

The science behind success

Asset or Liability? Integrated thinking for mine planning and legacy mines

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PLAN



OPERATE




REGENERATE

Asset or liability

- Framing the question
 - Now, or 100 years from now?
 - From what perspective: society, nature, regulator, landowner, investor, future generations?
 - What defines asset, financial?
 - What defines liability, financial?

SUSTAINABILITY

- Shared value of health and safety
- Safeguard our social licence to operate
- Committed to our 'Net Zero' target and supporting our local communities:
 - Convert Mt Rawdon open pit into a 1-2GW Pumped Hydro generator
 - Feasibility Study to be completed in FY23
 - Significant new renewable energy source to support Queensland's renewable energy targets
 - Continuing asset in the community after mining ends



Steward of
Dow Jones Sustainability Indices
Powered by the S&P Global DBI

ISS ESG
'Enviro' category improved from 6 to 1
and 'Social' category improved from 8
to 2 (year-on-year)

MSCI ESG RATINGS
AA
CCC B BB A AAA

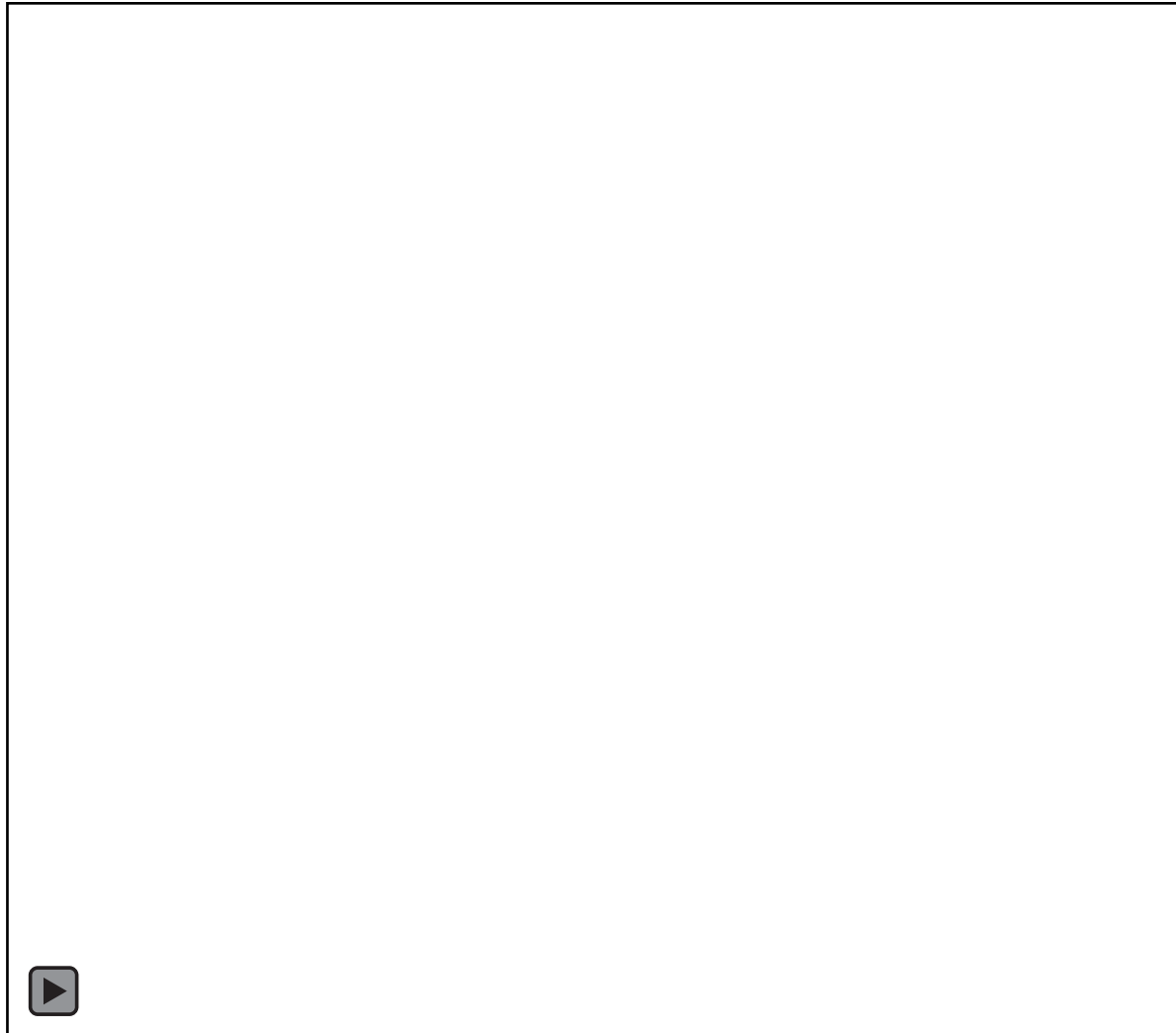
SUSTAINALYTICS
with ESG-CLIMATE
RATED

Mt Rawdon Pumped Hydro Project – more information at
<https://mtrawdonhydro.com.au/>

Assets of the future, liabilities of the present

Asset (future)

- Resource value
- Land value
- Ecological value
- Socioeconomic value
- Utilisation value
- Reputational value

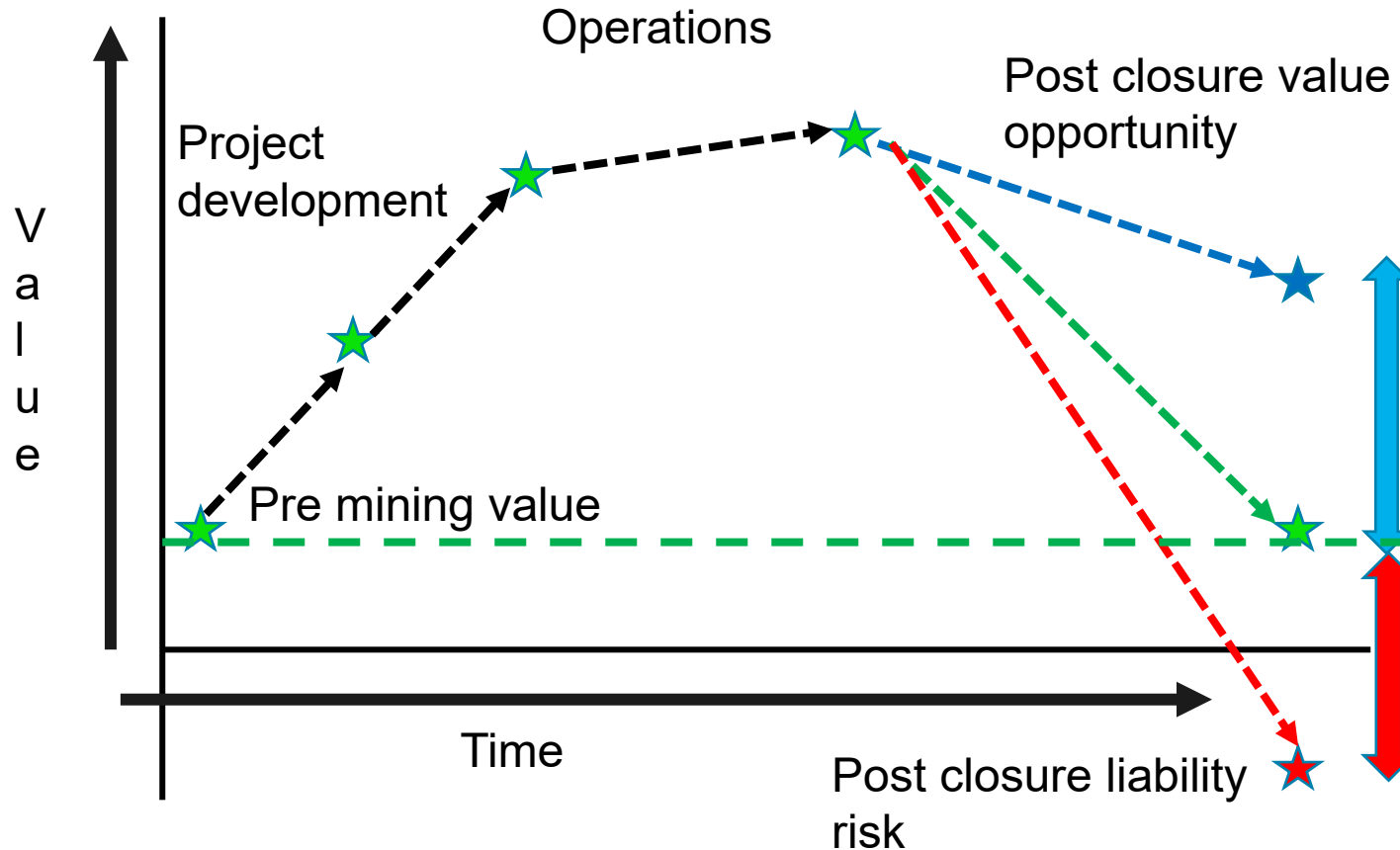


Liability (present)

- Environmental risk
- Socioeconomic risk
- Financial risk
- Reputational risk
- Utilisation risk

Thinking about closure vision and value

Typically it is assumed that mine sites should be “returned to previous condition”



Conflict over land use means sites that are currently a “liability” may have a future value

'Right idea, wrong place'

He added the charity is very much for renewable energy as a response to climate change.

"Unfortunately this fragile and complex wetland ecosystem is just not suitable," he said. "We're not 'nimbies', or anti-solar farms - it's just right idea, wrong place, I'm afraid."

As part of its consultation on the project, Protium said: "We are aware of the importance of the Gwent Levels and local wildlife habitats such as Magor Marsh. By law, we are required to deliver an improvement in local biodiversity of at least 10%".



bbc.co.uk

Land use: Government has overpromised says Royal Society

1 February · Comments



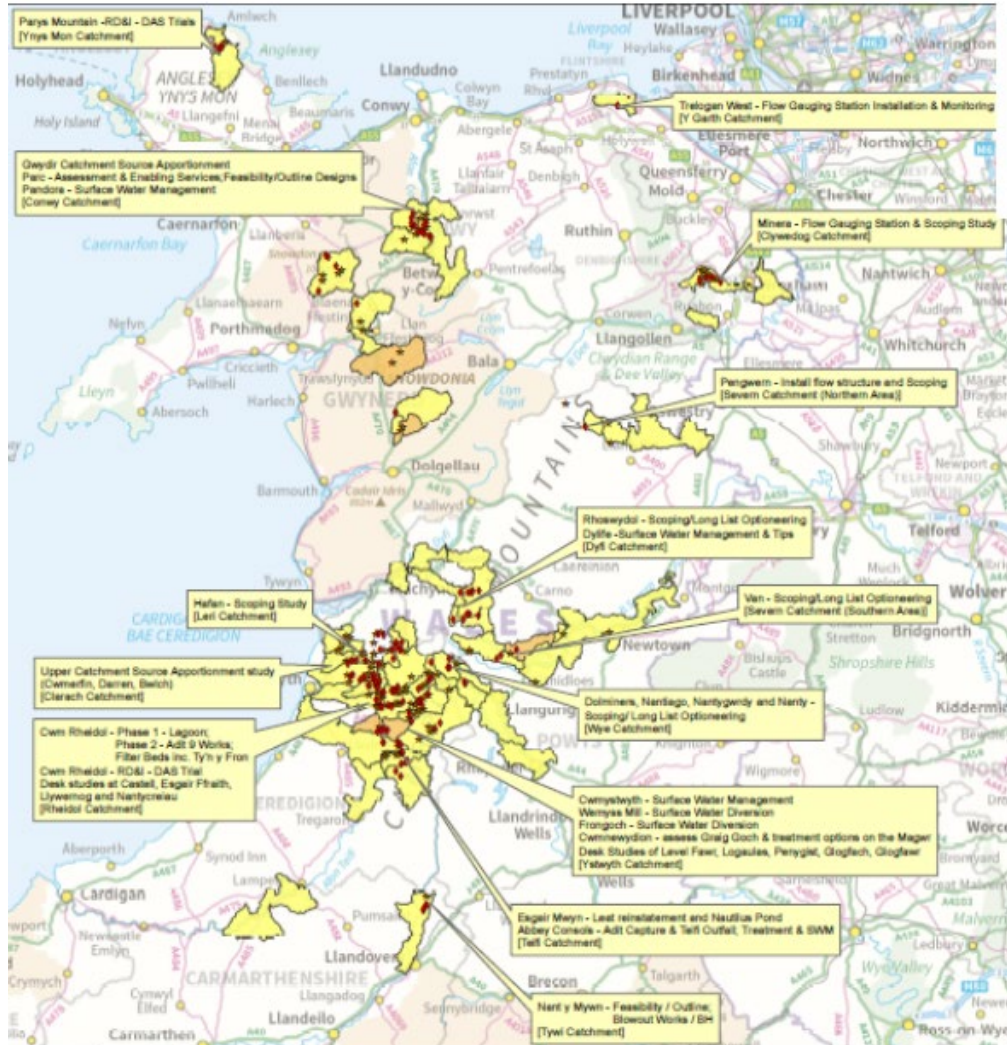
GETTY IMAGES

bbc.co.uk



Wemyss (photo credit Peter Stanley NRW)

Can we even quantify the “liability” of impacted assets



The Coal
Authority



Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales

Failing Waterbodies

Mines

Σ ~1300

129 red

140 amber

278 green

Legend

- ♦ Red Metal Mines [Higher Risk]
- ★ Amber Metal Mines [Medium Risk]
- Yellow Moderate Catchments
- Orange Poor Catchments

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Sewage discharged into rivers 400,000 times in 2020

© 31 March 2021 · Comments



bbc.co.uk

- ~£280m to “fix” the red sites (NRW ball park estimate)
- So far no lawsuits from aquatic ecosystem community...

Valuing clean water as an asset

- What is the value of water
 - Drinking water to customer: £2 m³
 - Treatment of household waste water: £2.90 m³
 - Good quality water in a river catchment?
 - Fish don't pay for their water....
- What about liability for poor quality water
 - Water treatment: 50l/s plant
 - 25 years: £7m (£2m CAPEX + £5m OPEX 25 years) = 18p/ m³
 - 1 year: £2.2m (£2m CAPEX + £0.2m OPEX 1 year) = £1.40/m³
 - Contaminating drinking water: 100 people class action suite: £200 million+
 - Contaminating river water: fish cant hire layers to sue for damages.....

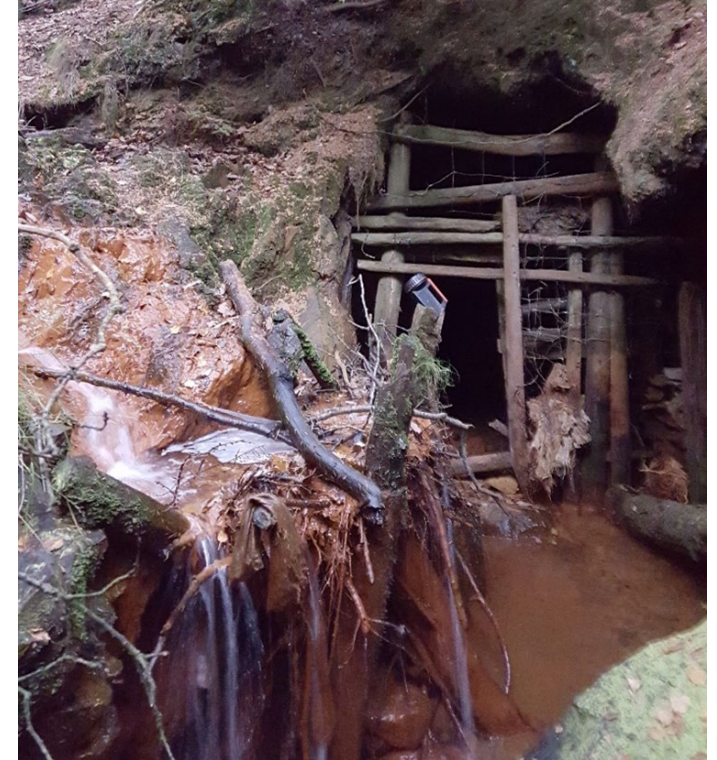


Photo Credit. Peter Stanley (NRW)

Contaminated water “value” in mine discharges

- Typical Zn 10-20 mg/l, typical flow 10-30 l/s
- Annual load range 3-20t of Zn per site
- 10 sites: 30-200t/yr
- Current price zinc: USD \$3,000/t, Future USD \$5,000/t?
- Value today per year: USD \$0.1m - USD\$ 0.6m
- Future value per year: USD \$0.2m - USD \$1m
- Treatment cost per year: USD \$1m - USD \$2m
- Drinking water value per year: USD \$8m - USD \$23m
- Climate change, water may have much higher value in future



- On current trend may become economic to treat water to recover zinc at some point in the future
- However if water was valued as “drinking” water it would be economic today. Reason it is not treated is because it is given no intrinsic value

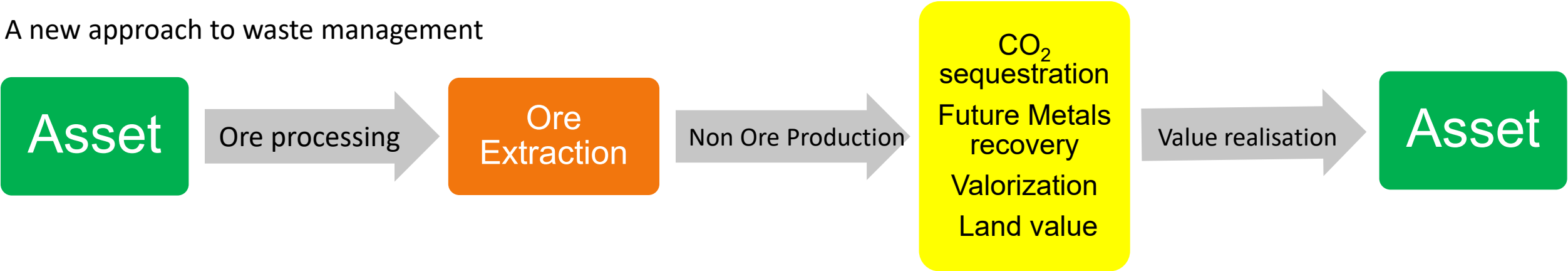
Mine waste asset or Liability

Viewing mine waste in a new way

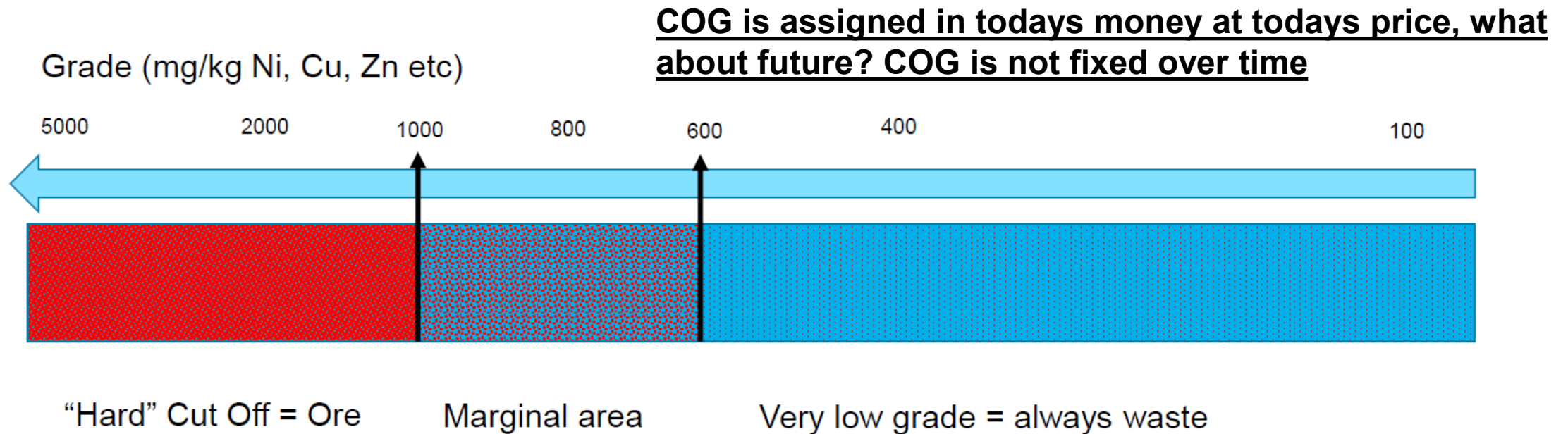
Traditional thinking



A new approach to waste management



What is waste and ore?



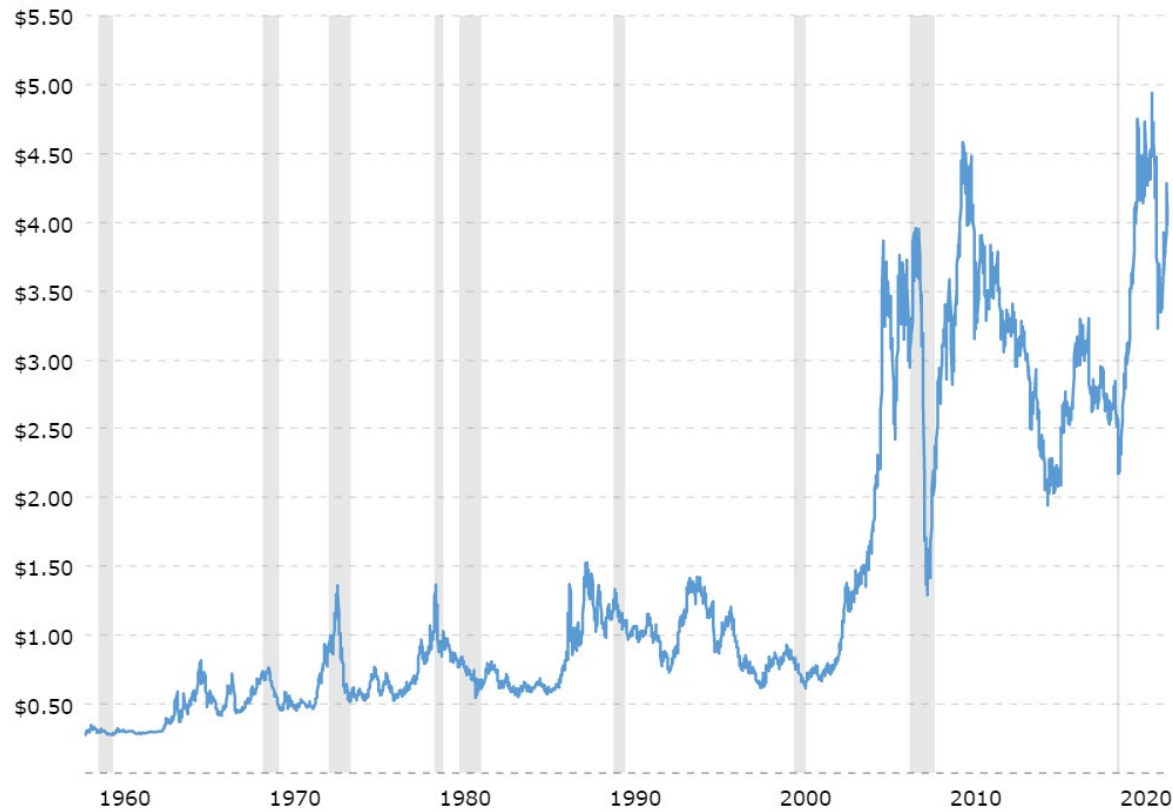
Marginal material can be viewed as **“high grade waste”** or **“low grade ore”**

Waste is often given zero value in the mine model and mine plan, but this assumption needs to be validated:

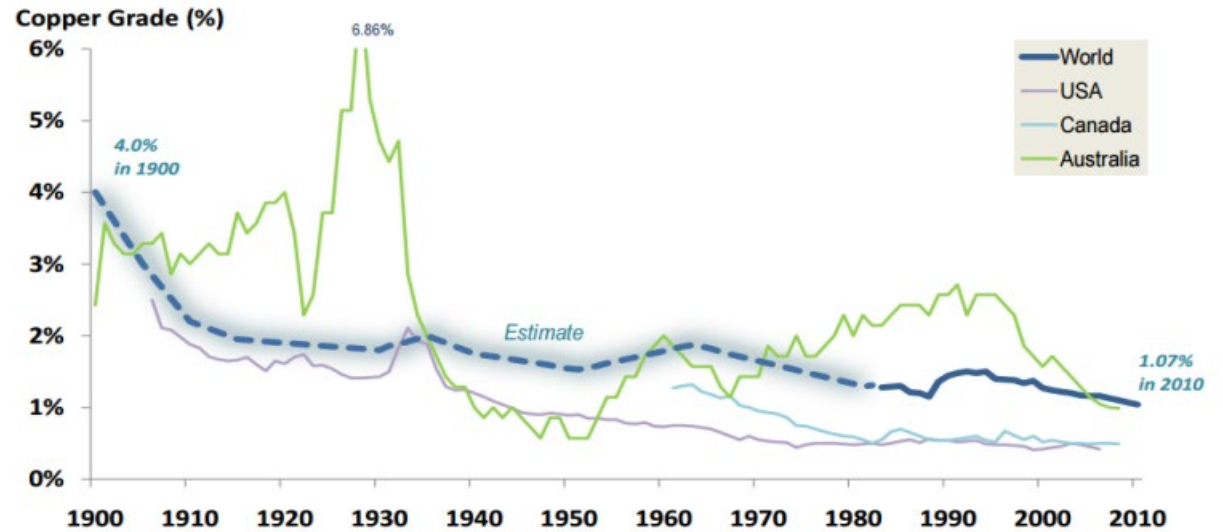
- High risk waste has a strongly negative value due to significant future liability costs/risks of storage.
- If waste is treated as low grade ore and can be processed for net neutral value this still produces a relative positive LOM return if environmental costs/risks over LOM are reduced.

What is the value of resource?

Copper price 60 year historical chart



<https://www.macrotrends.net/1476/copper-prices-historical-chart-data>



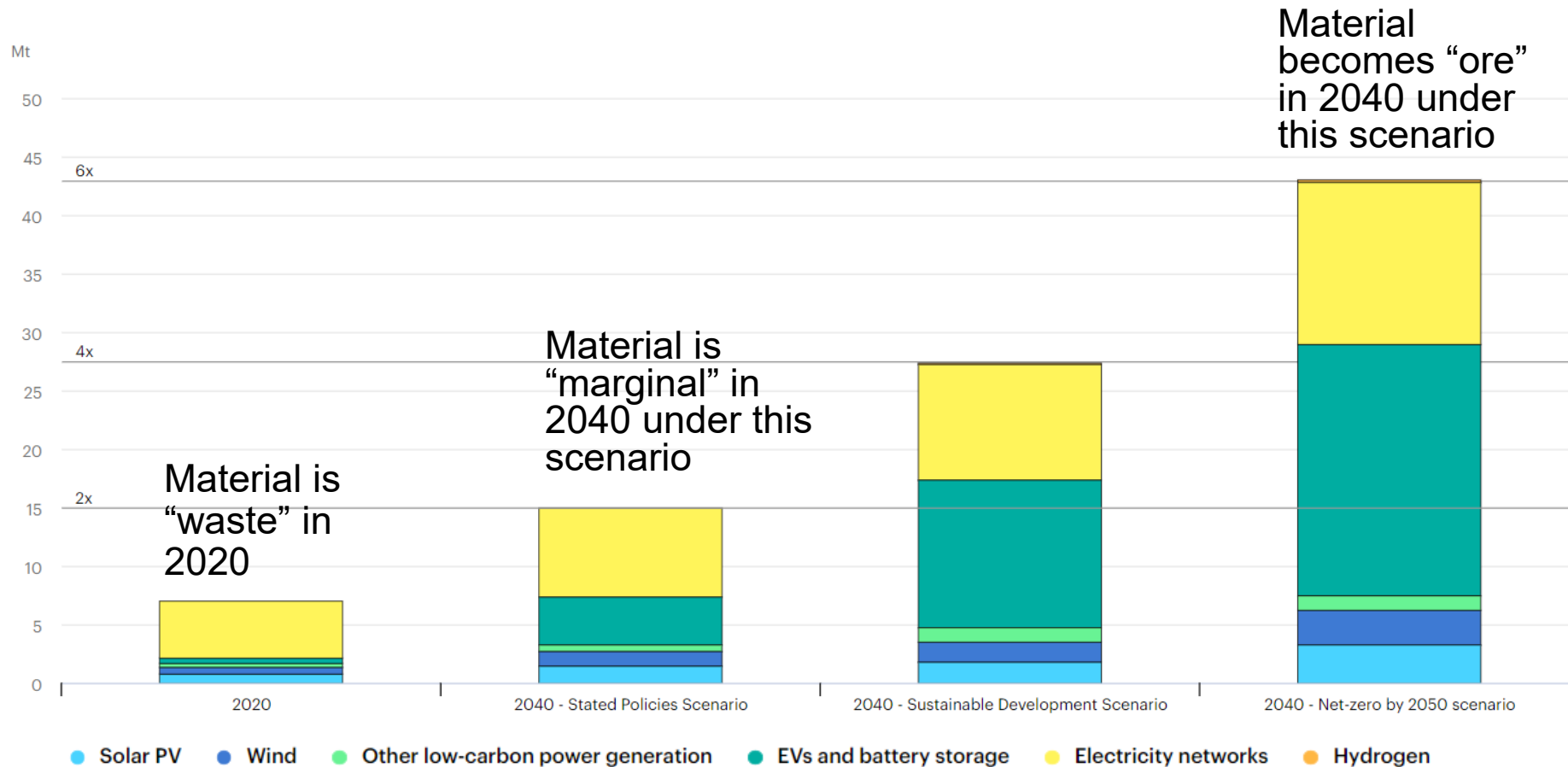
[http://www.minexconsulting.com/publications/Growth Factors for Copper SME-MEMS March 2010.pdf](http://www.minexconsulting.com/publications/Growth%20Factors%20for%20Copper%20SME-MEMS%20March%202010.pdf).

Long term trends

- Price increasing
- Grade decreasing

Long term demand requirement

Total mineral demand for clean energy technologies by scenario, 2020 compared to 2040

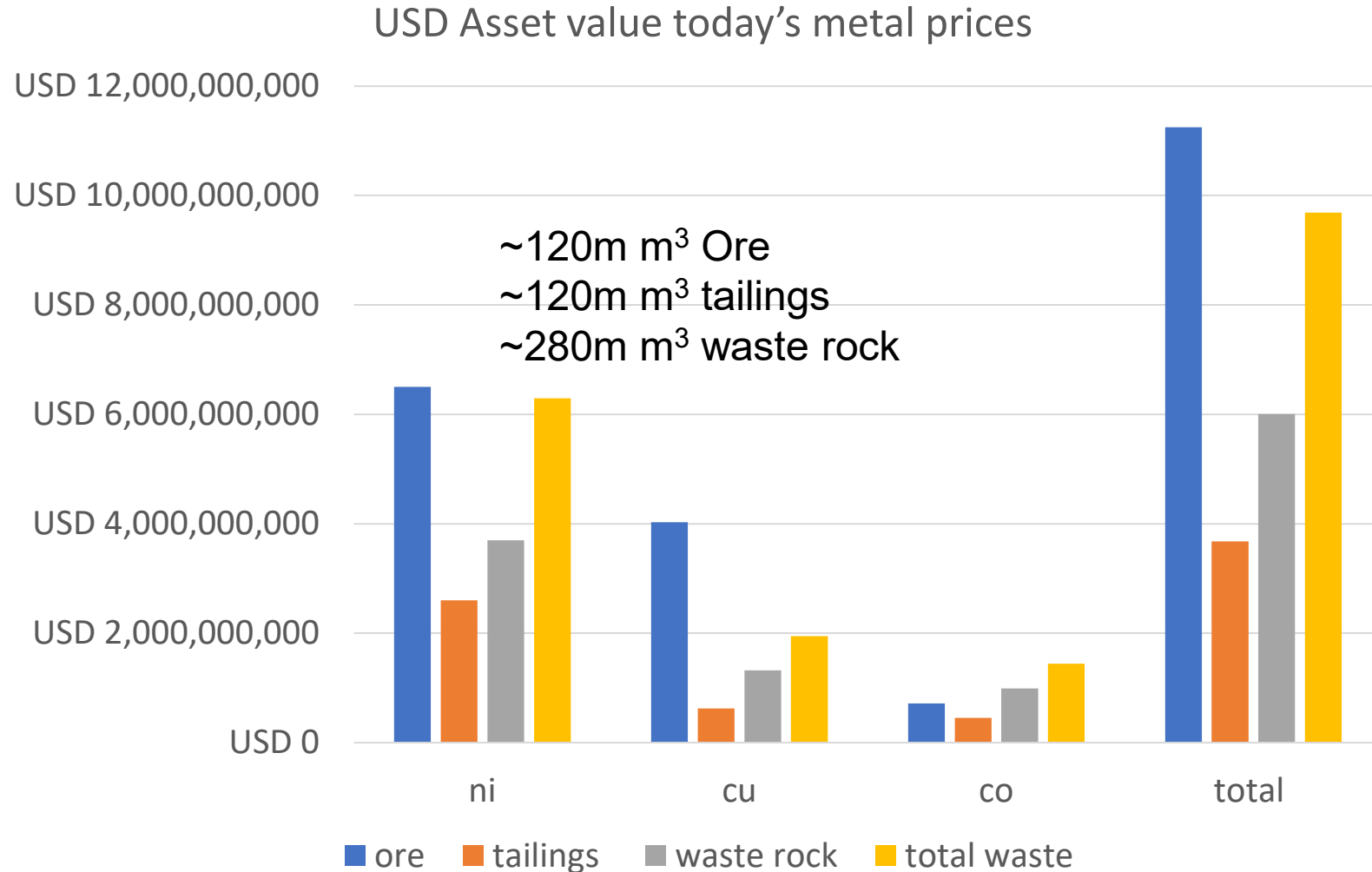


It is impossible to determine in 2020 what will be ore and what will be waste in 2040 because the range in possible outcomes is so extreme

If we truly believe in net zero then much of what is waste today is in fact ore

The truth is the market does not believe in net zero.....

Asset value remaining LOM: Case study (Ni/Cu/Co mine)



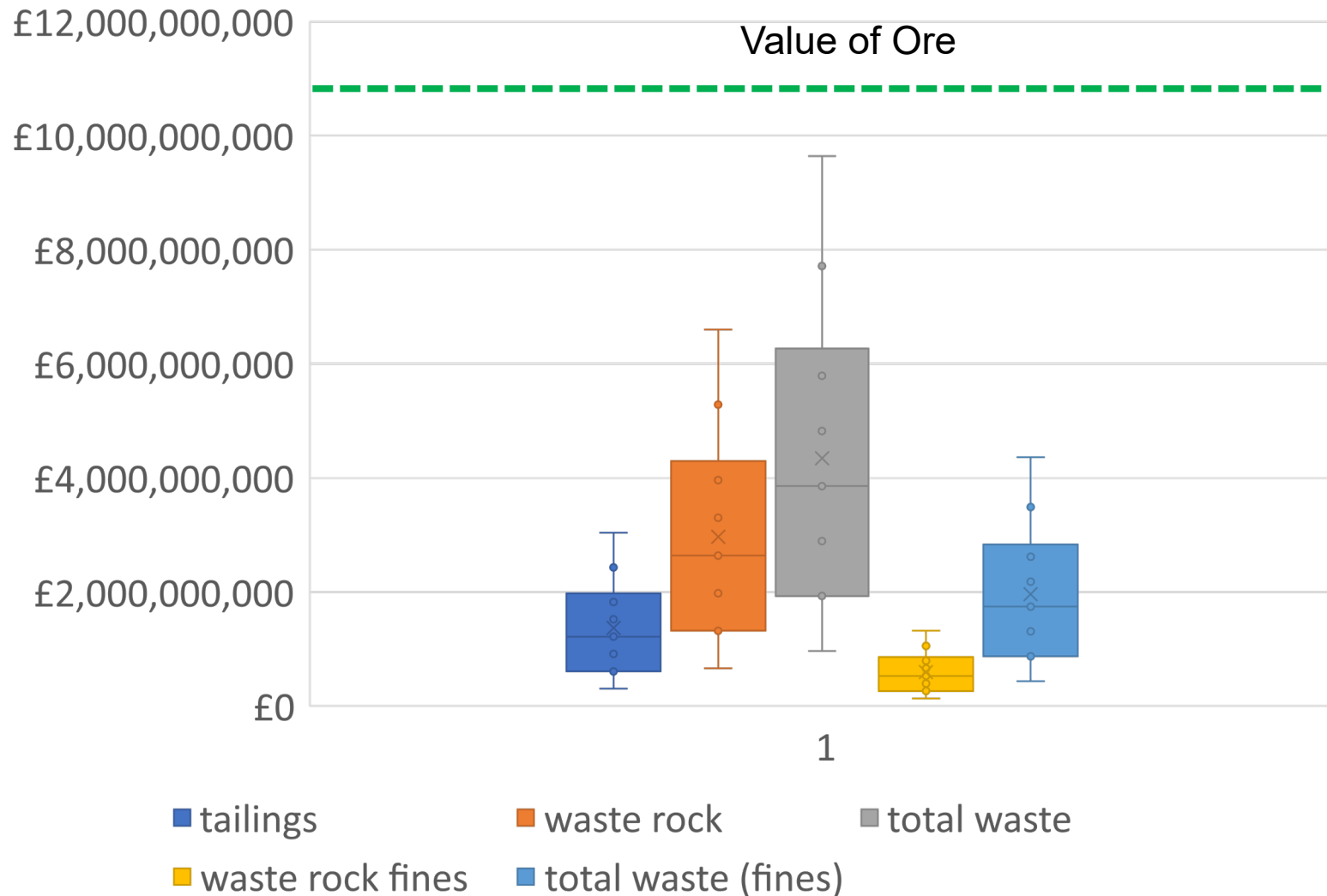
Almost as much 'value' in the waste as is in the ore

*Excluding CCS 'value'

Note plenty of other uses for non ore rock:

- Aggregate
- Drainage rock
- Kitchen worktops...

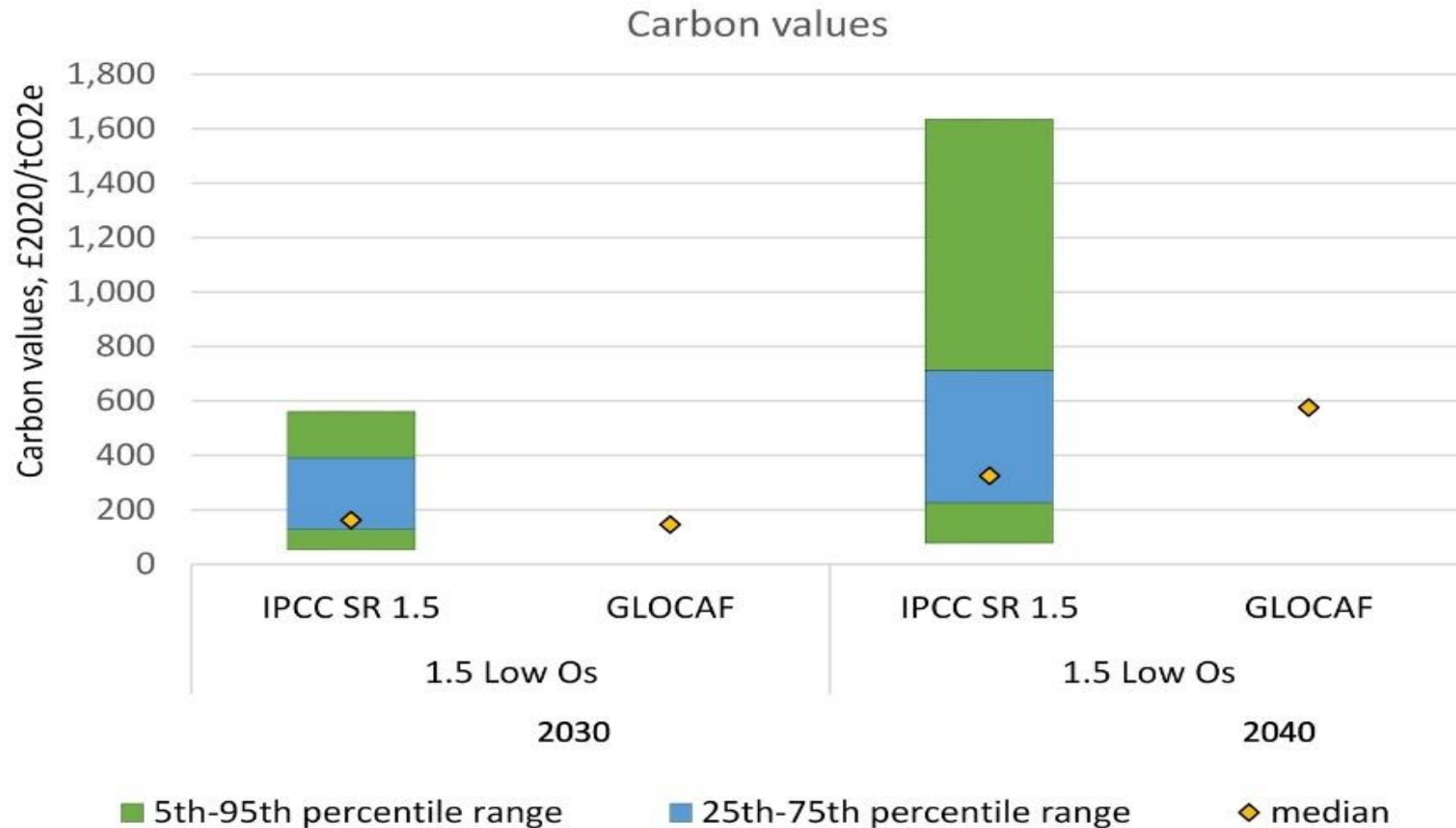
Carbon capture and storage potential (ultra mafic material from same mine)



Total CSS potential

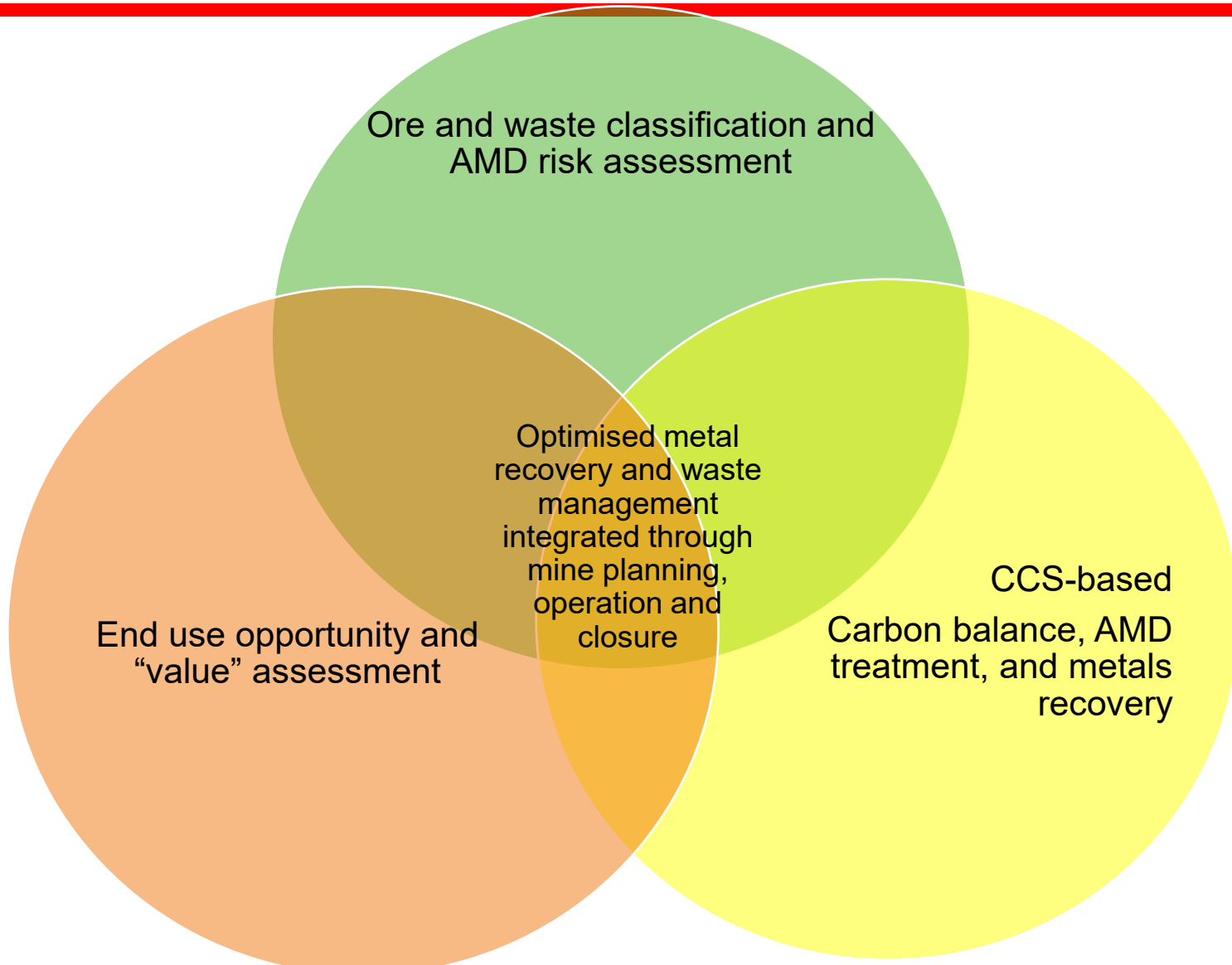
- Tailings = USD \$300m-\$3b
- Waste rock = USD \$600m-\$6b
- Waste rock fines = USD \$60m-\$600m
- Total waste = USD \$1b-\$10b
- Total waste (fines) = USD \$400m-\$4b
- To compare Ore = USD~ \$11b

Carbon Values?



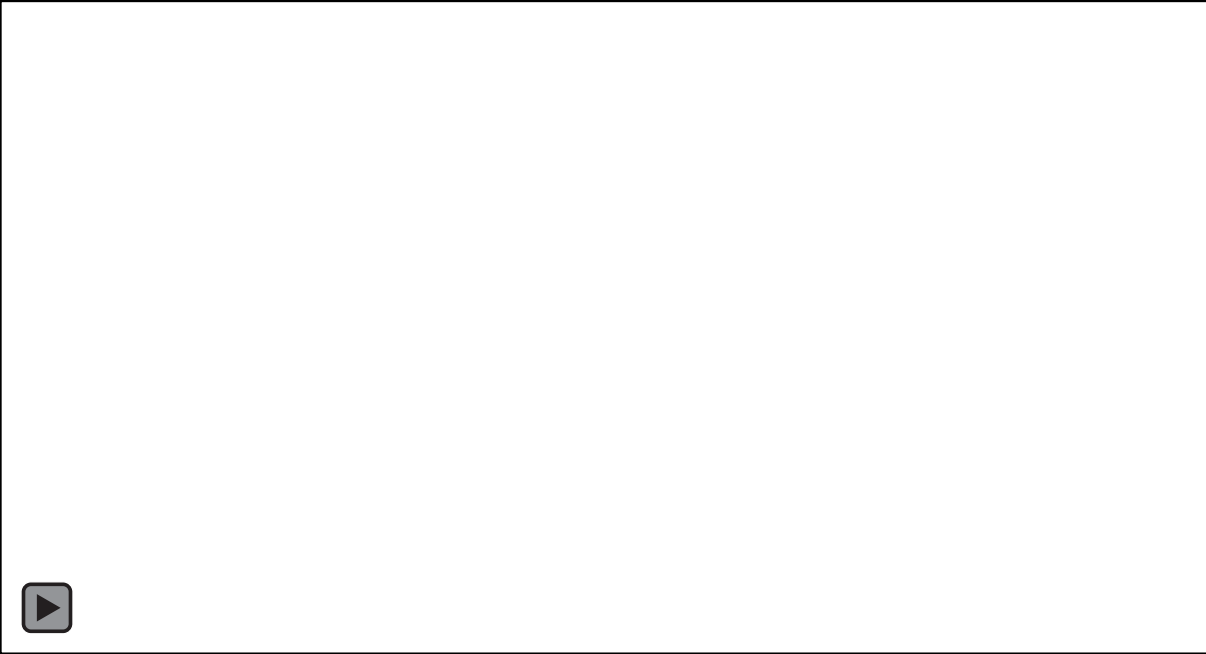
- The range in “value” is so large as to make business decision making very difficult
- Current carbon “price” is not reflective of net zero

Integrated review of project value



Integration of methods to manage and treat mine wastes, in order to reduce risks related to AMD, increase metal recovery efficiency, reduce the overall mining environmental foot print of an operation and maximise long term value realisation

Thank you



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Re-use of waste: European law on wastes

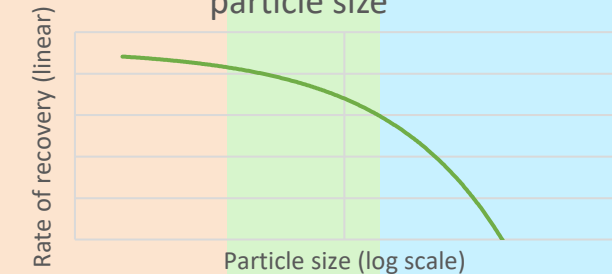
- As matters now stand, waste rock and tailings are defined as a waste by the European Framework Directive on Wastes 2008/98/EC, which burdens operators with tight regulatory restrictions, and reduces the value of the tailings as an asset. There is a possible way to change that position because the Directive includes measures to convert a waste to a non-waste under the following conditions:
- According to Article 6 (1) and (2), *'certain specified waste shall cease to be waste when it has undergone a recovery (including recycling) operation and complies with specific criteria to be developed in line with certain legal conditions, in particular:*
 - a) *The substance or object is commonly used for specific purposes;*
 - b) *There is an existing market or demand for the substance or object;*
 - c) *The use is lawful (substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products);*
 - d) *The use will not lead to overall adverse environmental or human health impacts.'*

Ore processing, “recovery” and closure risk

- Processing is driven by the optimisation of recovery, closure liability is an unintended but unavoidable consequence
- Processing directly impacts on the short and long-term liability from tailings BUT rarely considered in detail when process flow sheets are developed
- Particle size affects hydrological and geotechnical properties including plasticity, strength, permeability, density
- Finer grainsize in many cases increases risk/liability/cost of management and therefore requires considering alongside recovery as a key metric as part of optimising process flow sheets



Schematic recovery improvement vs particle size

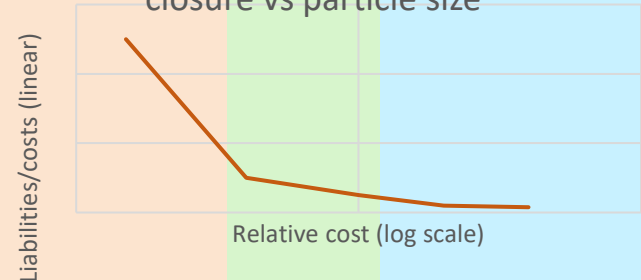


Clay

Silt

Sand

Schematic cost of management and closure vs particle size



Increases in recovery likely lower than increases in cost

Optimal grind size

Recovery improved by finer grinding, cost of closure won't be significantly different