Comminution Energy and How to Reduce it

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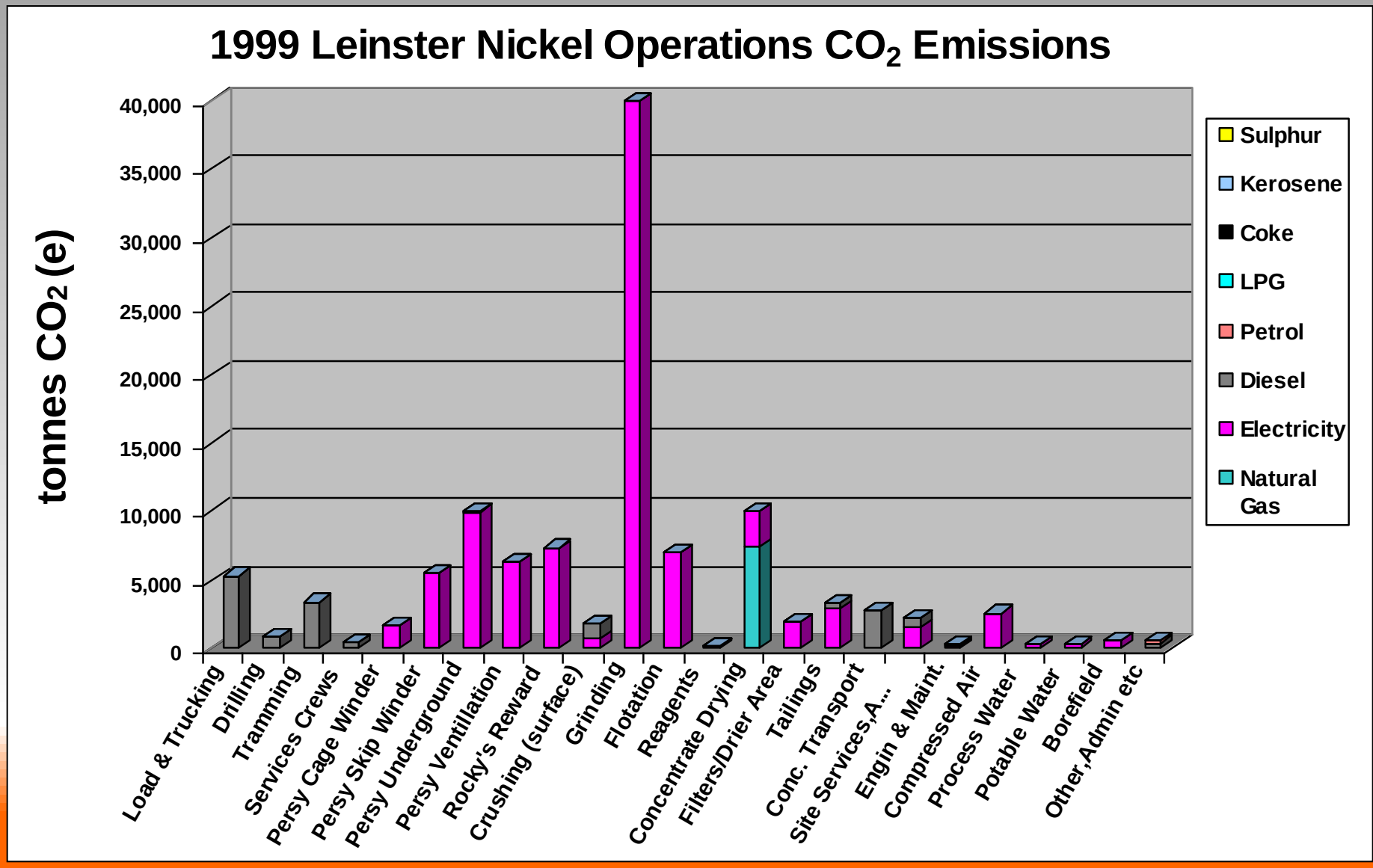
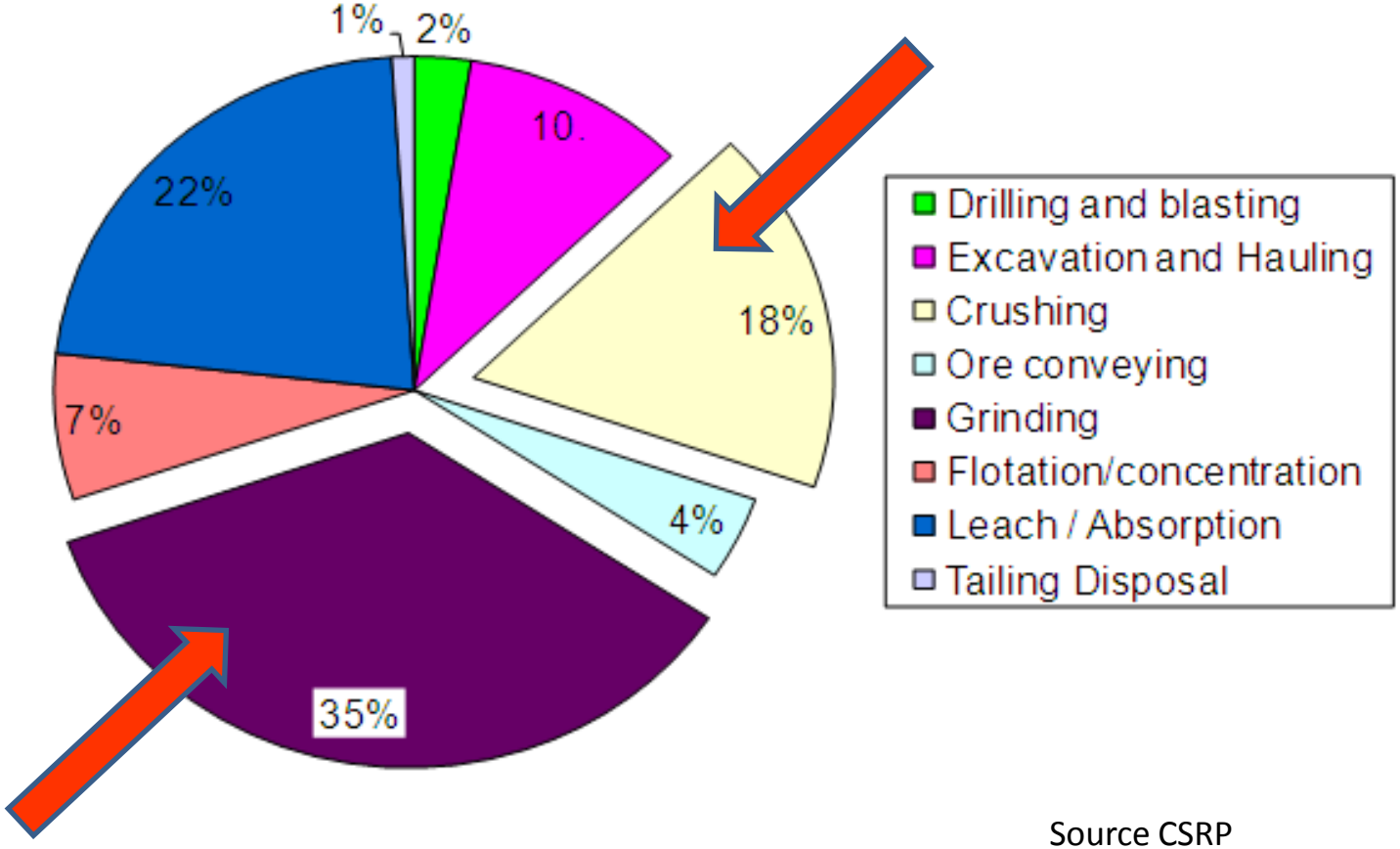
THE FUTURE

- Comminution is the major consumer of energy on the minesite.
- It is a significant component of total global electricity consumption.
- It is an important component of project capex and opex, and GHGe emissions.

Typical minesite comminution energy footprint

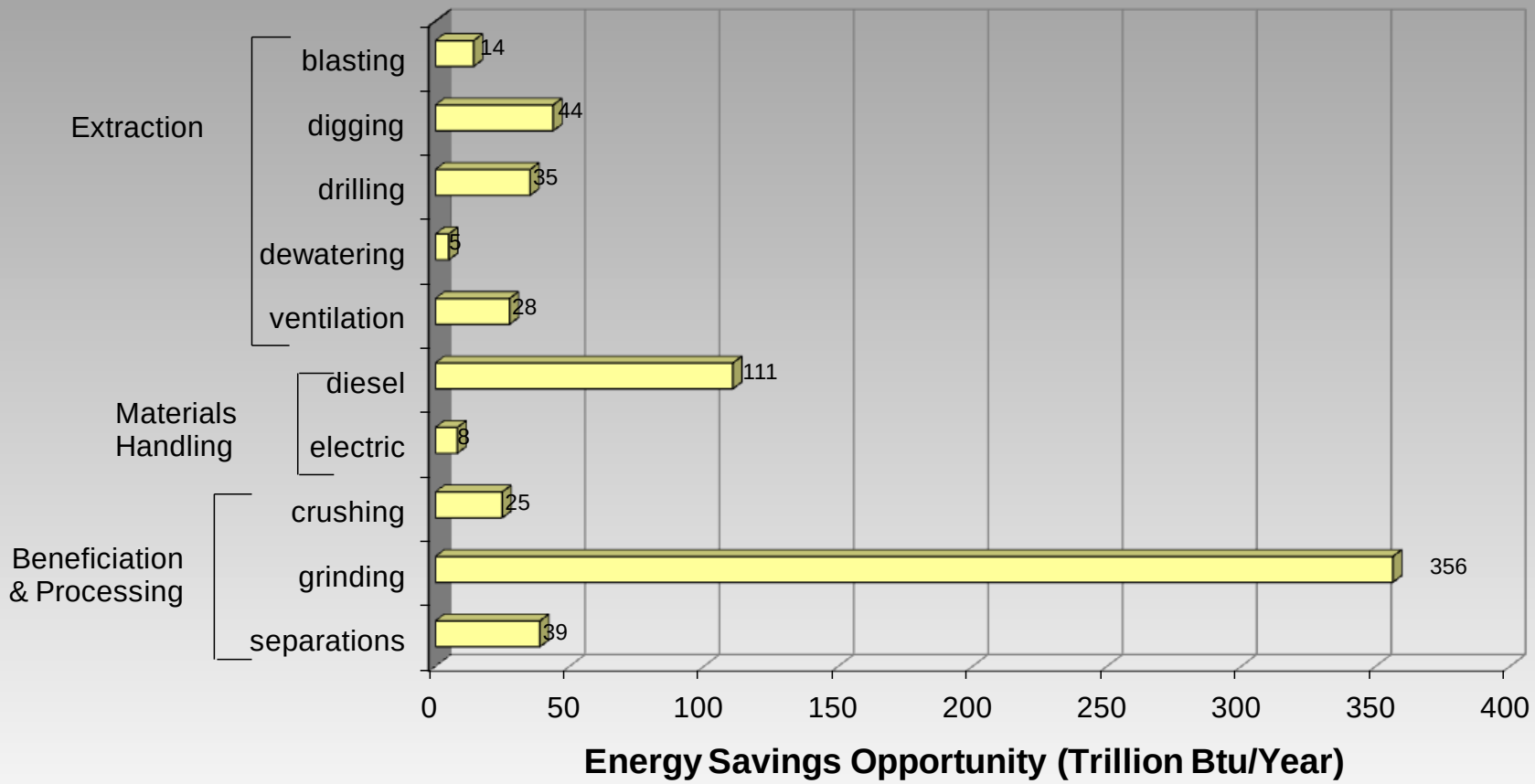


Source La Nauze, Temos 2002



Source CSRP

Energy use in the mining industry

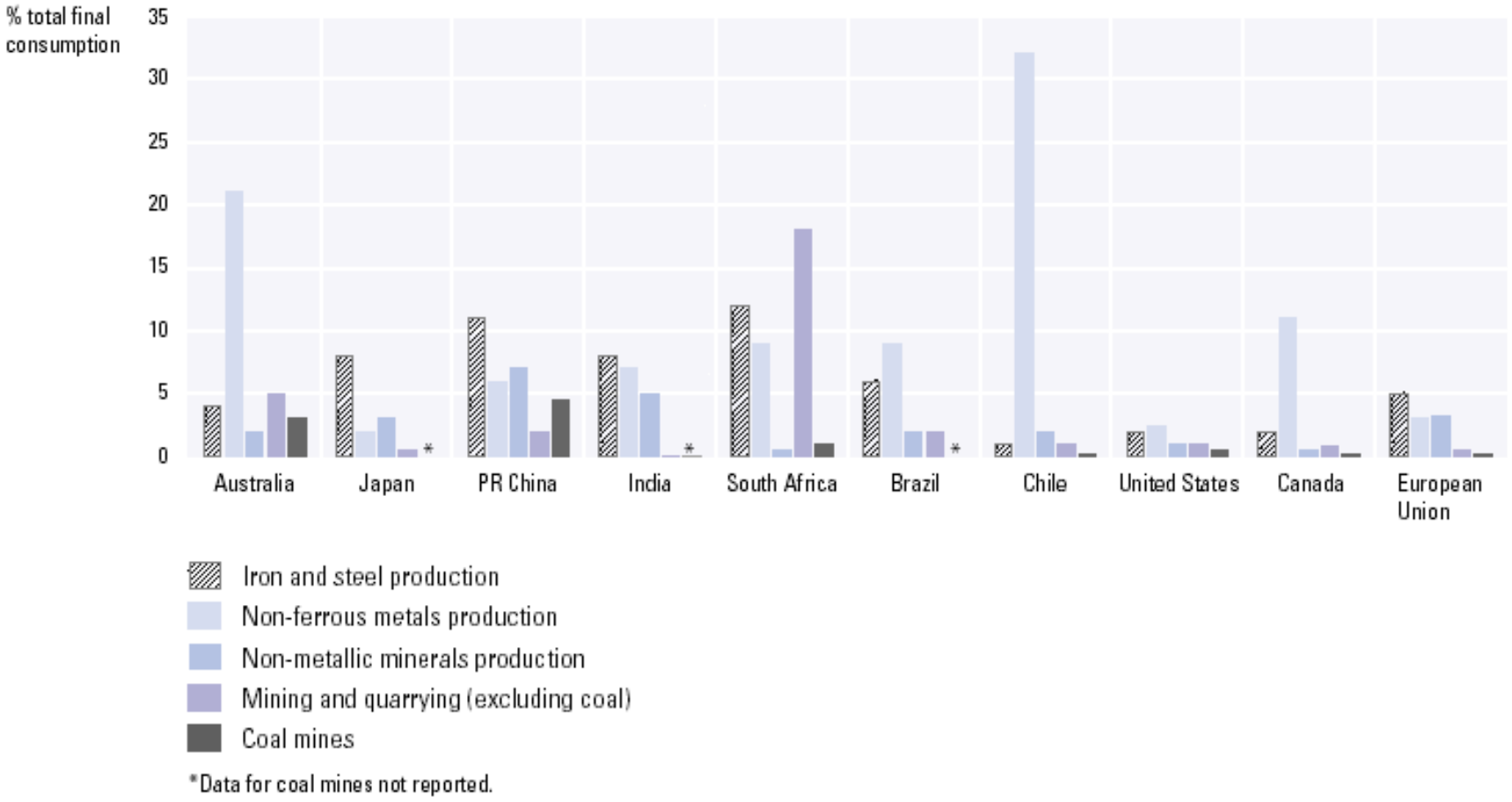


Source: Mining Energy Bandwidth Study (Draft 2007)

Potential energy savings in the mining industry

Figure 10–3. Percentage of Total Electricity Consumption Used by Mining and Minerals Industries, Selected Countries and the European Union, 1998

Source: IEA (2001a) and IEA (2001b)



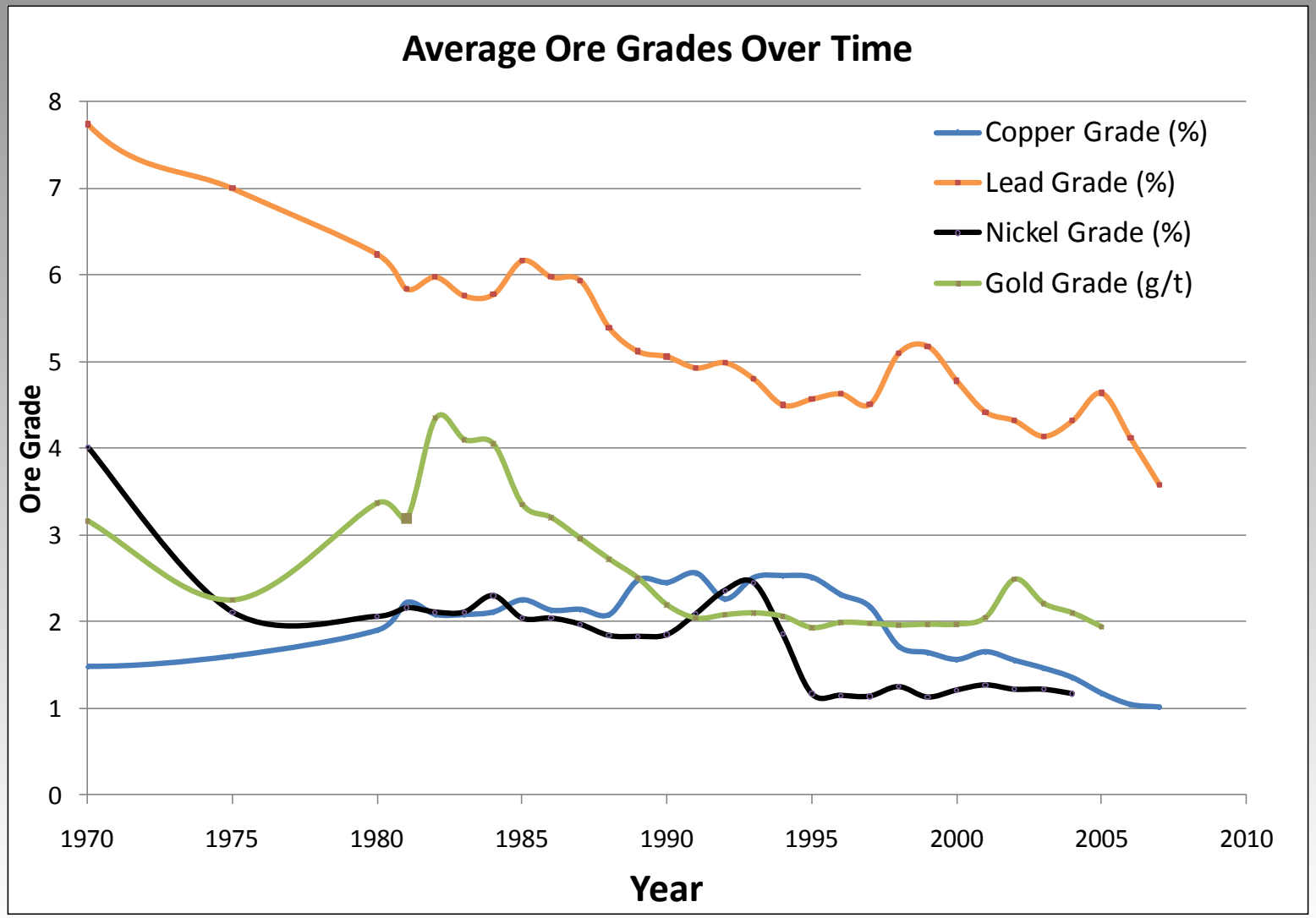
Energy consumption in international mining industry

Comminution consumes 1 - 4 % of *all electrical power generated in the world* (7-10% in Australia)

(Report of the US NRC Committee on Comminution and Energy Consumption, 1981; Prof. Fuerstenau, Berkeley University, 2003; etc.)

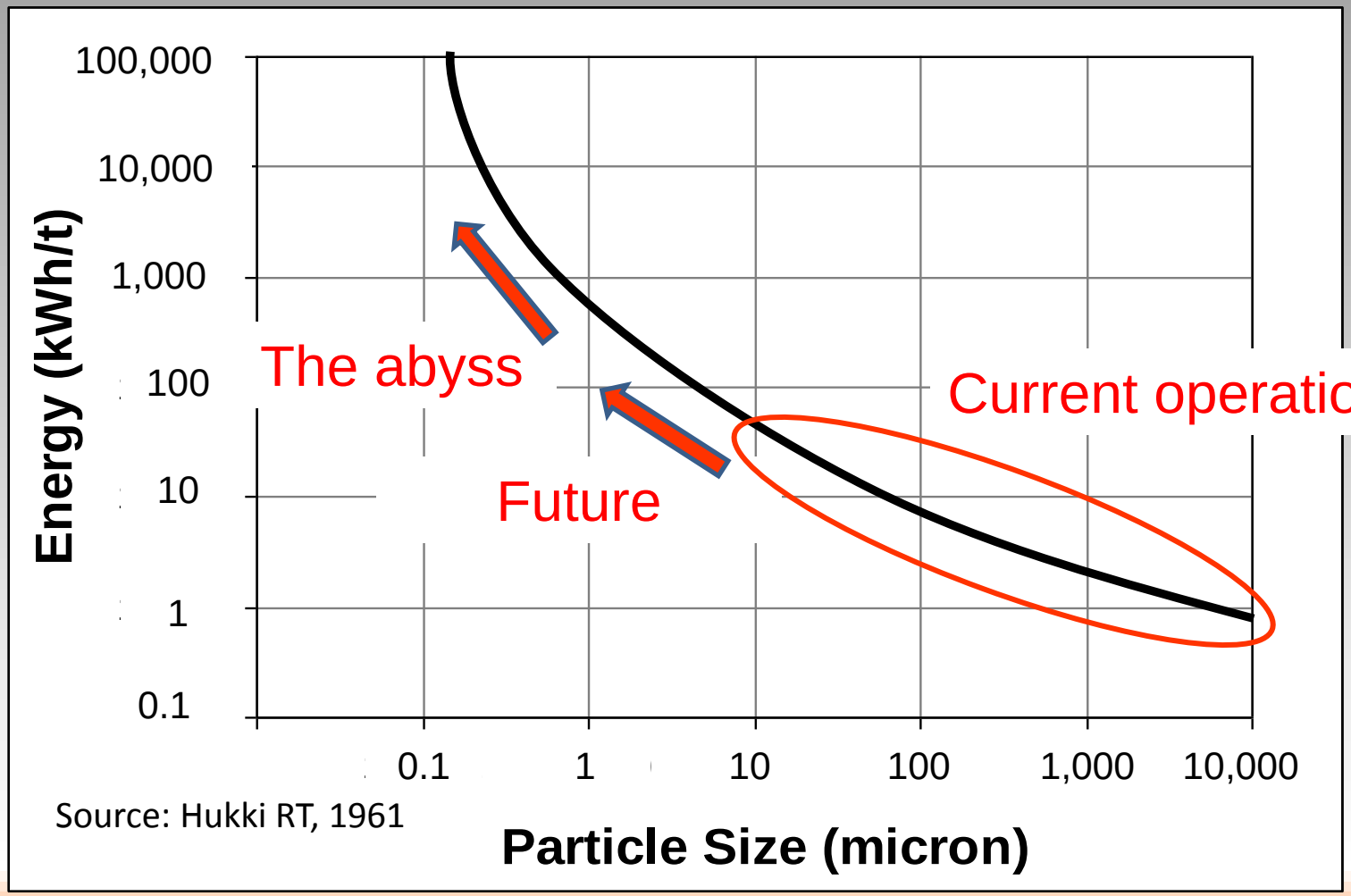
About 50% of minesite energy consumption is in comminution

Consumption of electrical energy



Things are only going to get worse…

Energy & grind size

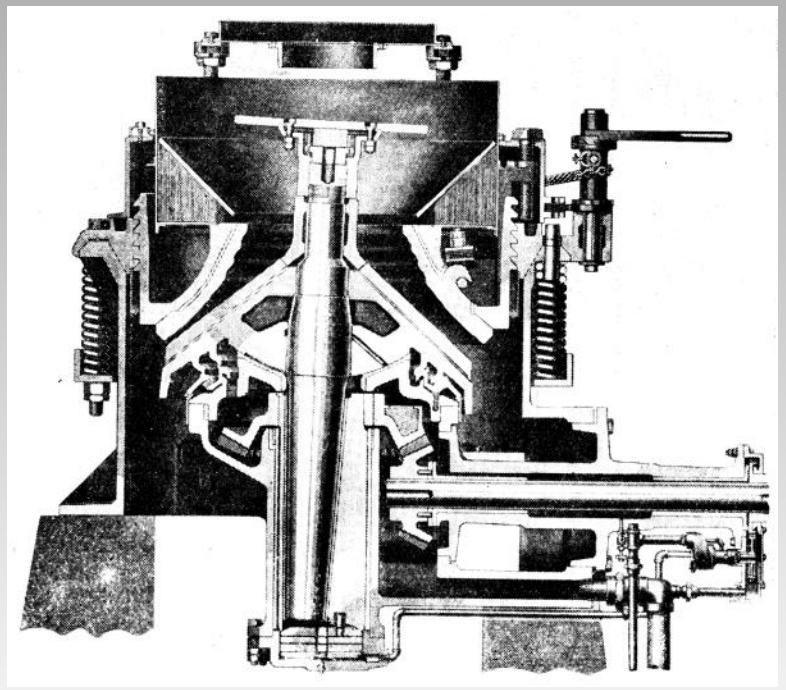


Things are only going to get worse…

Grinding is expensive in capex, opex and GHG emissions.

It has very low energy efficiency: perhaps 20% in practical terms and only 3-5% in fundamental terms.

The march of technology



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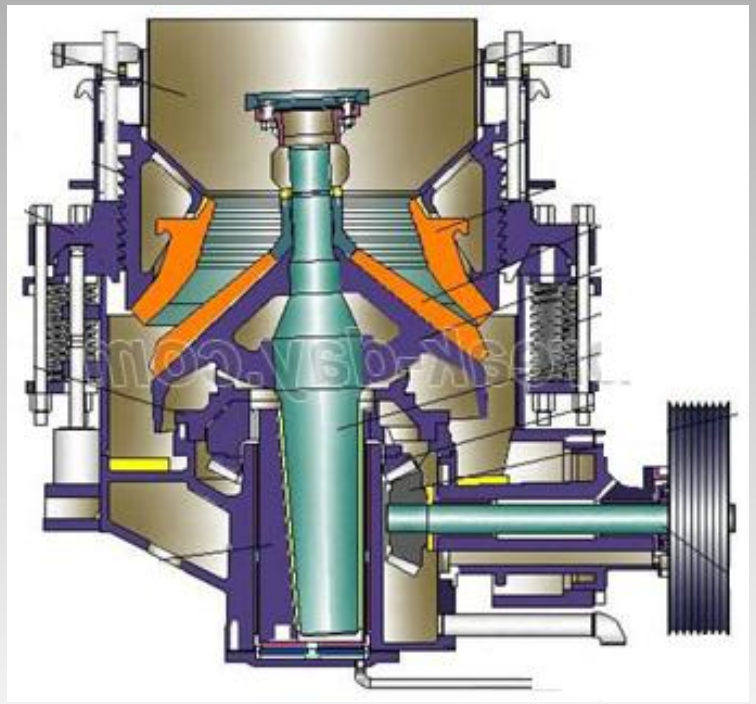
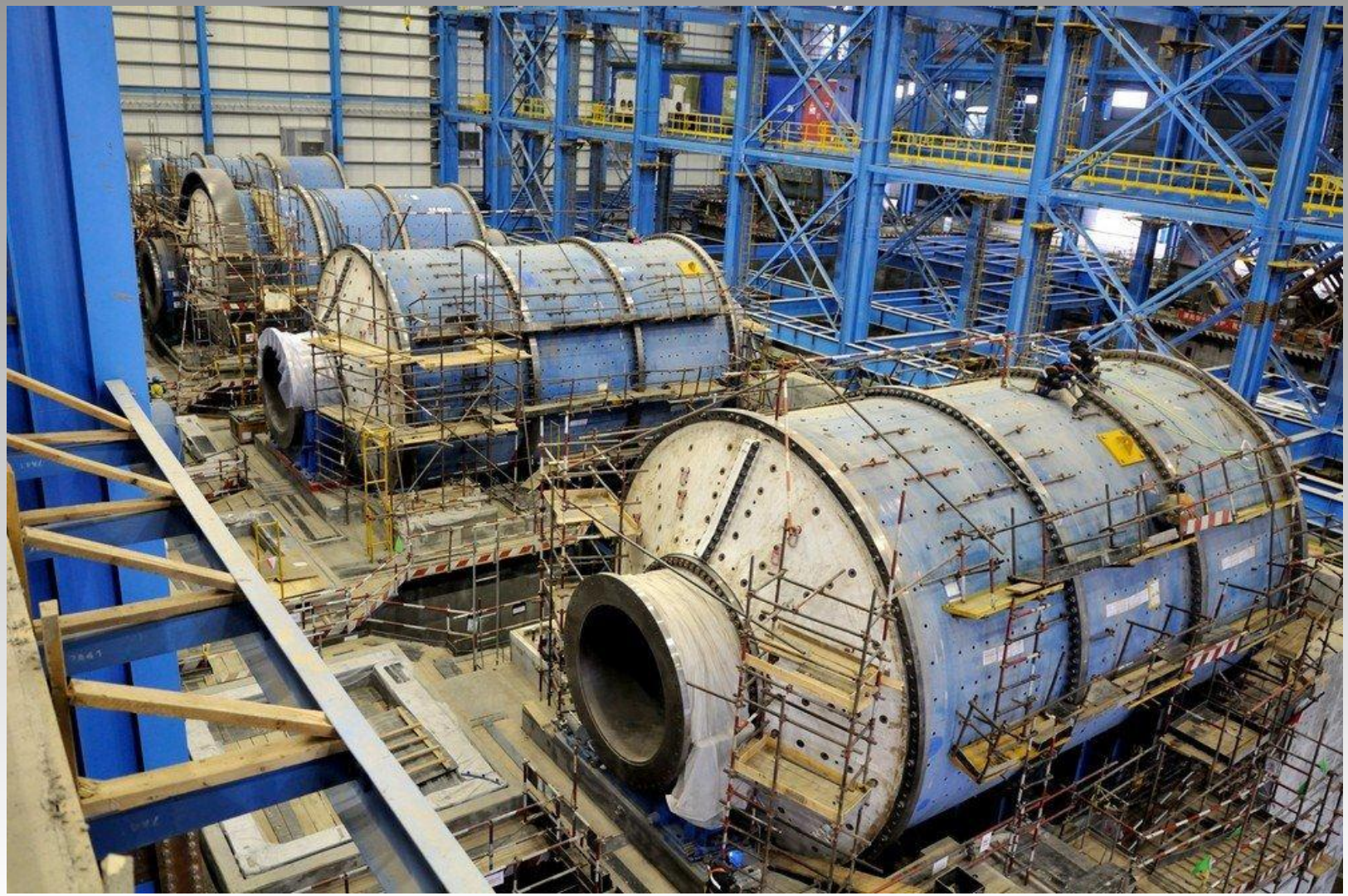


2012

Newcrest Cadia SAG mill, 40’, 20 MW

Citic AG mills, 40’, 26 MW (x 6)



Oyu Tolgoi ball mills (6 x 11.4 MW)

CLIENT	G.C. REF.	PROJECT	LOCATION	EQUIPMENT	YEAR
ESSAR STEEL	54535	MINNESOTA STEEL 3rd LINE	USA	1 SM Ø36'x18.5' – 3x120°	2011
ESSAR STEEL	53534	MINNESOTA STEEL 3rd LINE	USA	1 BM Ø21' x 32'-7" - 3x360°	2011
GIBRALTAR MINES	54533	GIBRALTAR	CANADA	1 SM Ø34'x16' 9" – 3x120°	2011
CITIC HIC.	54529	BONG IRON	LIBERIA	1 SM Ø30' x 16,5' in 3x120°	2011
FLSMIDTH INC.	54527	TASIAST	MAURITANIA	1 SM Ø40' x 26' in 6x120°	2011
F&T	55526	GEITA MINES	TANZANIA	1 END PLATE Ø30' x 18' (2X180°)	2011
FLSMIDTH INC.	54513	XSTRATA II	PERU	1 SM Ø40' x 25' in 6x120°	2010
FLSMIDTH INC.	53514	ESCONDIDA	CHILE	2 BALL MILL SHELL Ø26' X 42' (3X360°)	2010
FLSMIDTH INC.	54511	CASERONES	CHILE	2 BALL MILL SHELL Ø27' X 46' (6X180°)	2010
FLSMIDTH INC.	54510	DETOUR GOLD	CANADA	1 SM Ø36' x 20' in 4x180°	2010
FLSMIDTH INC.	54468	DETOUR GOLD	CANADA	2 BALL MILL SHELL Ø26' X 40.5' (6X180°)	2010
FLSMIDTH INC.	54502	CENTRAL ASHANTI	GHANA	1 SM Ø34' x 22' in 2x180°	2010
METSO MINERALS - USA	54504	PAVLIK GOLD	RUSSIA	1 SM Ø28' x 13' in 2x180°	2010
METSO MINERALS - USA	53503	PAVLIK GOLD	RUSSIA	1 BALL MILL SHELL Ø18' X 32'	2010
FLSMIDTH MINERALS-USA	54494	TOROMOCHO	PERU	1 SM Ø40' x 26' in 6x120°	2009
METSO MINERALS - USA	54486	NORILSK	RUSSIA	1 SM Ø34' x 16' 9" in 3x120°	2009
METSO MINERALS - USA	53442	SEDIBELO	SUDAFRICA	1 BALL MILL SHELL Ø22' X 36,5'	2008
OUTOTEC FIN	53451	PIRDOP	BULGARIA	1 BALL MILL SHELL Ø6500X7800 MM	2008
FLSMIDTH MINERALS-USA	53465	PICADILLY POTASH	CANADA	3 BALL MILL SHELL Ø14.5' X 47'	2008
FLSMIDTH MINERALS-USA	53470	XSTRATA II - LAS BAMBAS	PERU	2 BALL MILL SHELL Ø26' X 40.5'	2008
METSO MINERALS - USA	53472	SEDIBELO	SUDAFRICA	1 BALL MILL SHELL Ø22' X 36,5'	2008
METSO MINERALS - USA	54416	THOMPSON CREEK	CANADA	1 SM Ø36' x 17,75' in 3x120°	2008
METSO MINERALS - USA	54419	PETAQUILLA I	PANAMA	1 SM Ø38' x 24' in 4x180°	2008
METSO MINERALS - USA	54418	ESCONDIDA	CHILE	1 SM Ø40' x 24'8" en 4x180°	2008
METSO MINERALS - USA	54421	MT. MILLIGAN	CANADA	1 SM Ø38' x 24' in 6x120°	2008
FLSMIDTH MINERALS-USA	54429	CASERONES	CHILE	1 SM Ø40' x 26' in 6x120°	2010
FLSMIDTH MINERALS-USA	54427	KAZAKHMYS	KAZAJSTAN	1 SM Ø40' x 26' in 6x120°	2010
FLSMIDTH MINERALS-USA	54430	LAS BAMBAS	PERU	1 SM Ø40' x 25' in 6x120°	2010
METSO MINERALS - USA	54436	PETAQUILLA II	PANAMA	1 SM Ø38' x 24' in 4x180°	2008

Very big mills on order

What are the solutions?

Incremental improvements

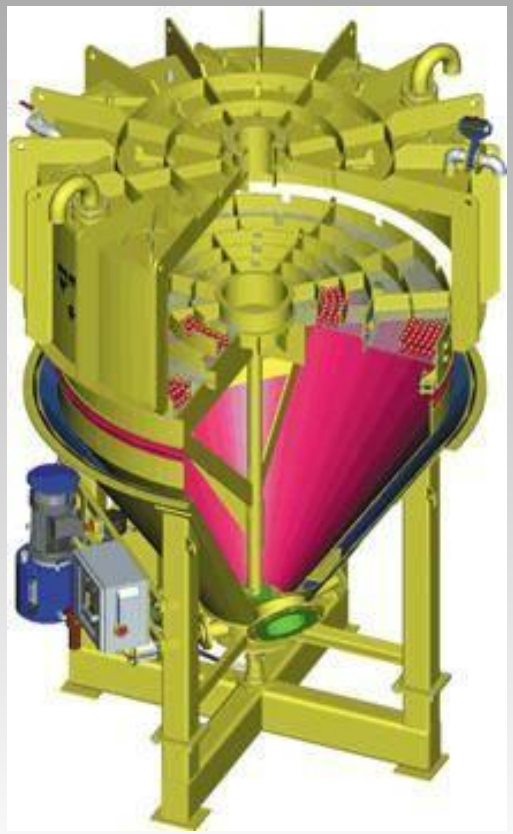
Barrick Gold Findings : Energy and GHG Reductions from Three Improvement Events

- 60,000 MWh annual savings
- 0.5% net efficiency improvement for Barrick global
- 43,000 tonnes of CO_2(e) annual reduction
- Average improvement of 5.3% for 3 mine sites' total energy.
- $5.2 million annual direct electrical savings
- $1.1 million potential future annual savings with CO_2 projected at $25/tonne

Reference: Buckingham et al, 2011; Improving Energy Efficiency in Barrick Grinding Circuits

Smart blasting

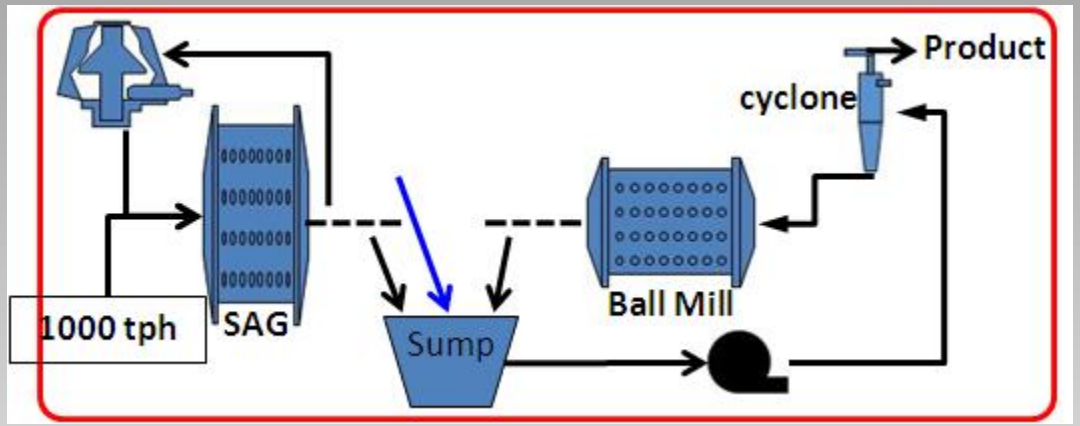
Don’t grind: pre-concentrate

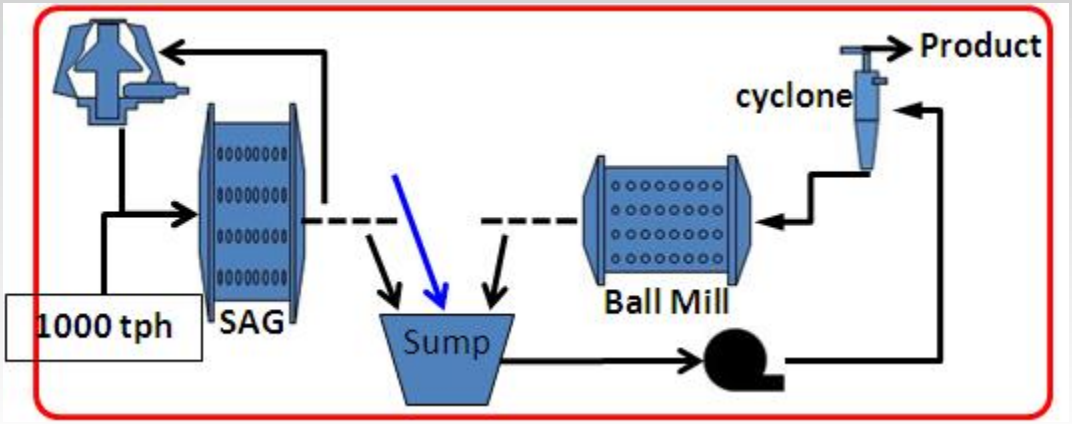


Jig

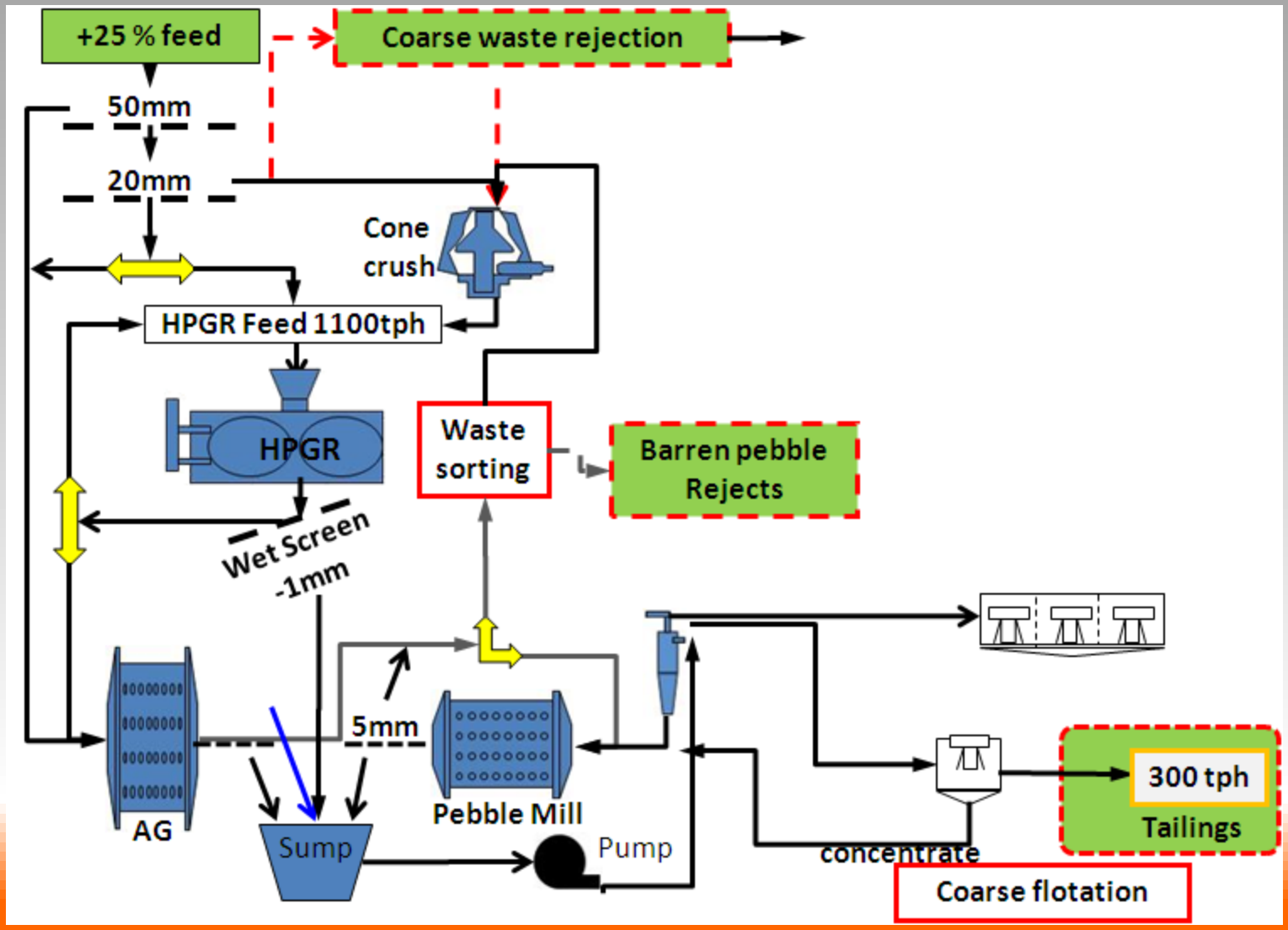
Electromagnetic sorter

Novel flowsheets





Novel flowsheets

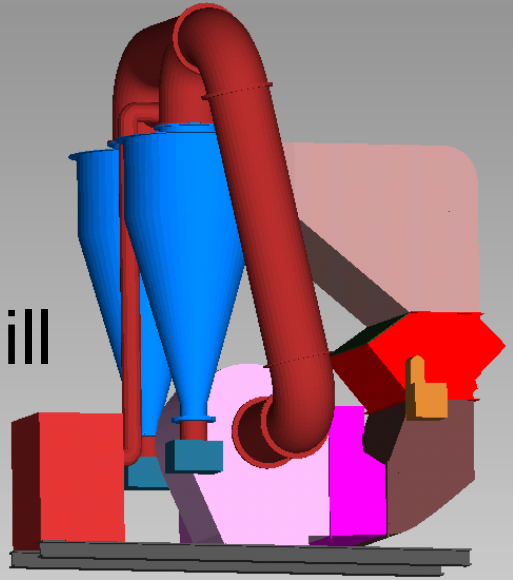


Novel flowsheets

- 60% reduction in total energy
- 3% increase in metal recovery

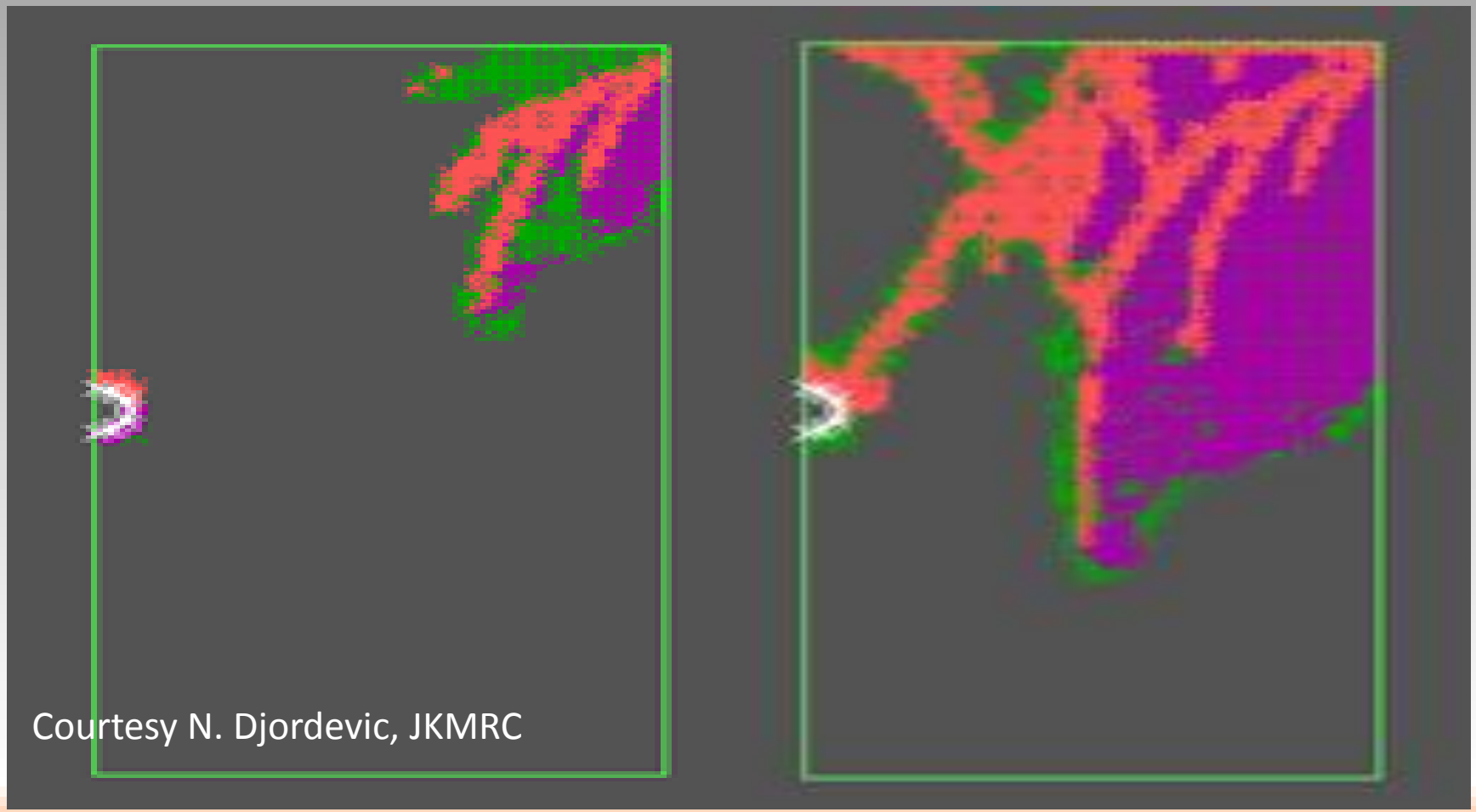
Do we need AG/SAG mills at all?

Plasma Mill



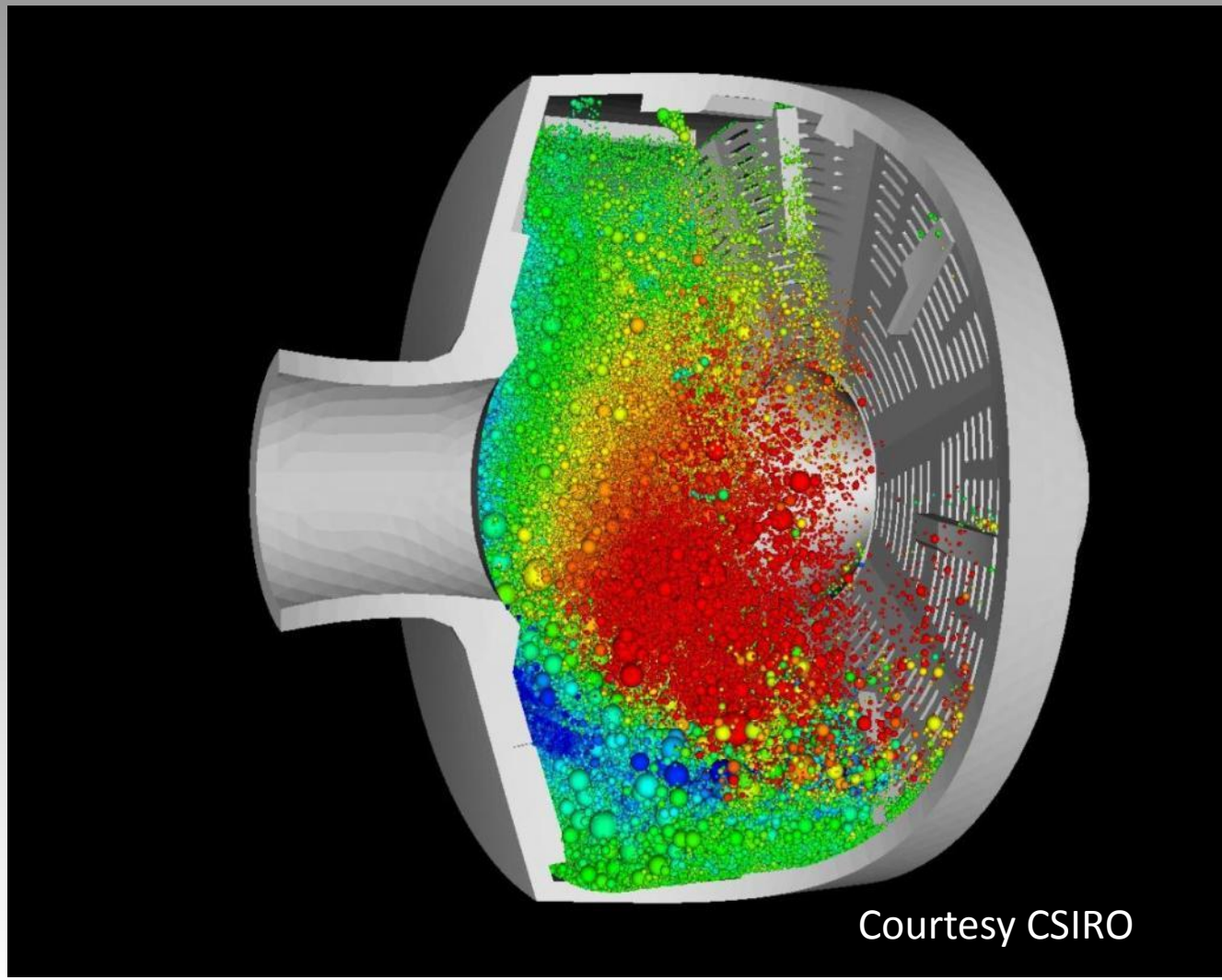
New comminution technology

Researching the fundamentals



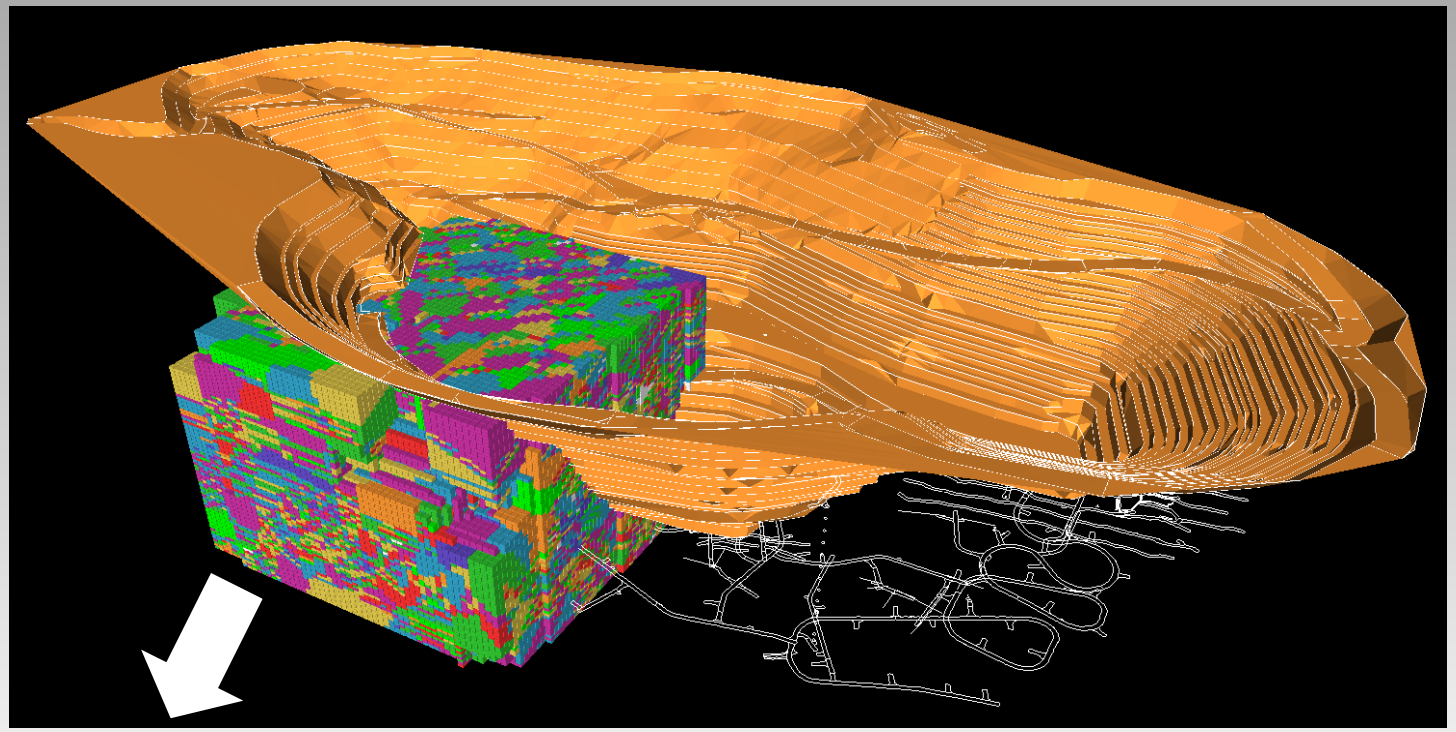
Finite element modelling of rock fracture

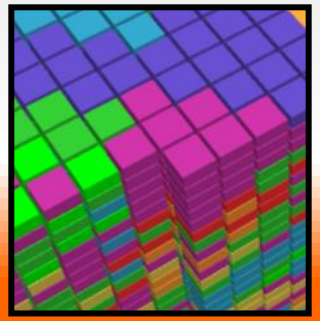
Researching the fundamentals



Discrete element modelling of milling

Optimising the value chain - geometallurgy





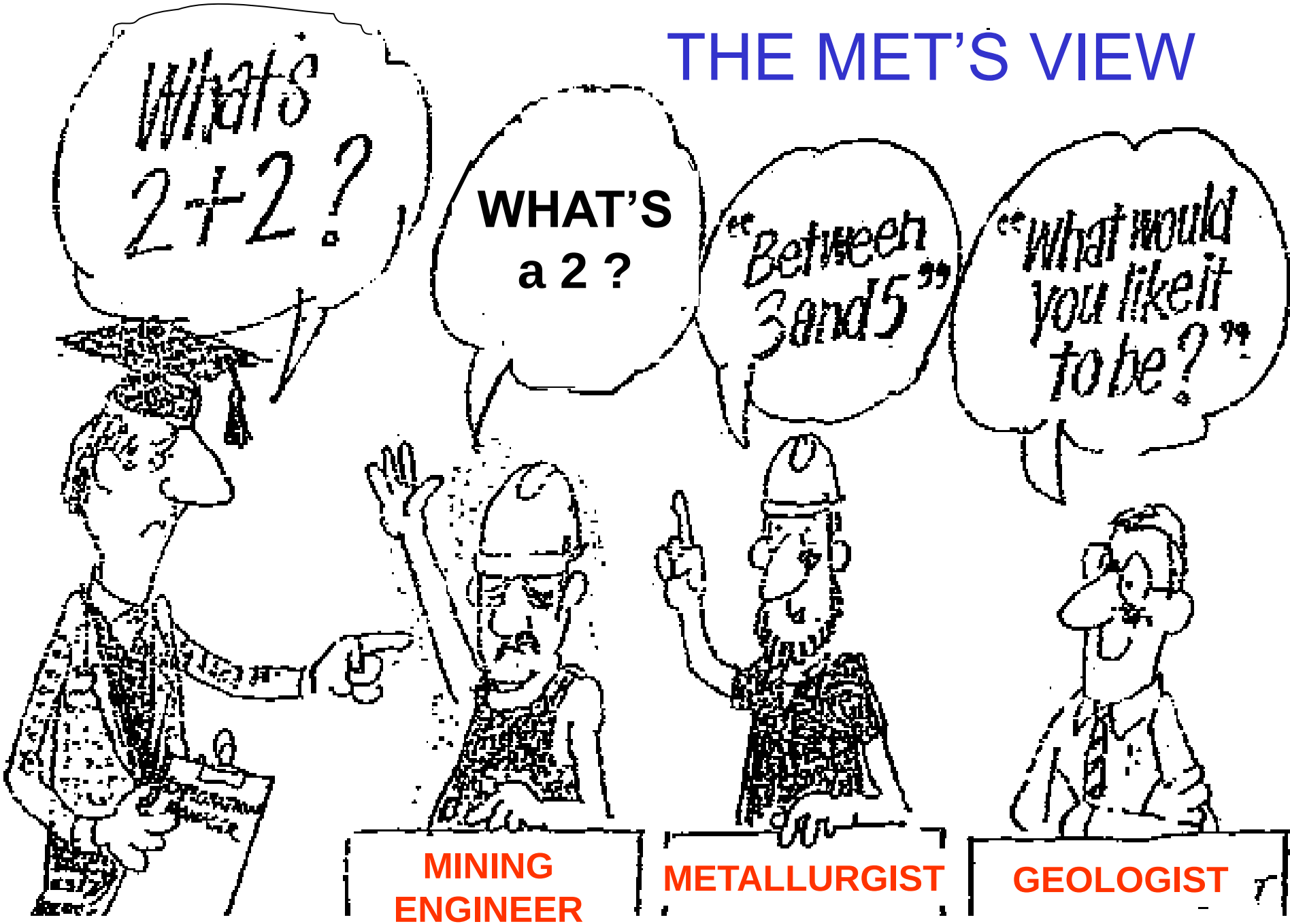
Each Model Cell to Contain

- Metal Content (Ounces)
- CO_2 Produced (CO_2/Oz)
- Total Water Consumption (Ml/Oz)
- Total Energy Consumption (kWhr/Oz)
- Total Cost (oz)

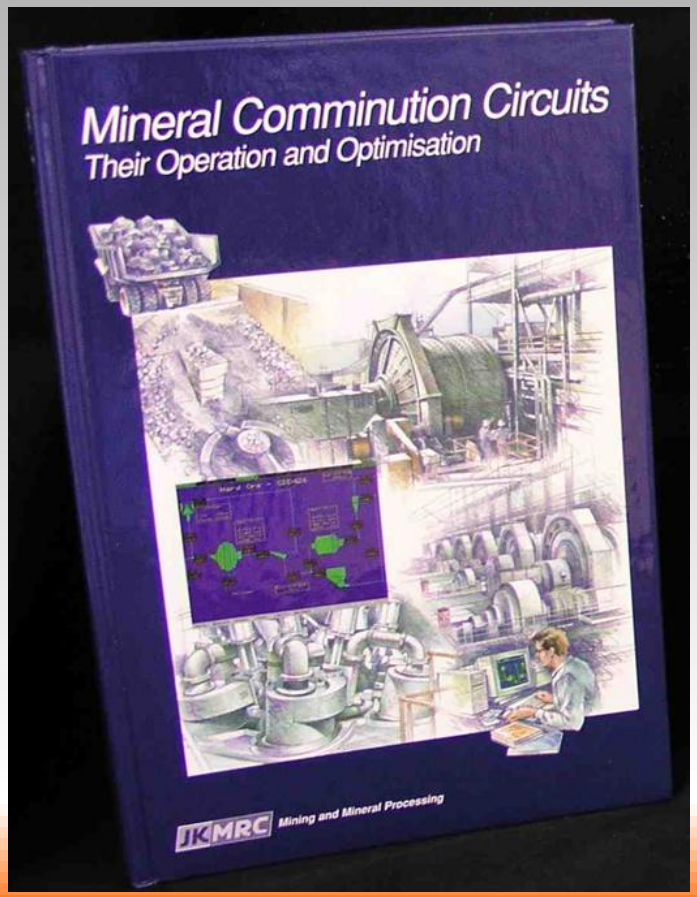
Courtesy CSIRO

Courtesy CRC Ore

THE MET'S VIEW



Professional development



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Vision

To accelerate implementation of energy-efficient comminution strategies through promotion of research, data and industry benefits

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it needs to be more energy efficient.

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Owen Hegarty, CEEC Patron

Welcome to the Coalition for Eco-Efficient Comminution

CEEC reviews technical papers, conference papers and presentations, publications and press articles from around the world. The tabs on the left will give you an insight into CEEC's selection of the most relevant reports relating to comminution, energy efficiency , modelling, simulation and more.

How? – information and awareness

- Key papers & reports posted to website.
- LinkedIn technical discussions.
- Presentations at conferences.
- Media.
- CEEC Medal.
- CEEC workshop, June 2012.

Stretch Targets

- 20% energy reduction ‘now’
- 40% by 2020
- 80% by 2050

The takeaway message

1. Comminution is very expensive.
2. We need smart ideas to reduce comminution capex, opex and GHG.
3. There is no shortage of smart ideas.
4. But we need a synthesis: whole > sum.
5. …..and investment in innovation.

Acknowledgements

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The measure of a man is what he does with power

- *Plato* *(429-347 BCE)*