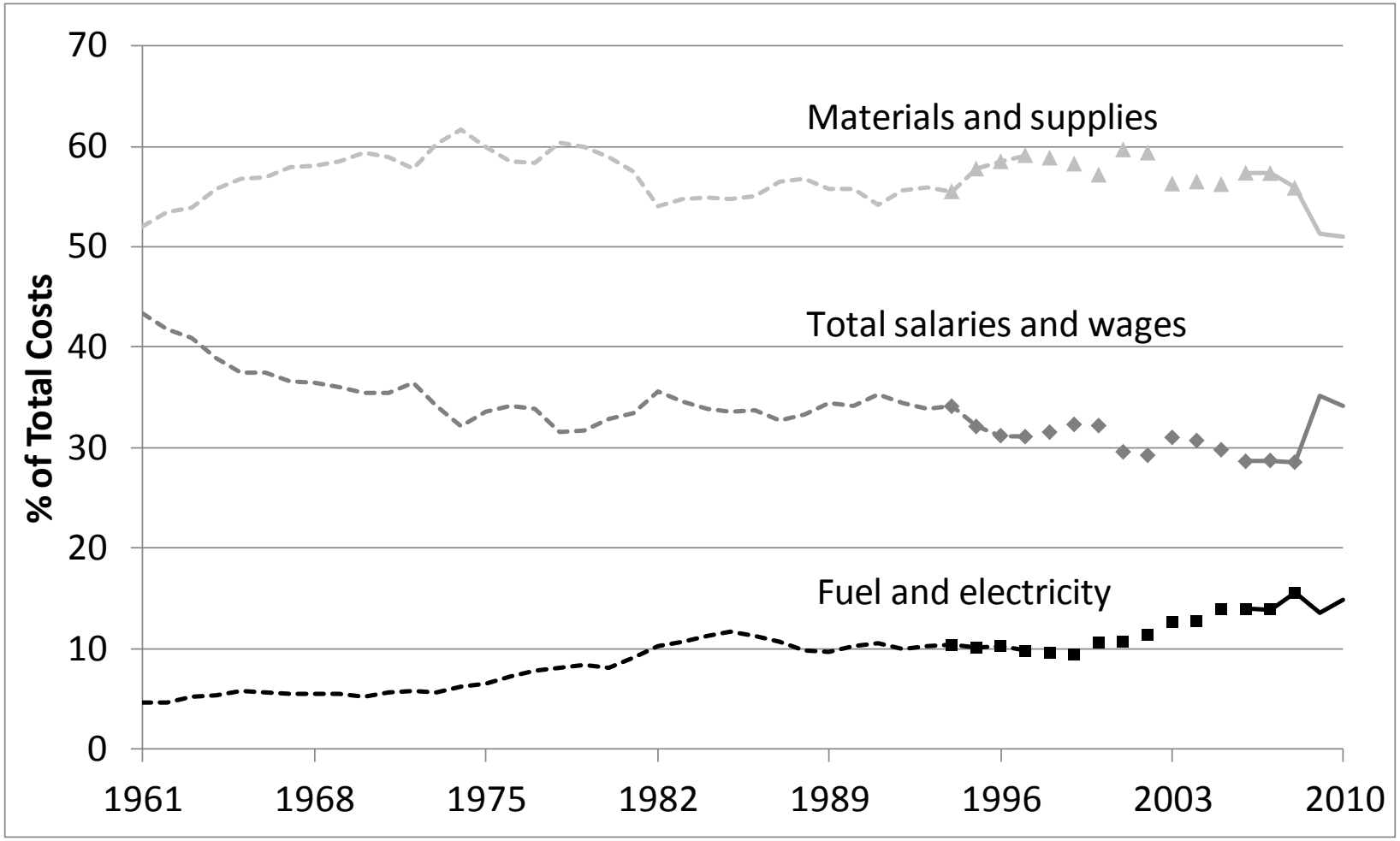
in Mining Innovation

Proportion of energy costs for metal mines in Canada has risen to 15%



Levesque *et al*, 2014

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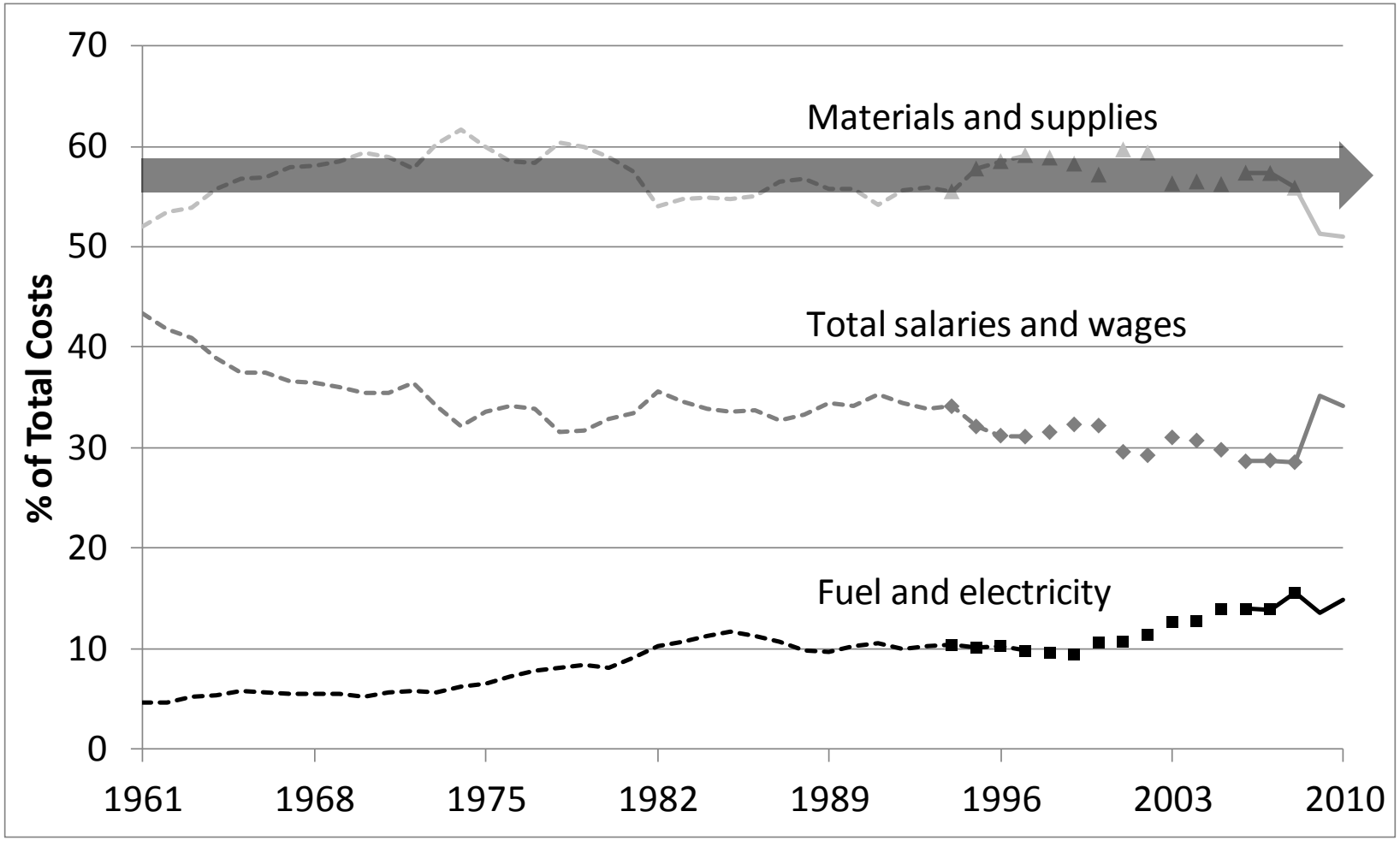

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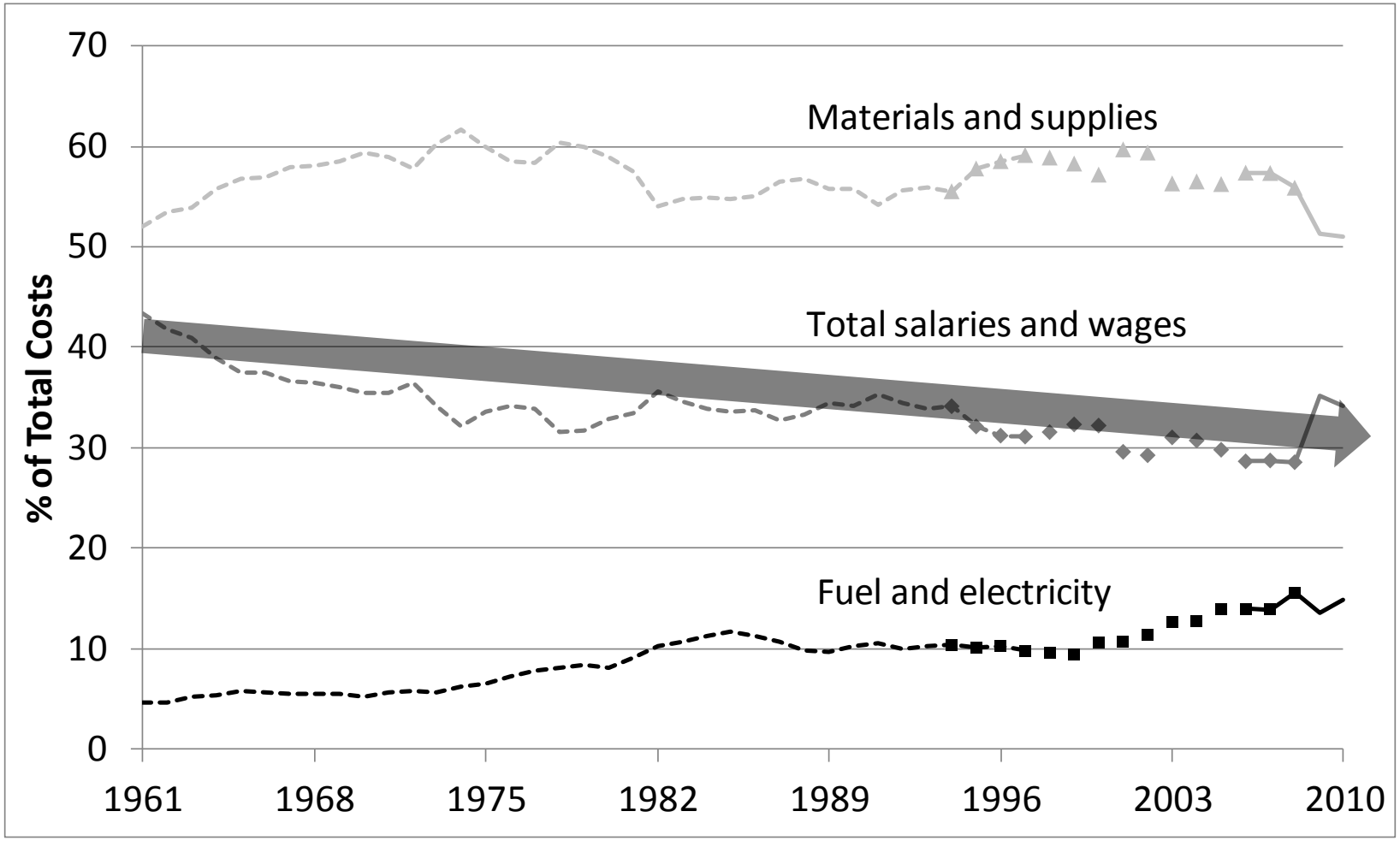

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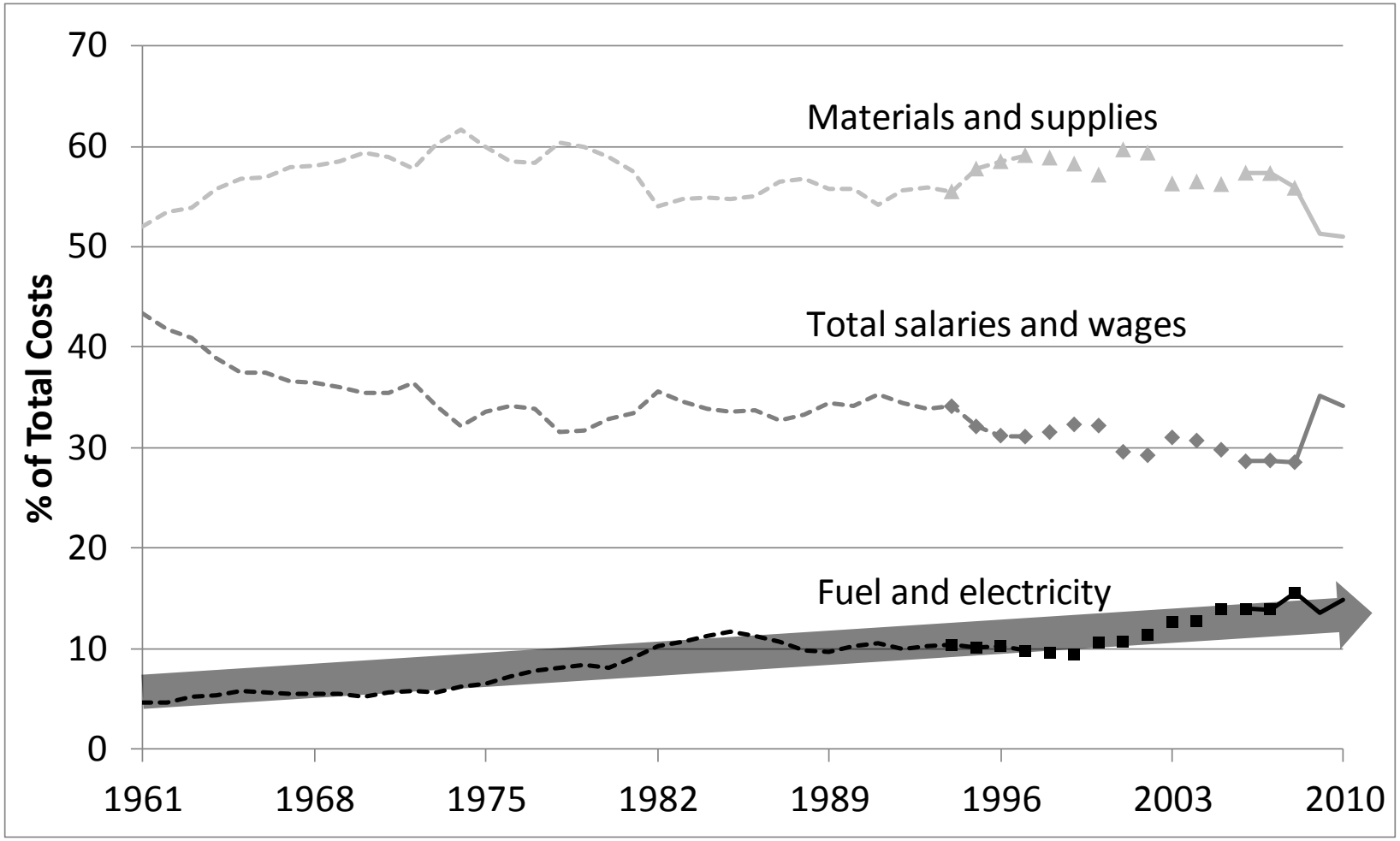

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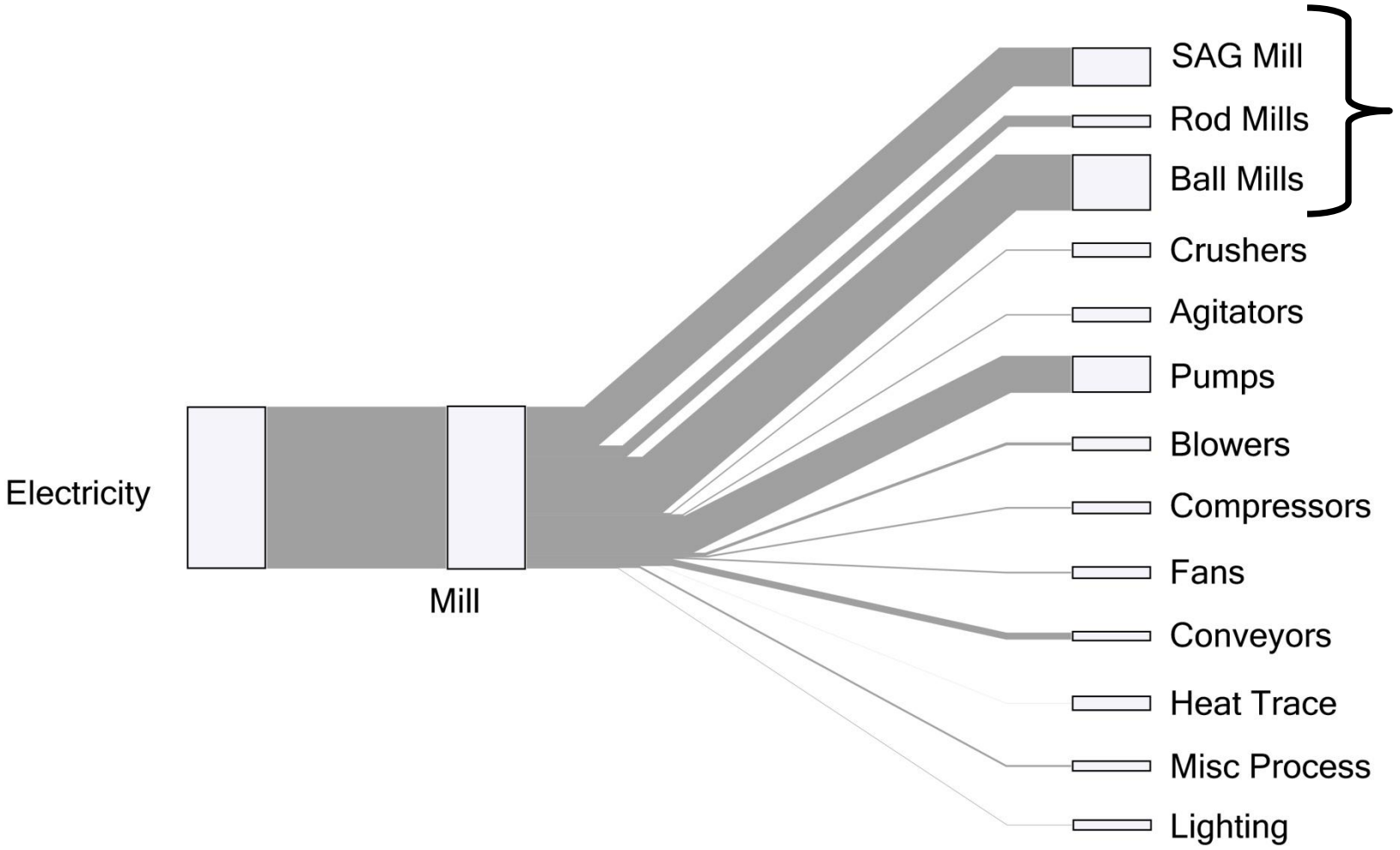
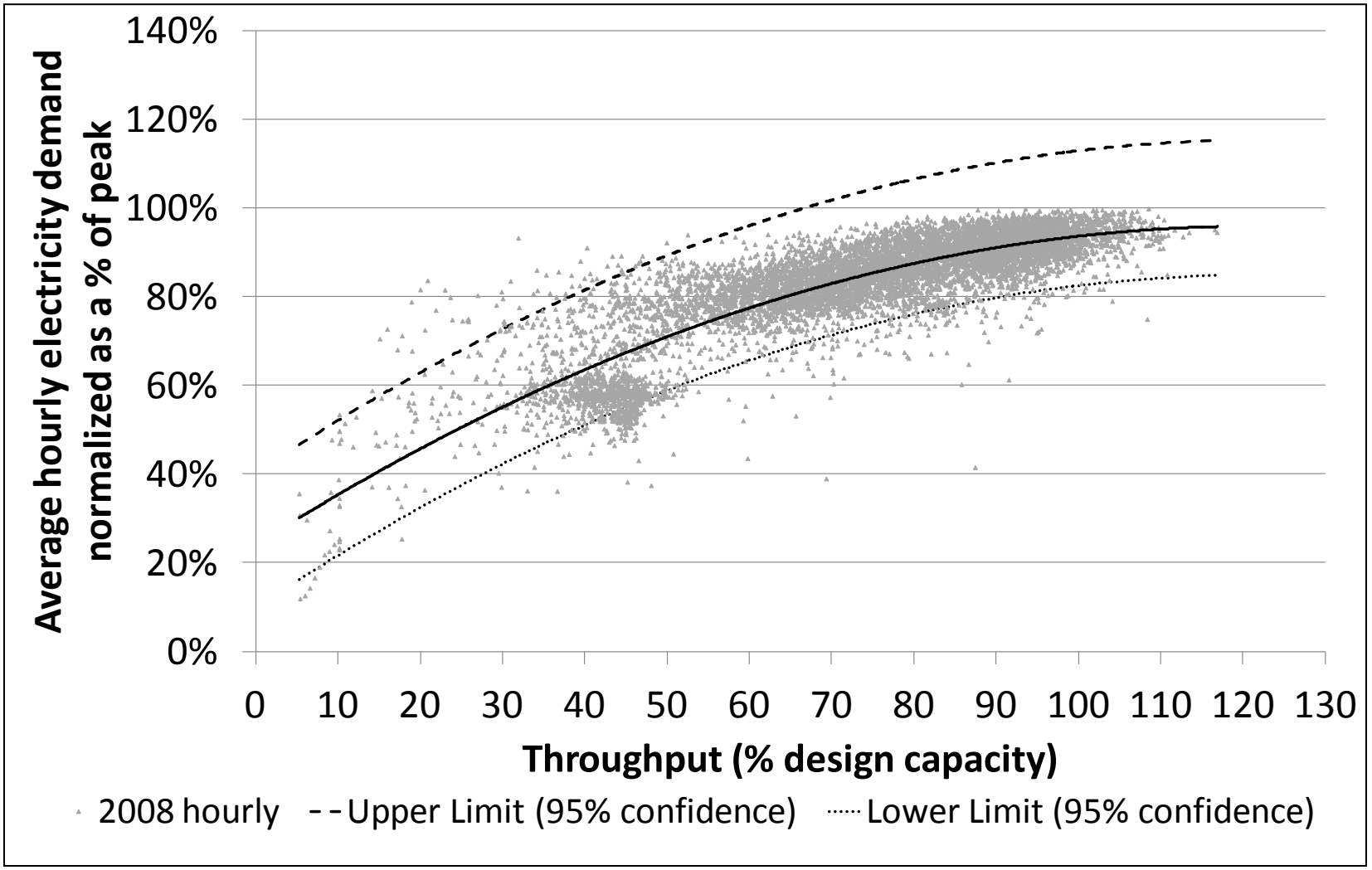
There are 3 main stages in a mill, but a substantial amount of equipment

- Crushing
- Grinding
- Separation

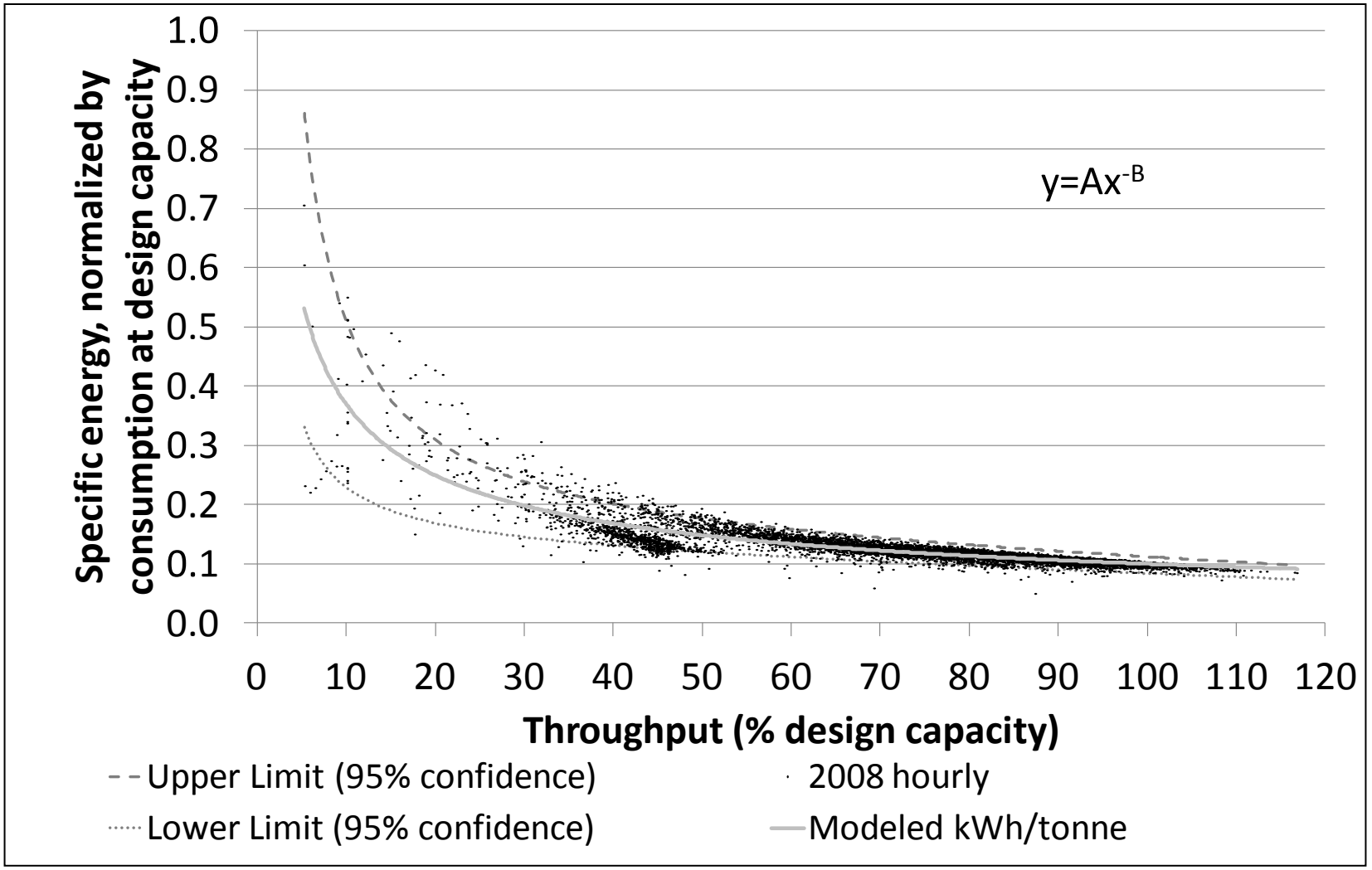
Most of the electricity in a milling plant is used for grinding



As throughput is increased, so is electricity demand, but in lower proportion



More electricity is used to process a tonne of ore below design capacity



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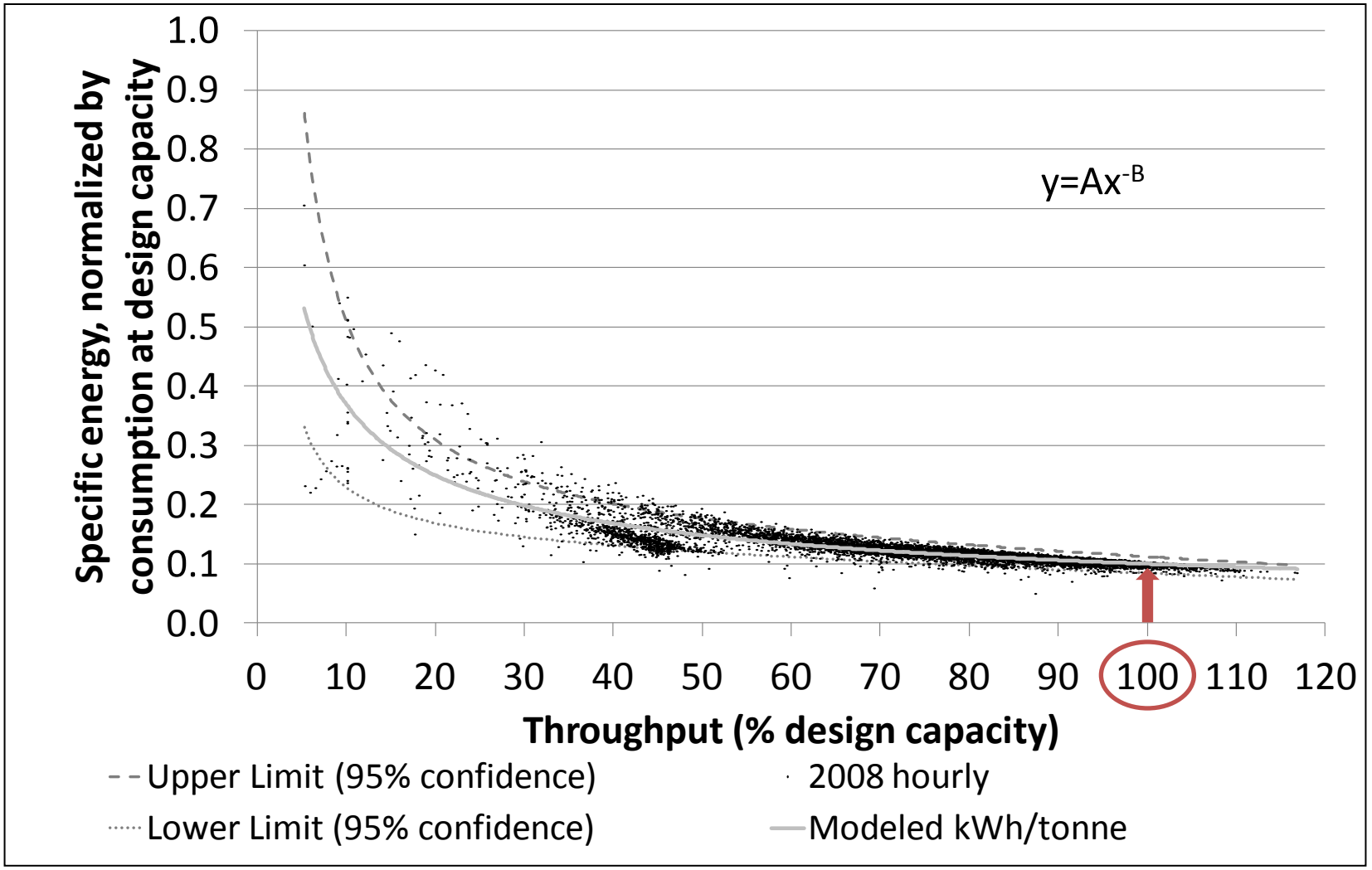

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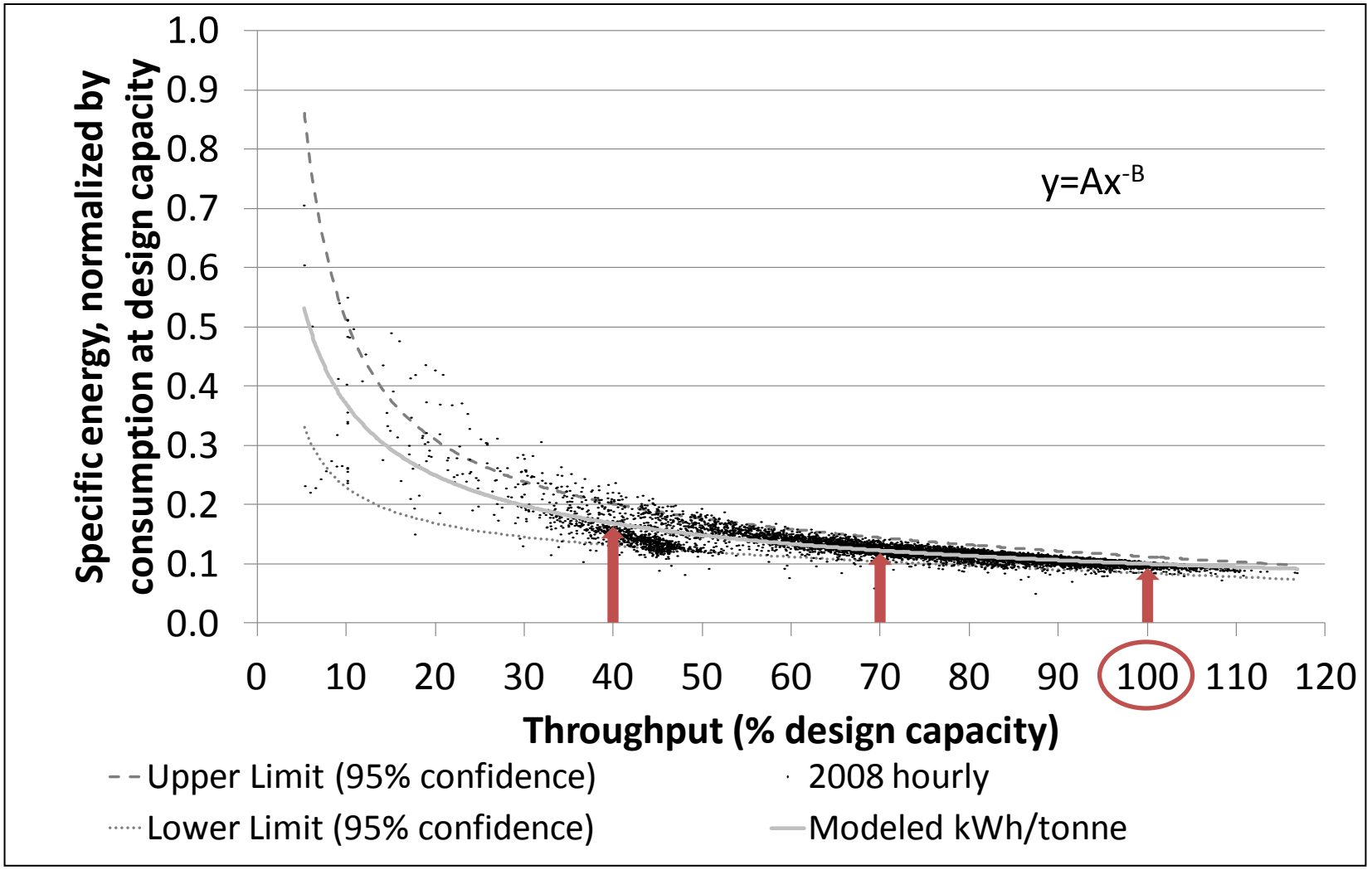
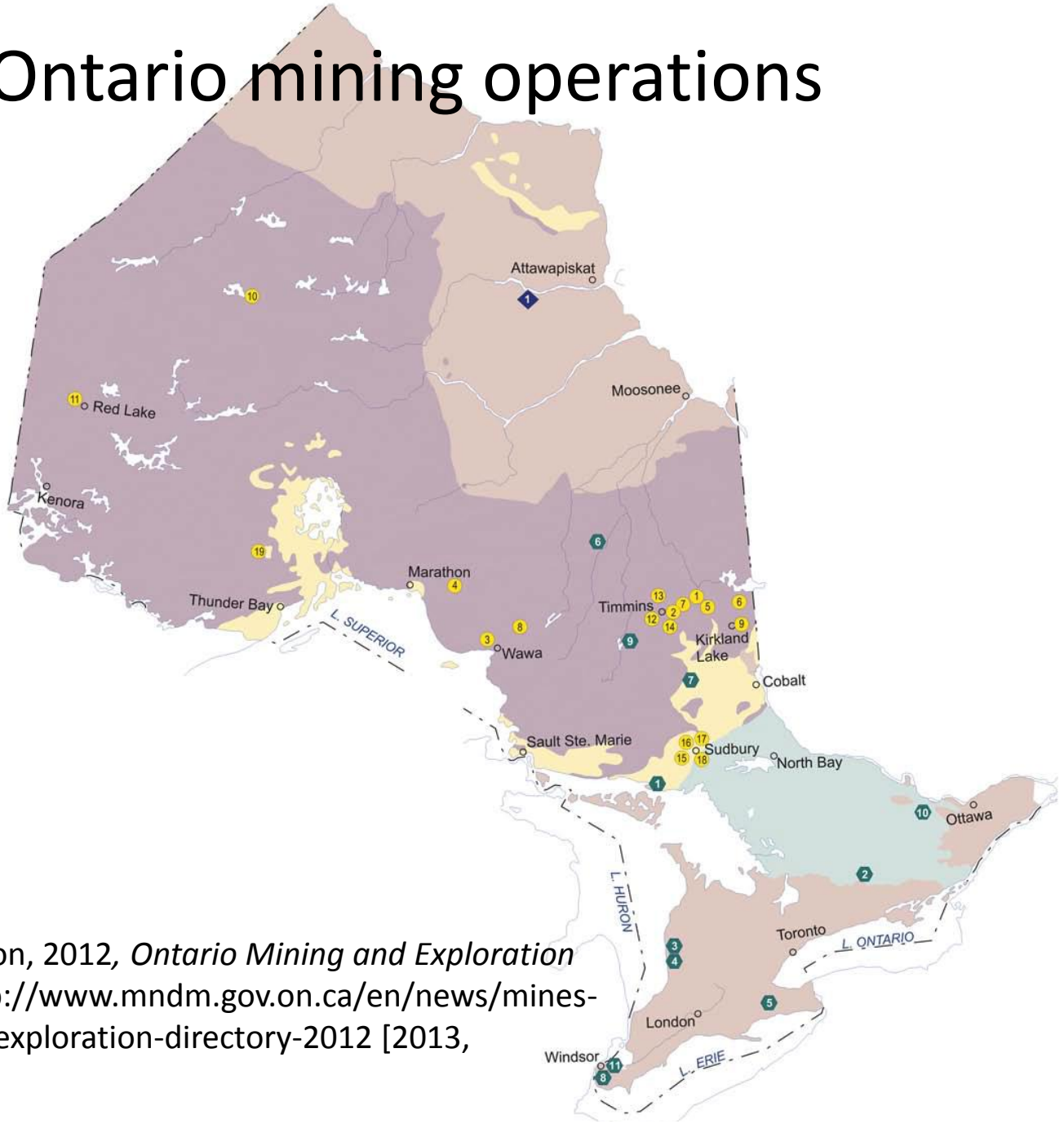


2012 Ontario mining operations

- 3 base metal mills
- 10 gold mills
- 1 PGM mill

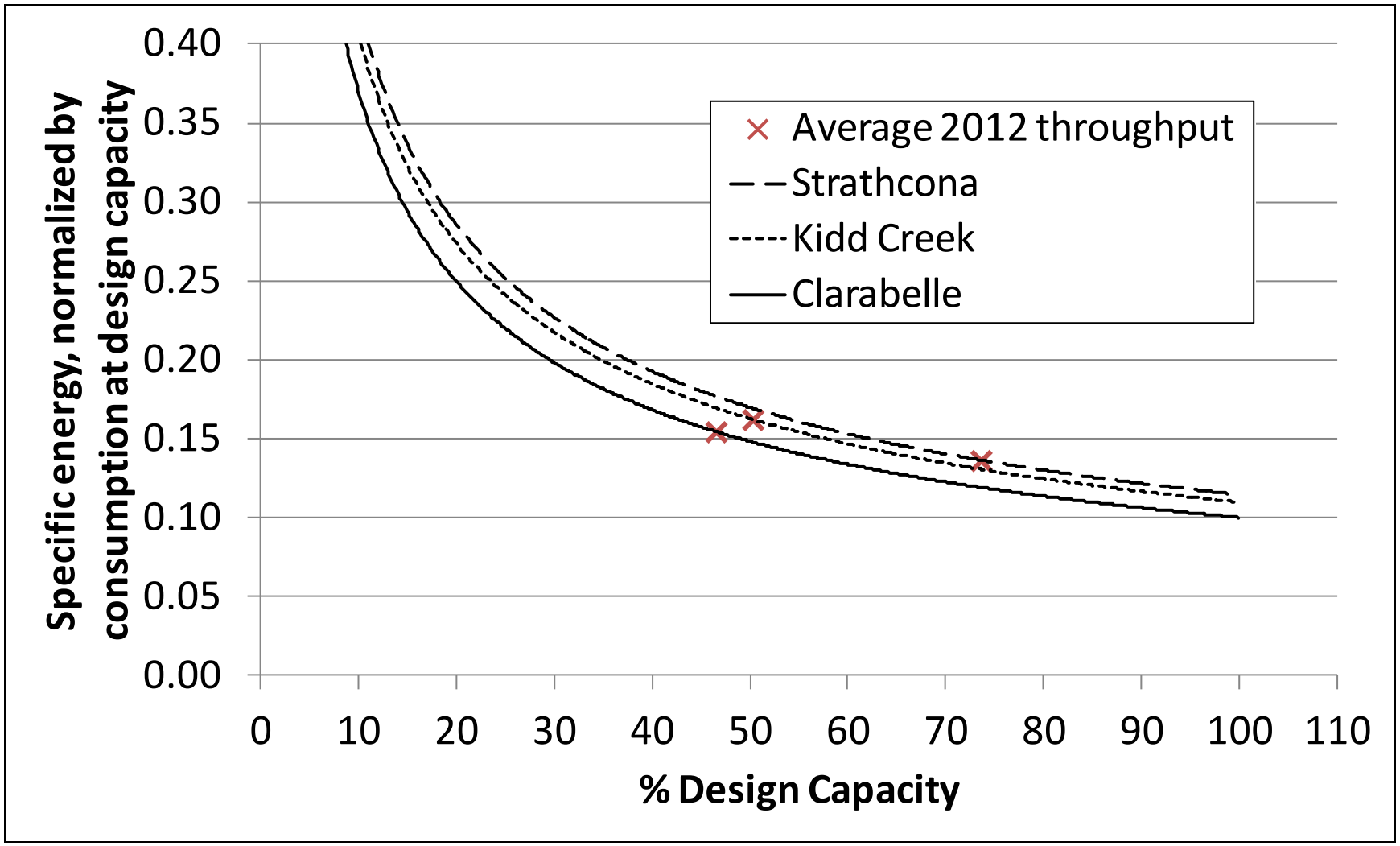


Ontario Prospectors Association, 2012*, Ontario Mining and Exploration Directory 2012*. Available: http://www.mndm.gov.on.ca/en/news/mines-and-minerals/ontario-mining-exploration-directory-2012 [2013, November 14].

Base metal mills in Ontario also operate below design capacity

Company	Mill	Design (tonnes per day)	2012 annual throughput	Utilisation
Vale	Clarabelle	36,300 (Kerr et al, 2003)	5,740,700 (Vale, 2013; KGHM International, 2013)	47%
Kidd Operations a Glencore Company	Kidd Creek	12,329 (Thwaites, 1983)	2,268,672 (Xstrata, 2013)	50%
Sudbury Integrated Nickel Operations a Glencore Company	Strathcona	7,534 (Gencore Xstrata plc., 2013)	2,029,753 (Xstrata, 2013)	74%

Part load curves for mills can be shifted to reflect economies of scale



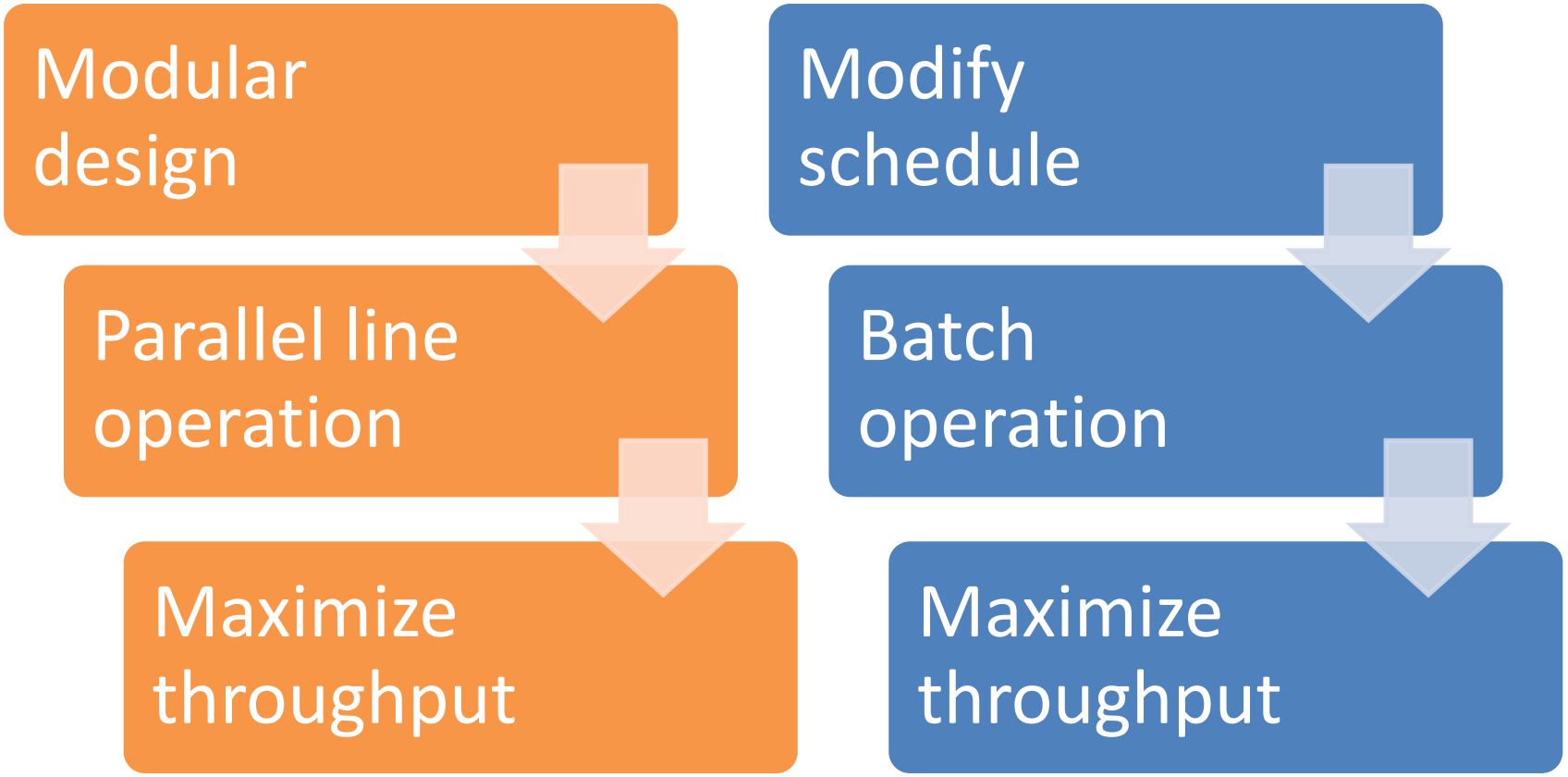
Energy penalties arise from operating below design capacity

Mill	Potential savings (2012)
Clarabelle	36%
Kidd Creek	32%
Strathcona	16%

Company	Mill	Utilisation
Kirkland Lake Gold Inc.	Macassa	59%
Goldcorp Inc.	Red Lake/Campbell	76%
Goldcorp Inc.	Musselwhite	79%
Richmont Mines Inc.	Island Gold	81%
St. Andrew Goldfields Ltd.	Holt	82%
Barrick Gold Corporation	Hemlo	84%
Brigus Gold Corp.	Black Fox	91%
Lake Shore Gold Corp.	Bell Creek	98%
Goldcorp Inc.	Dome	103%
Wesdome Gold Mines Ltd.	Eagle River	120%

9 out of 10 gold mills have higher utilisation than base metal mills

There are solutions to low utilisation



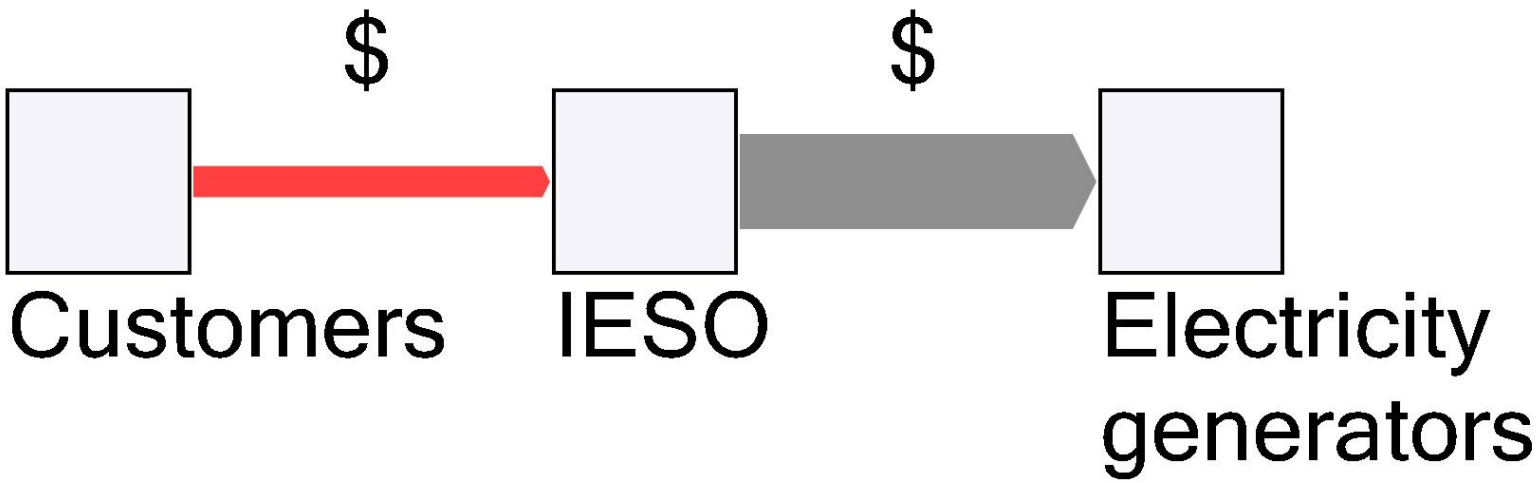
NAP's Lac des Iles mill has already realized such benefits

2012 schedule: 14 days on, 14 days off

Design (tonnes / day)	2012 annual throughput	Utilisation	
		Actual	BAU
15,000	2,063,260	75%	37%

North American Palladium, 2013

Hourly rates paid by customers don't cover the rates paid to generators



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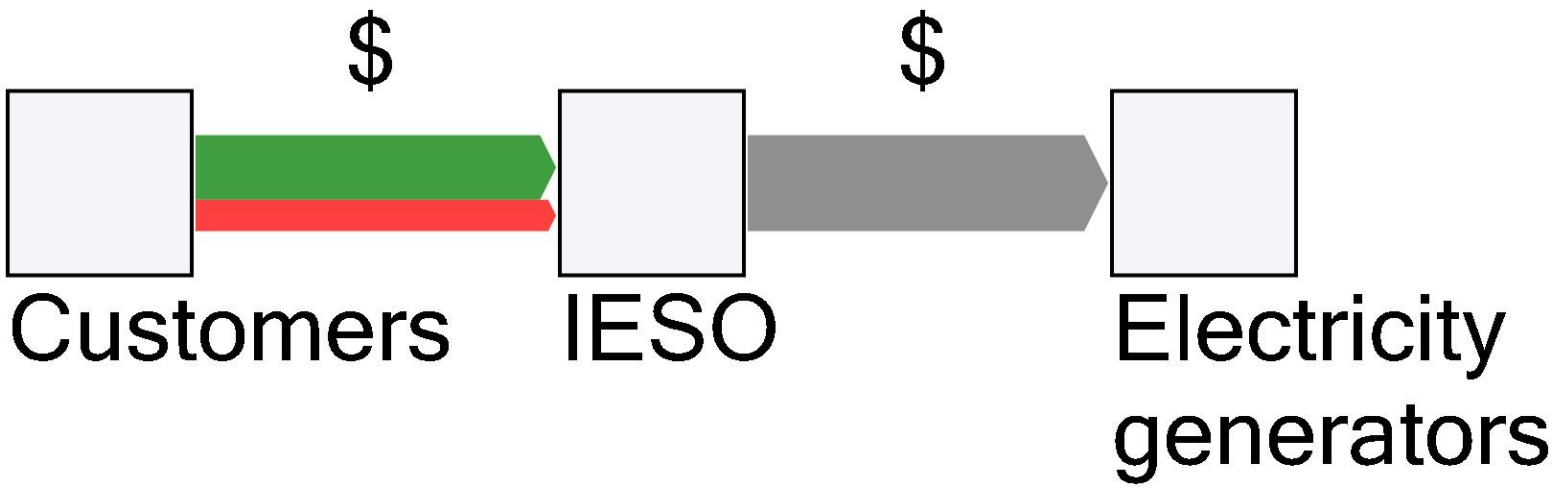

A flexible schedule offers potential for further savings due to 5CP billing

- Coincident peak (CP) pricing mechanism
- Class A: average peak demand > 5MW or
  average peak demand > 3MW for certain sectors
- Global Adjustment (GA) = difference between HOEP and contract rates
- Share of Ontario demand during 5 peak hours determines share of GA

The cost of a MW in Ontario is rising

Year	Total hourly cost (million CDN$)	Global adjustment (million CDN$)	Average demand charge ($/MW)
2011	4,451	5,310 (54%)	217,406
2012	3,404	6,456 (65%)	273,004
2013	3,725	7,727 (67%)	323,537

* January to February 2014 - GA constitutes minor share of total cost.

IESO, 2014a; IESO, 2014b; IESO, 2014c; IESO 2014d

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Proper timing is like winning the lottery

Average Mill Demand (MW)	Demand Response Reduction (MW)	2012 Annual Savings ($ million)
3	2.7	0.8
5	4.5	1.3
10	9.0	2.5
15	13.5	3.8
20	18.0	5.0
25	22.5	6.3

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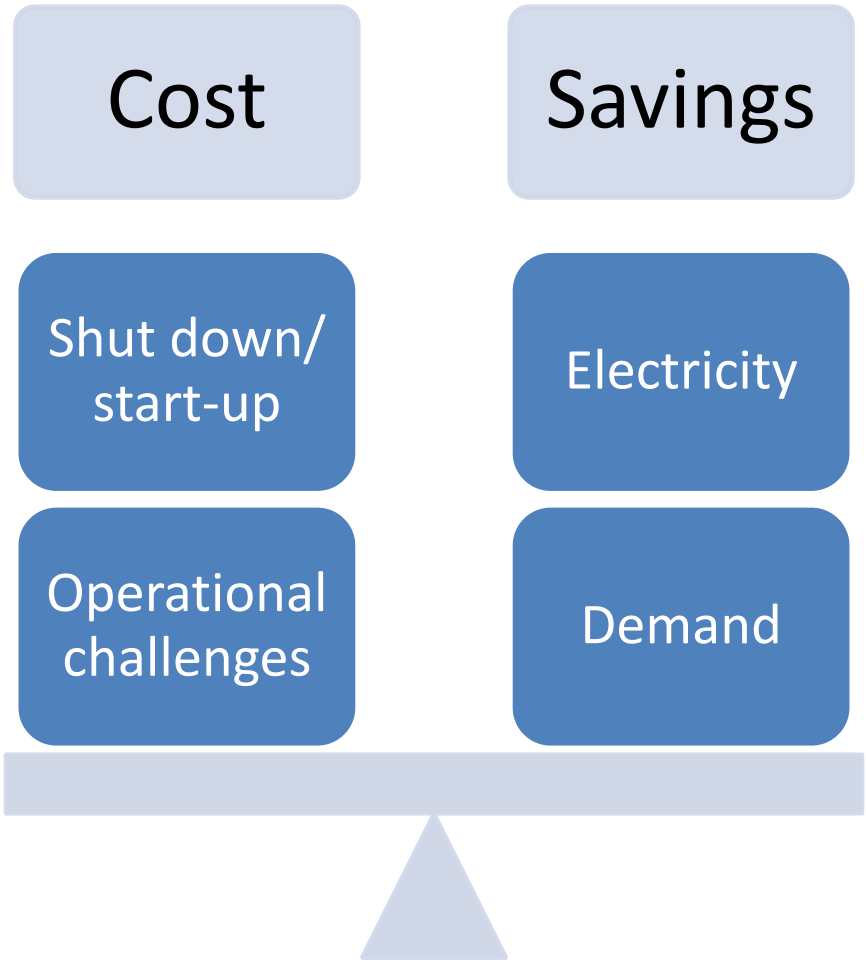
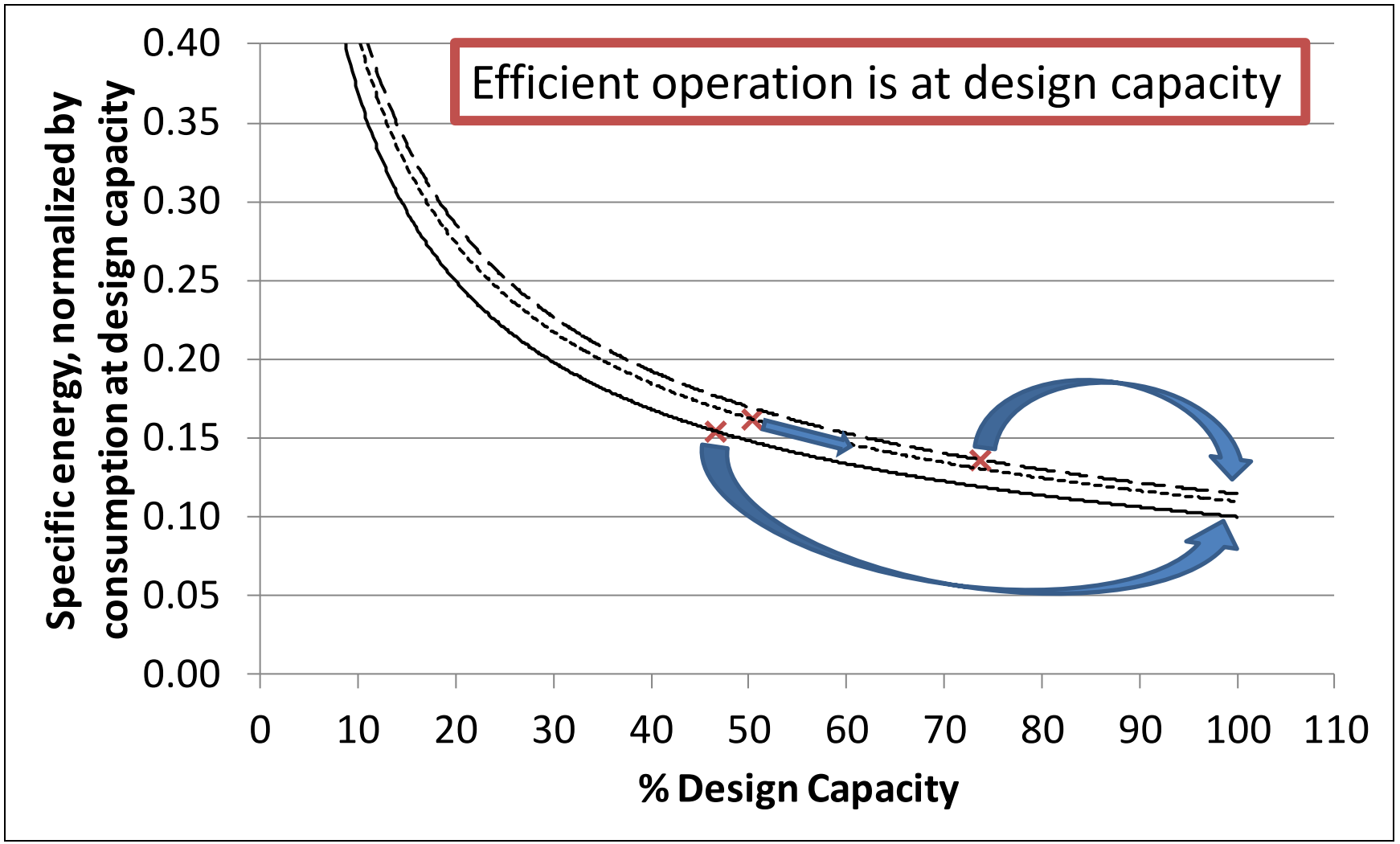
From an energy management perspective alone it's a 'no-brainer' but…



Lessons learned



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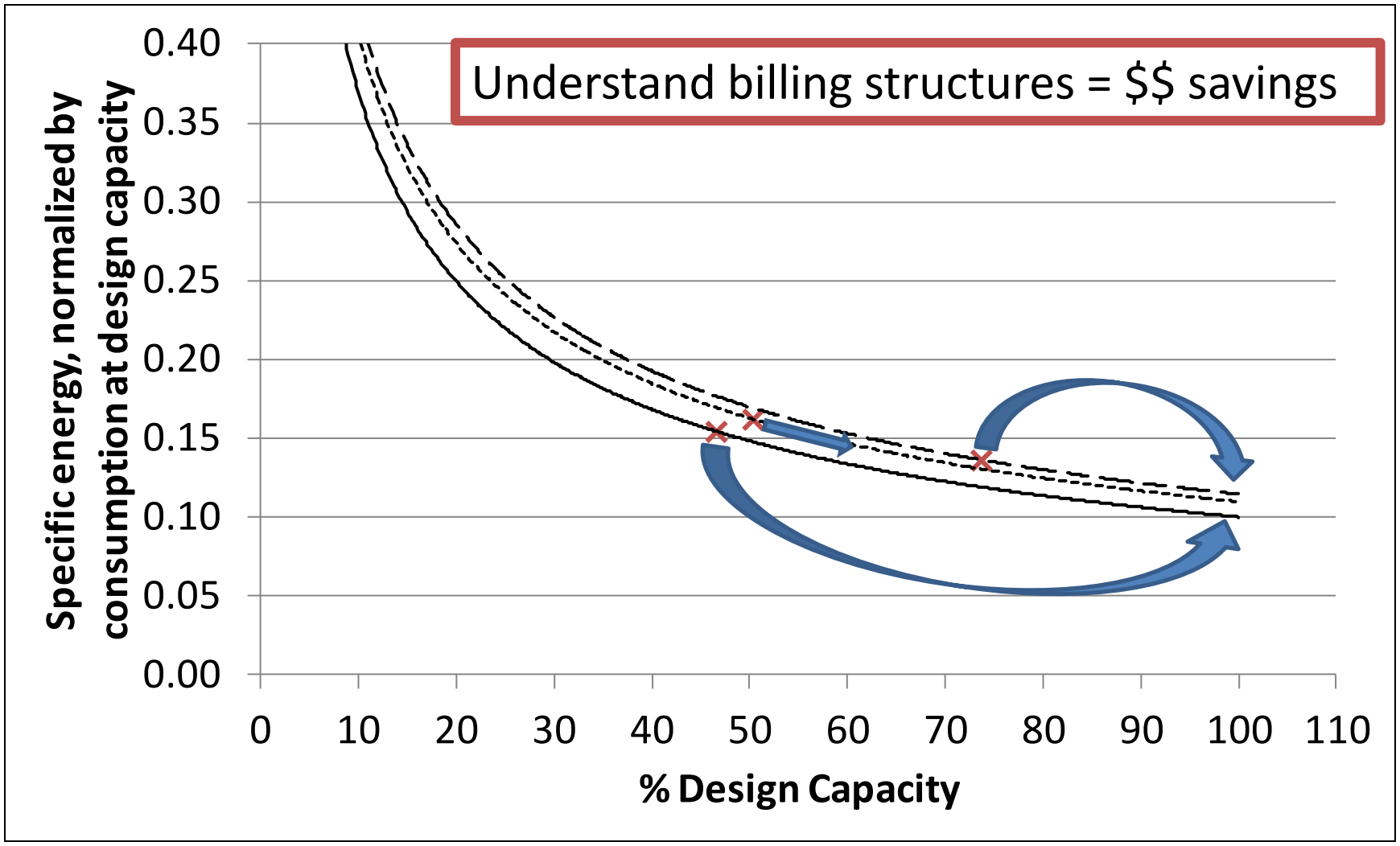

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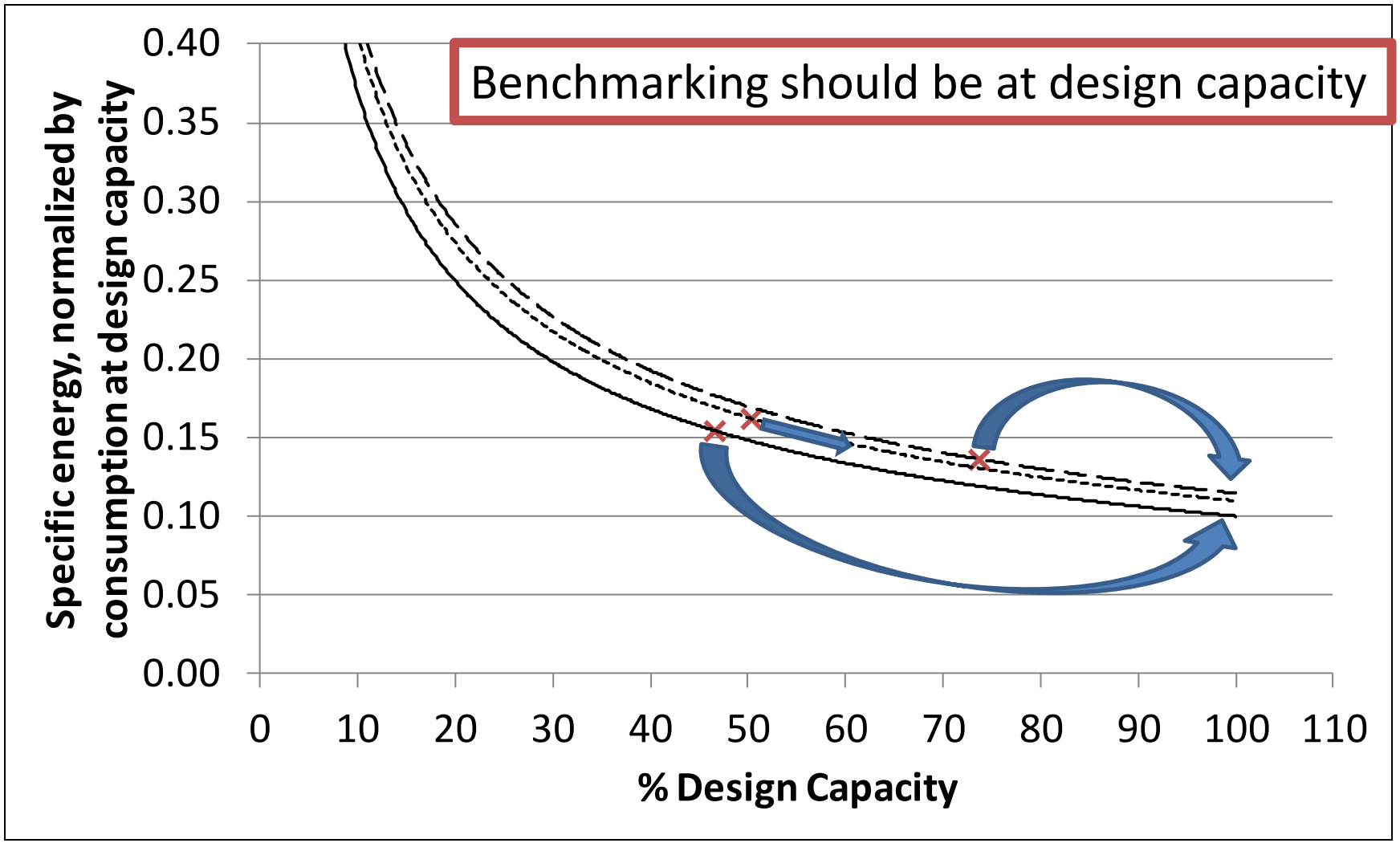

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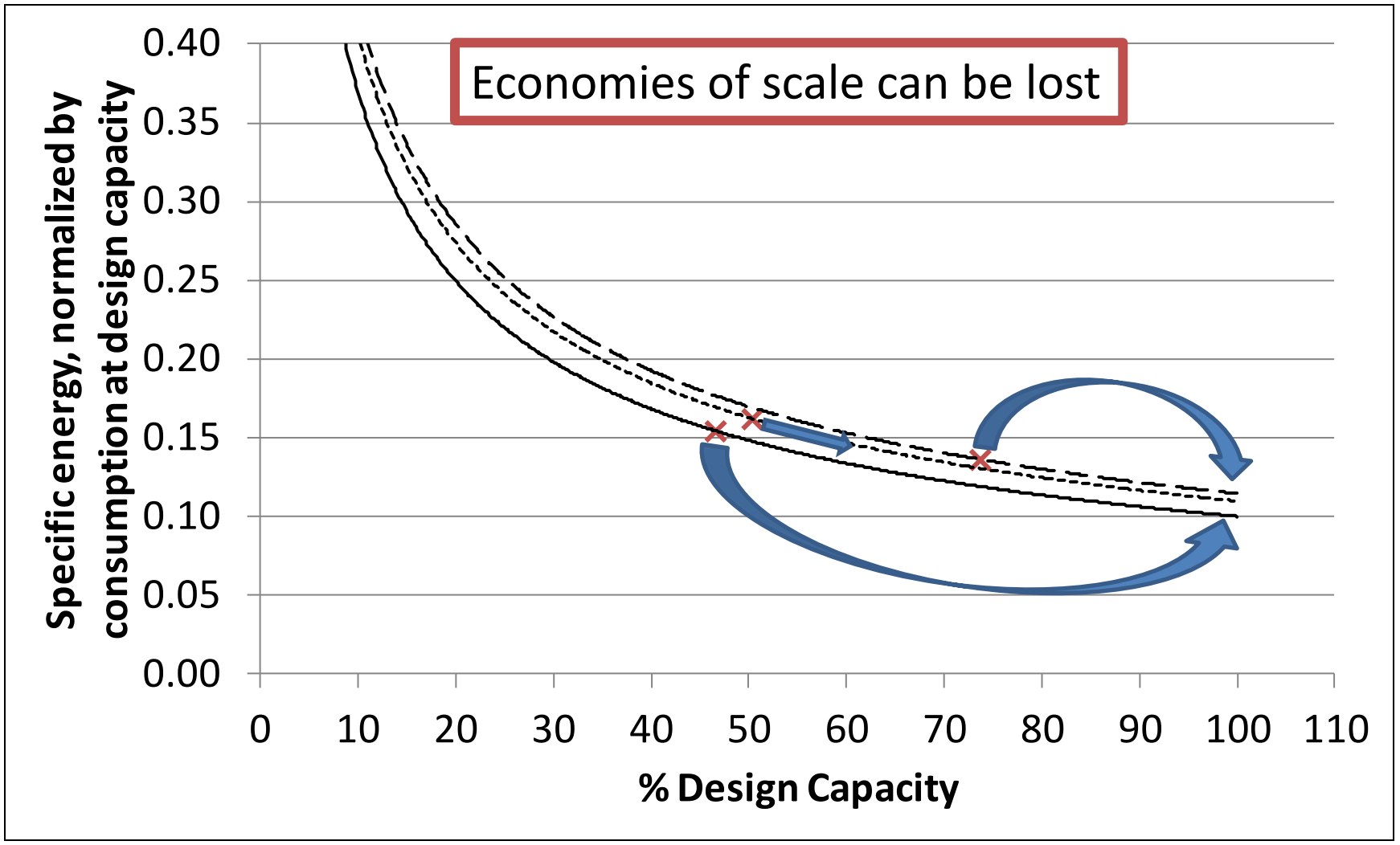
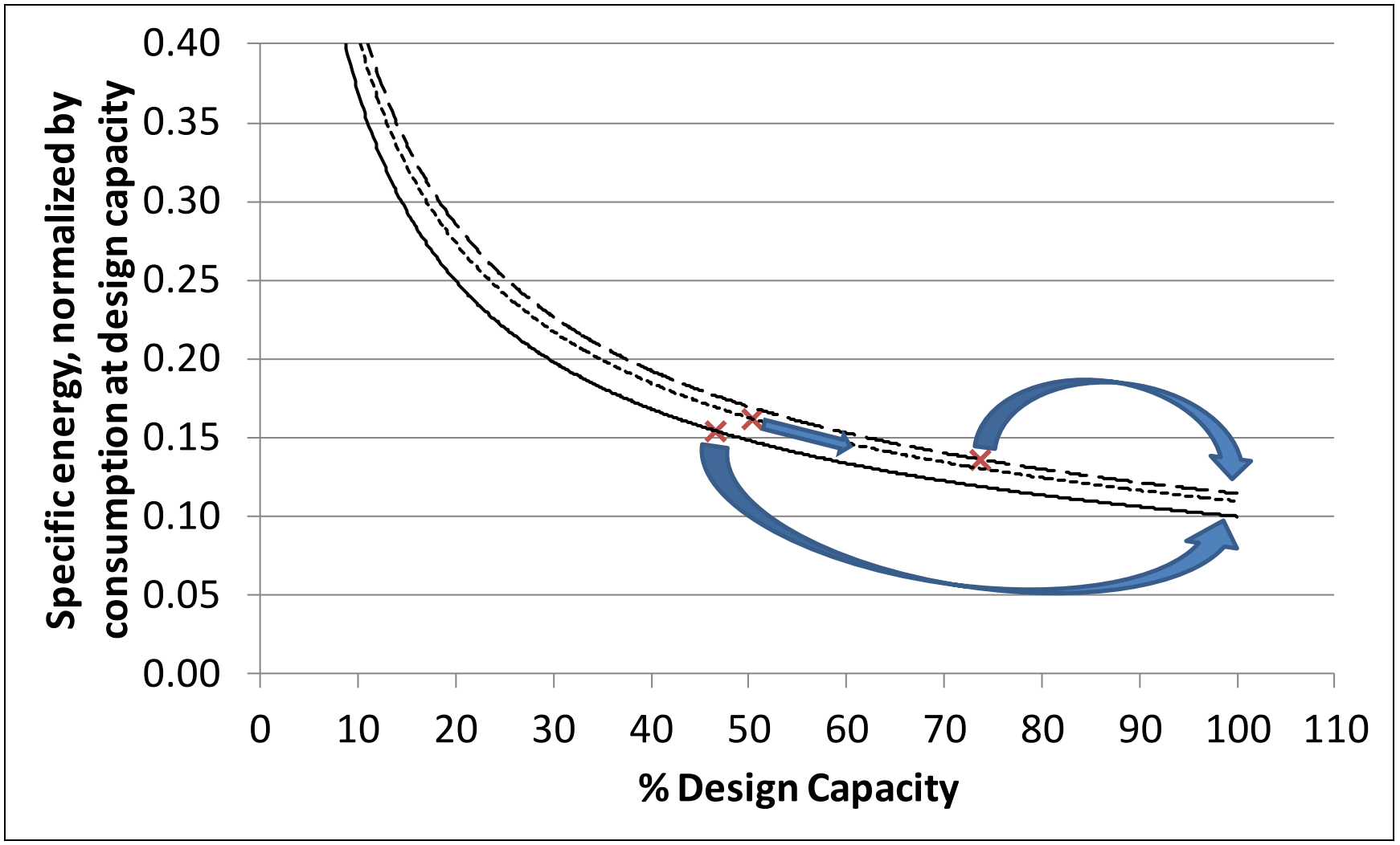


Thank you!


Specific energy, normalized by consumption at design capacity
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
10
20
30
40
50
60
70
80
90
100
110
% Design Capacity

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