

# The Halion™ Loop: Copper Made Green

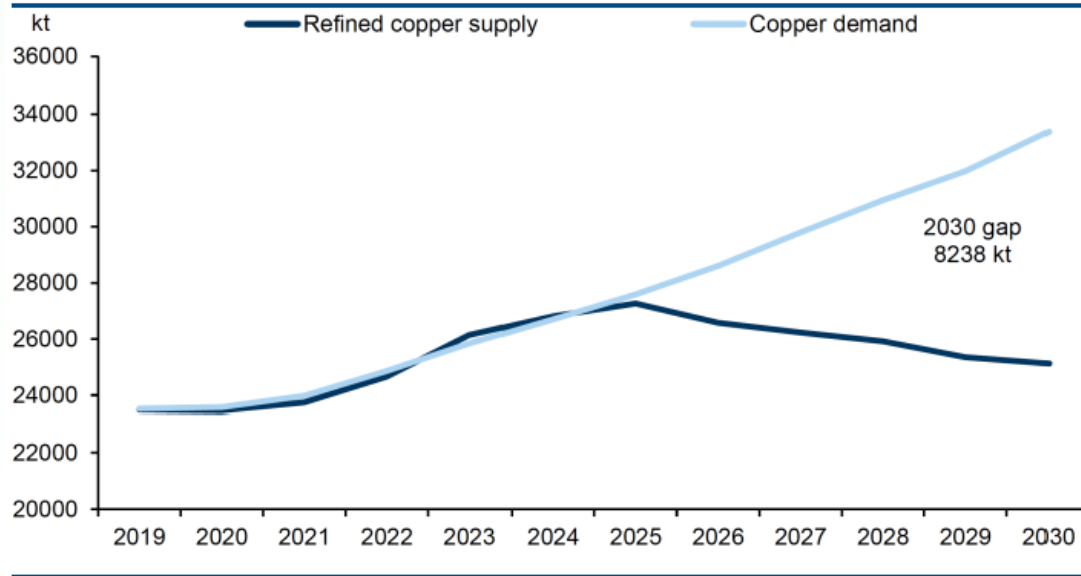
Dave Sammut

Loop Hydrometallurgy



# Global Copper Demand

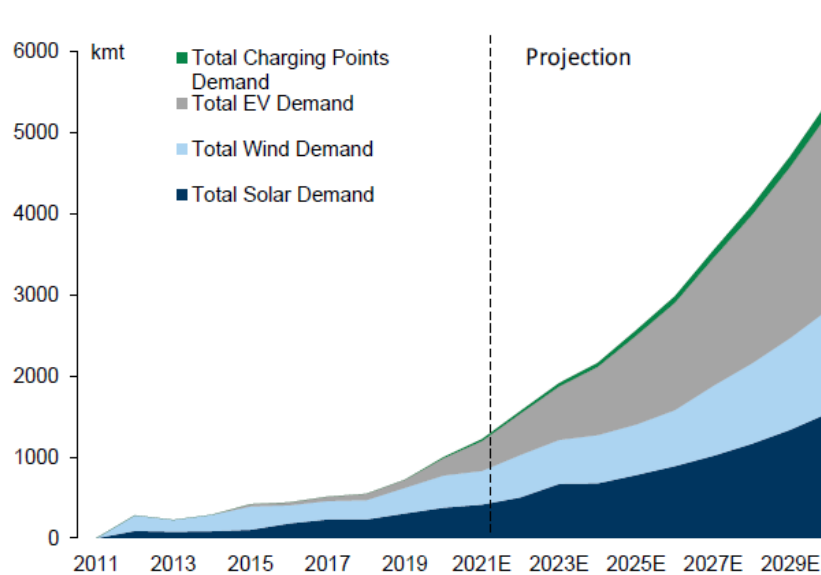
- Copper demand is growing swiftly: ~500kT /yr
- 8MT shortfall forecast by 2030



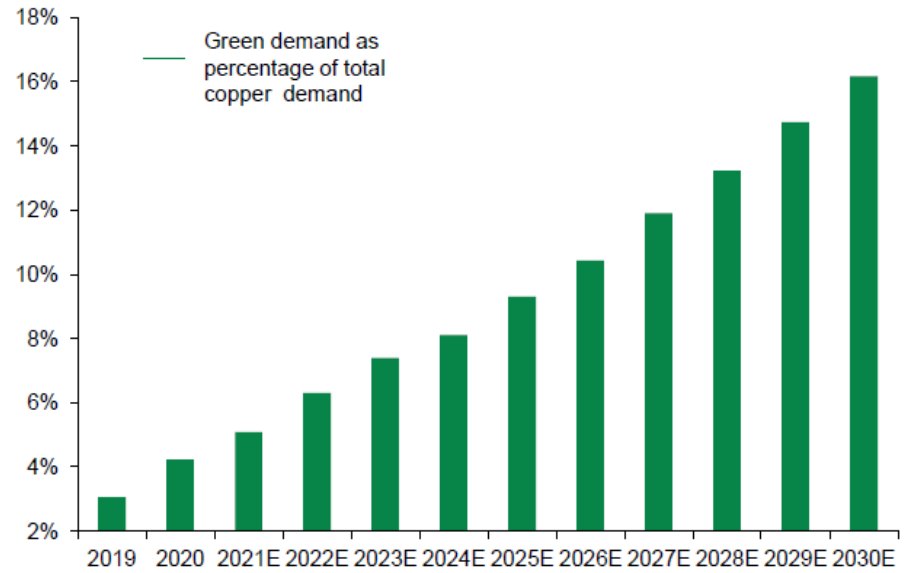
Source: Goldman Sachs.

# Green Copper Demand

- Green applications represent ~60% of total demand growth



Source: Goldman Sachs Global Investment Research



Source: Woodmac, Goldman Sachs Global Investment Research

# Green Copper Demand

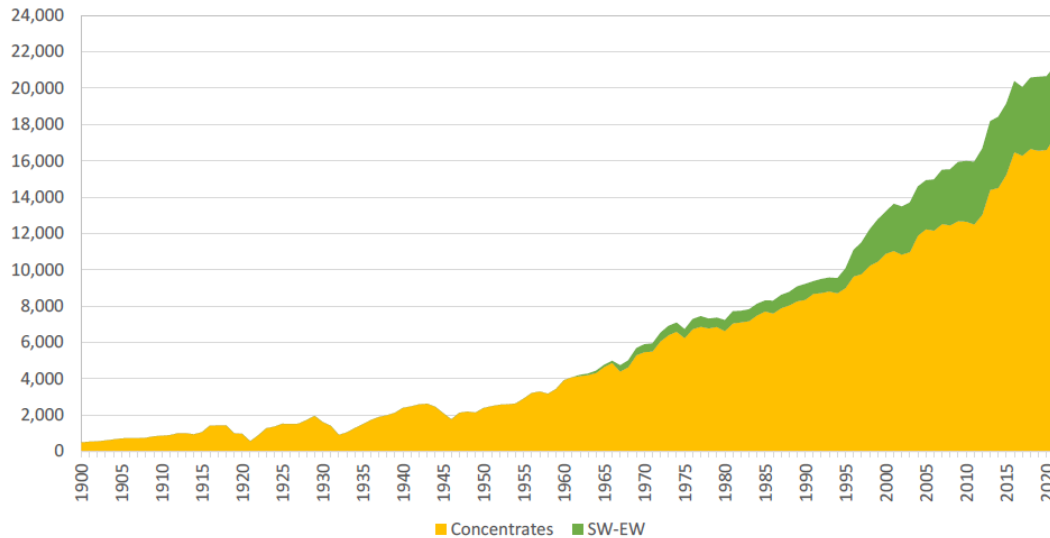


# Smelting Still Dominates

## COPPER MINE PRODUCTION: WORLD COPPER MINE PRODUCTION, 1900-2021

Thousand metric tonnes copper

Source: ICSG



- Smelting & refining: 80% of primary copper production

# Sulphate Hydrometallurgy

- Sulphate hydrometallurgy: 20%
  - Pressure oxidation & sulphate E/W
  - Bacterial leaching & sulphate E/W
  - Heap leaching & sulphate E/W



# Chloride Hydrometallurgy Options

- Chloride hydrometallurgy:
  - Cl/Br leach – Cl/Br E/W
    - Intec Process leach & E/W in mixed halide
  - Cl leach – SX – SO<sub>4</sub> E/W
    - CESL, Nikko Chloride, HydroCopper, Platsol, Kell

# Comparing Hydromet Options

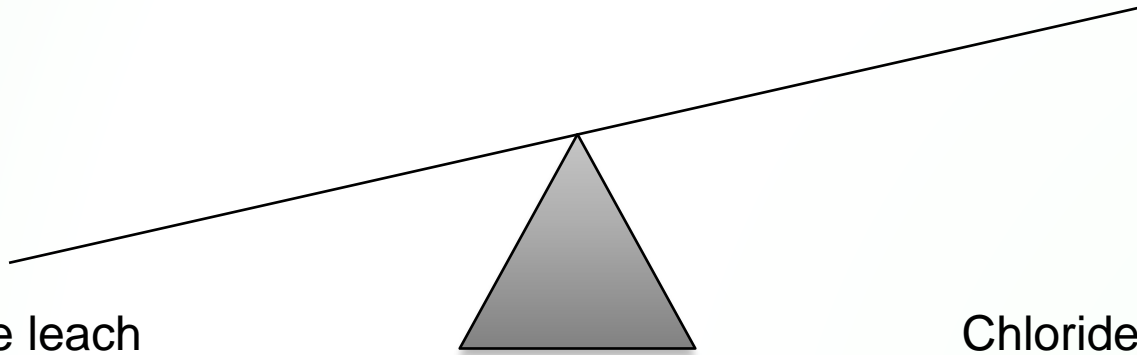
Ease of extraction **OR** Ease of Recovery

Chloride leach

Sulphate E/W

Sulphate leach

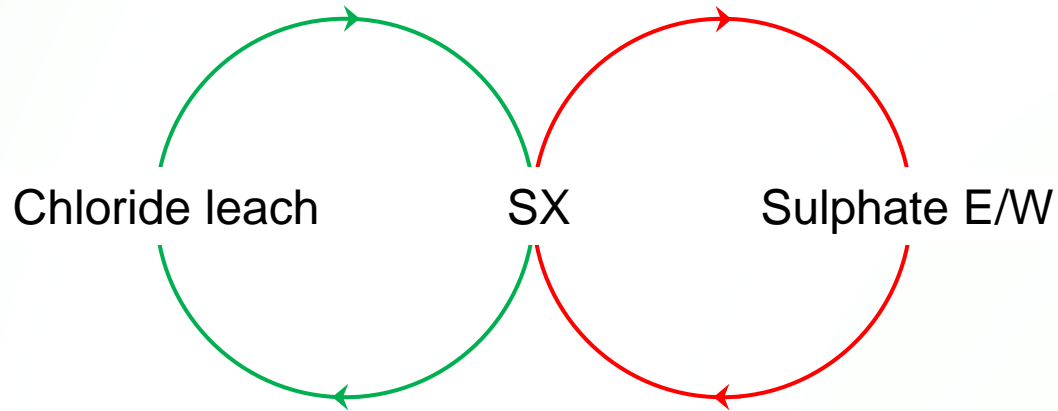
Chloride E/W





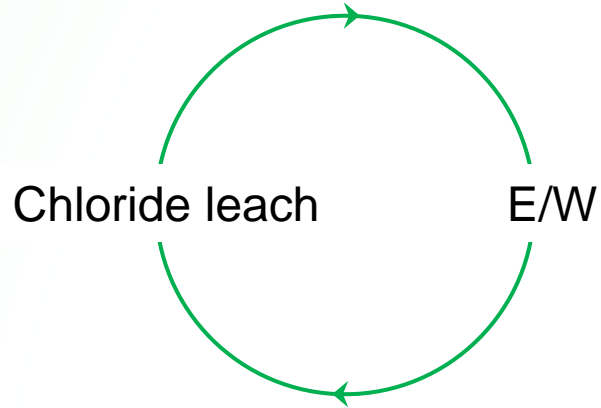
# Comparing Hydromet Options

Ease of extraction **OR** Ease of Recovery



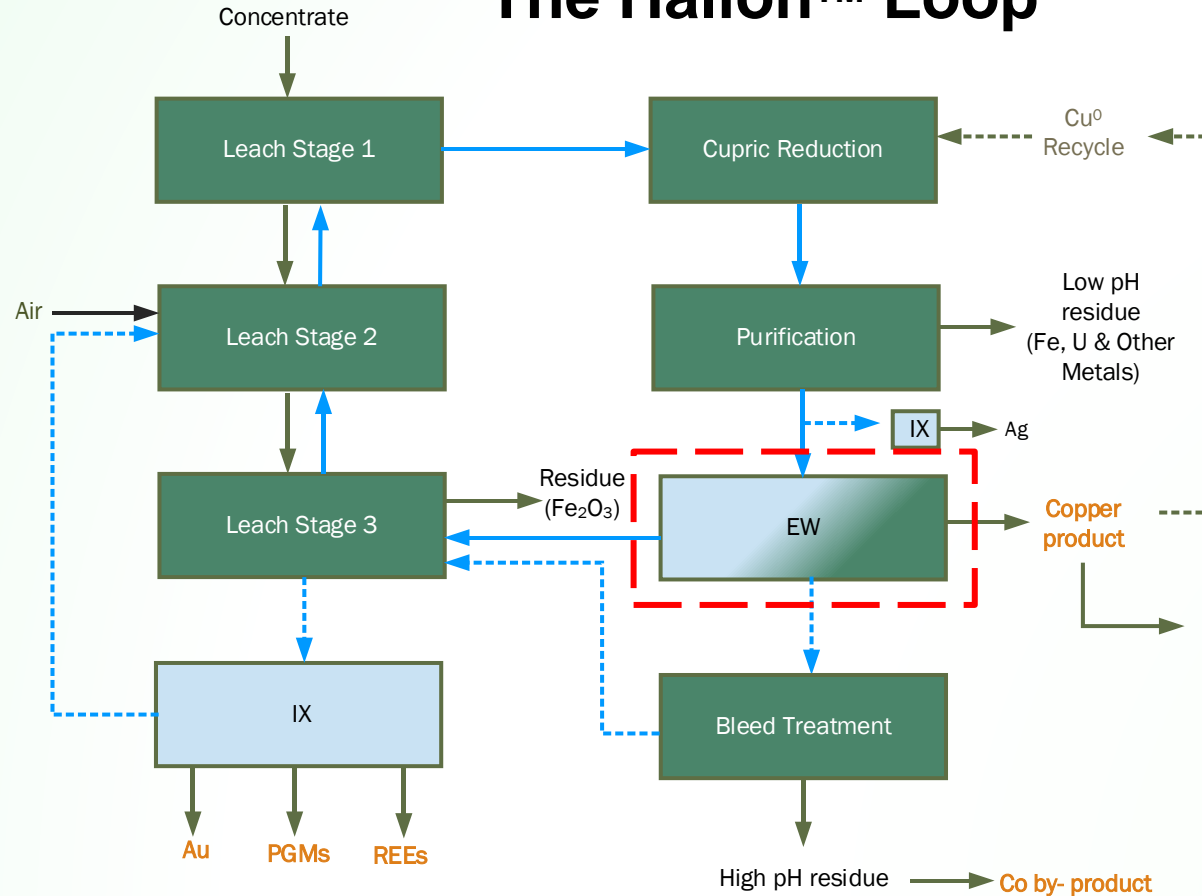
# Comparing Hydromet Options

Ease of extraction **OR** Ease of Recovery



Why not BOTH?

# The Halion™ Loop



TRL 1
TRL 2
TRL 3
TRL 4
TRL 5
TRL 6
TRL 7
TRL 8
TRL 9

# The Halion™ Loop

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- Process Parameters
  - Atmospheric pressure
  - <100°C
  - >5M Cl<sup>-</sup> / Br<sup>-</sup>
  - pH ~2

# The Halion™ Loop

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## ■ Process Parameters

- Atmospheric pressure
- <100°C
- >5M Cl<sup>-</sup> / Br<sup>-</sup>
- pH ~2

## ■ Feedstocks

- 15-65% Cu
- 25-75 μm
- Pb, Zn, Ni, Co ✓✓✓✓
- Ag, Au, PGMs ✓✓✓
- High As ✓
- REEs ✓

# The Halion™ Loop

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## ■ Primary Reagents

- Air (not oxygen)
- Sulphuric acid
- Limestone

## ■ Feedstocks

- 15-65% Cu
- 25-75  $\mu\text{m}$
- Pb, Zn, Ni, Co ✓✓✓✓
- Ag, Au, PGMs ✓✓✓
- High As ✓
- REEs ✓

# The Halion™ Loop

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## ■ Primary Reagents

- Air (not oxygen)
- Sulphuric acid
- Limestone

## ■ Products

- High purity Cu metal
- Pb, Zn, Ni, Co as intermediates
- REEs as 99% oxides

## ■ Feedstocks

- 15-65% Cu
- 25-75  $\mu\text{m}$
- Pb, Zn, Ni, Co ✓✓✓✓
- Ag, Au, PGMs ✓✓✓
- High As ✓
- REEs ✓

# The Halion™ Loop

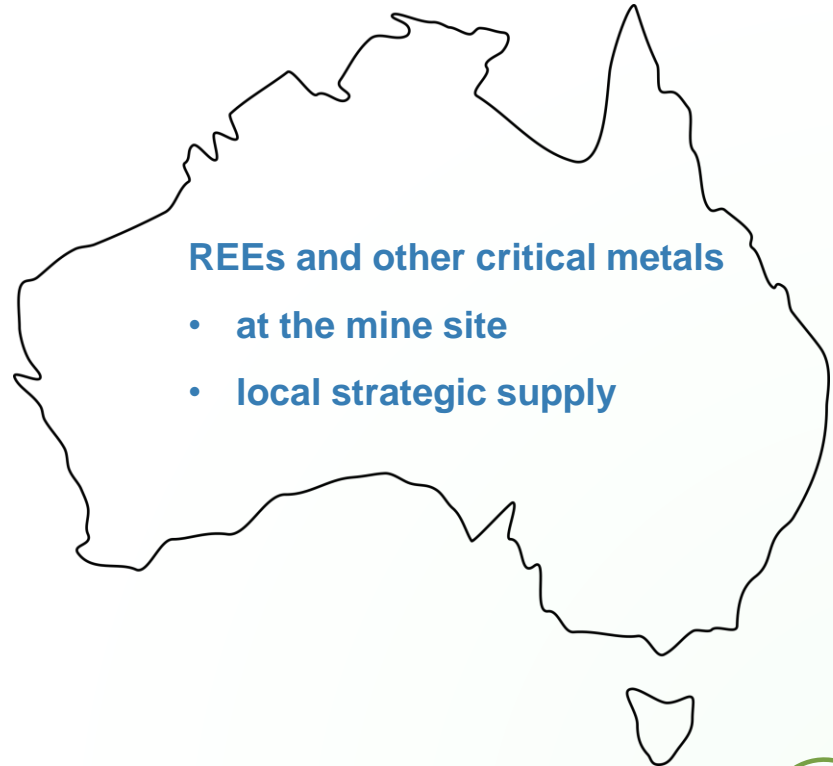
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- Primary Reagents
  - Air (not oxygen)
  - Sulphuric acid
  - Limestone
- Residues
  - Hematite
  - Elemental sulphur
  - Alkaline precipitate
- Products
  - High purity Cu metal
  - Pb, Zn, Ni, Co as intermediates
  - REEs as 99% oxides



# Strategic Advantages

- Critical Metals
  - REE, PGM and Co co-products
  - Australian technology
  - Downstream processing of critical minerals within Australia
  - Reducing dependence on dominant markets
  - Supporting Australian sovereign capability



# Environmental Advantages

- No gaseous emissions
- No liquid effluents
- No off-site transport
- Safe disposal of stable solid residues at mine
- Low carbon footprint



(creator 'Tennis expert', image licence: <https://creativecommons.org/licenses/by-sa/2.5/deed.en>)

# Economic Advantages

## OZ Minerals Ingenious Extraction Challenge

- 65% cost saving

	Concentrate Sale*	Halion™ Loop
	US\$/lb	US\$/lb
Concentrate Transport	22.6	0
Treatment Charge/ Refining Charge	13.4	0
Downstream treatment	-	17.6
(Estimated) Value loss: Smelter payable metal discount 4%	~16	0
<b>Total Cost</b>	<b>50.0</b>	<b>17.6</b>

# The Halion™ Cell

## Sulphate E/W Cell

- Sulphate
- $\text{Cu}^{2+}$



- 350-400 A/m<sup>2</sup>

## Halion™ Cell

- Halion™ = Halide + ion
- $\text{Cu}^+$



50% less power

- >1,000 A/m<sup>2</sup>
- 1/3<sup>rd</sup> tankhouse area
- **Total power saving up to 70%**

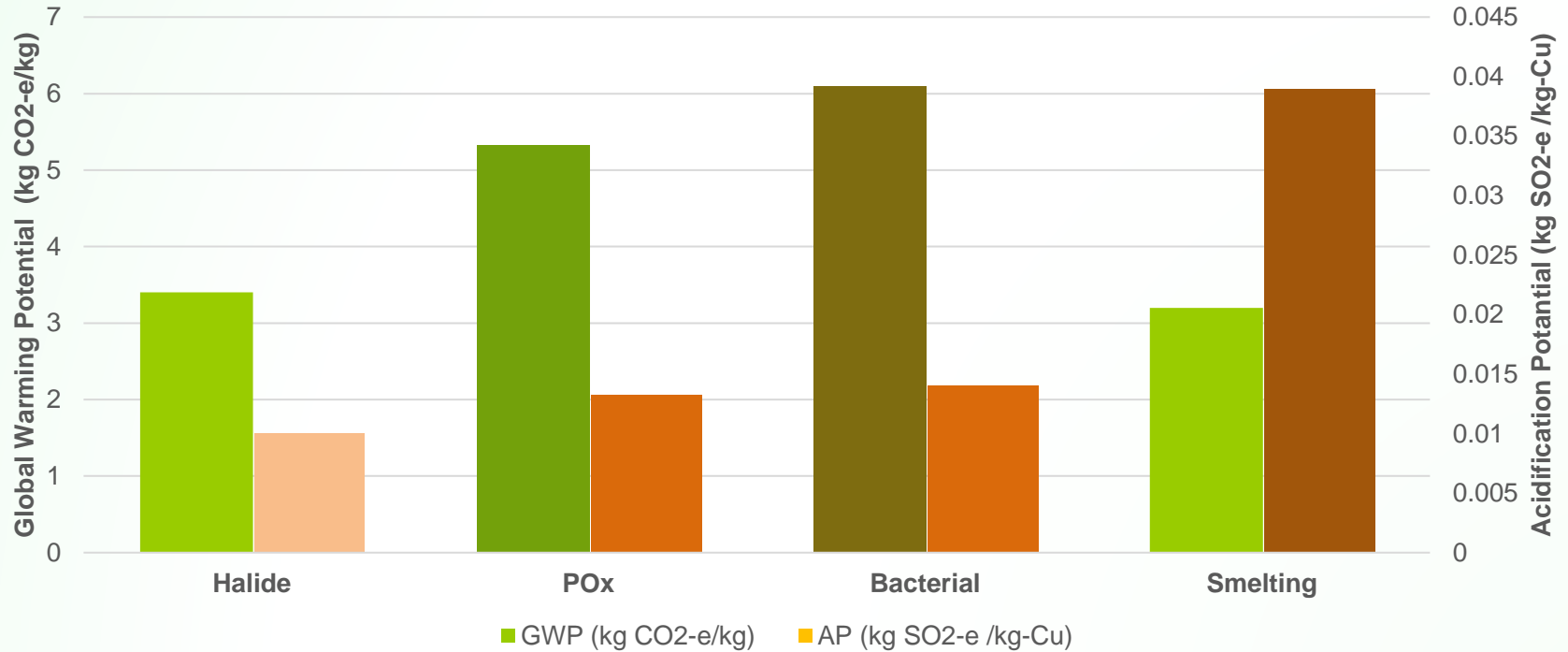
# The Halion™ Cell



Copper Cathode - Getty Images

# Life Cycle Assessment

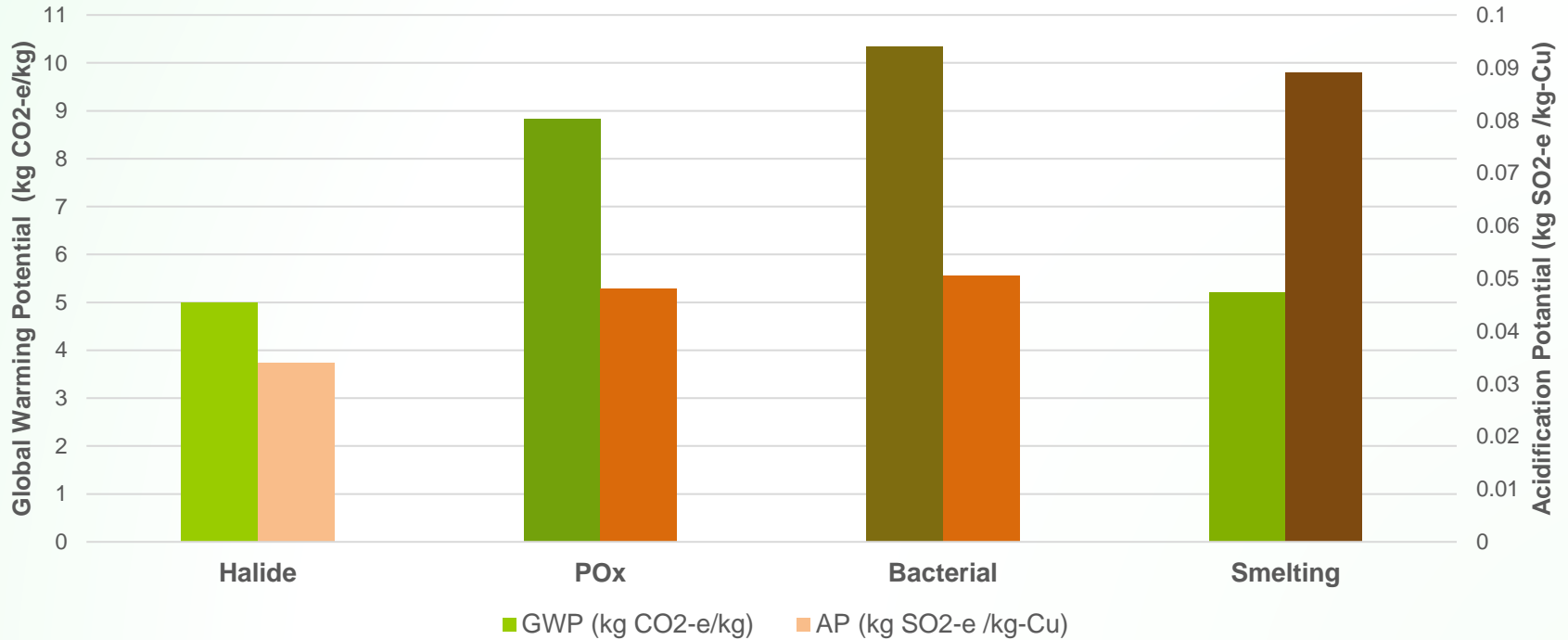
25% (natural gas)



CSIRO 2001

# Life Cycle Assessment

15% con (black coal)



CSIRO 2001

# Target Market & Opportunities

Smaller scale  
mining  
opportunities

Australian  
resources –  
particularly  
stranded assets

Copper, gold +  
critical minerals

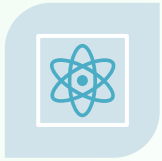
Polymetallic  
deposits

High arsenic /  
Refractory ores

High salinity  
site water  
environments



# Copper Made Green



BREAKTHROUGH  
TECHNOLOGY



CRITICAL METAL  
PRODUCTION



SIGNIFICANTLY  
IMPROVED  
ECONOMICS



SIGNIFICANTLY  
IMPROVED  
ENVIRONMENTAL  
OUTCOMES



SIGNIFICANTLY  
REDUCED  
CARBON  
FOOTPRINT



FAST PATH TO  
MARKET

# Contact

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