MANAGING MATERIAL FLOWS AND IMPACTS FOR COPPER

MMME'06
14–15 November 2006
Cape Town

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overview

- problem background and drivers
- system boundary and modelling approach
- results of case study:
  what does the USA copper cycle look like with 60% less CO_2 impacts?
- conclusions and future challenges

background and drivers

- metals are uniquely useful non-renewable resource
  - they are largely recyclable, so running out not main problem
- unsustainability arises from
  - rate and magnitude of use and environmental impacts from mining and refining and use (including energy use)
- increasing pressure to address impacts
  - Carbon disclosure project
  - Mining, Minerals and Sustainable Development Project

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- *What would improved metal management look like?*

historical approaches to problem

Company behaviour and Drivers (Reactive → Proactive)	Approach to Environment	Material chain focus
Pre-Compliance -profit	Foul and flee, then Dilute and disperse	Technology
Compliance - regulatory drivers	End-of pipe	Technology
Beyond Compliance - shareholders - technology efficiency	Cleaner production	Technology Material Chain
Integrated Strategy - opportunities for benefits - manage risks	Industrial ecology	Whole economy

Reactive

Company behaviour and Drivers

Proactive

Increased improvement potential

(Giurco, 2005)

historical approaches to problem

Company behaviour and Drivers (*Reactive* → *Proactive*)

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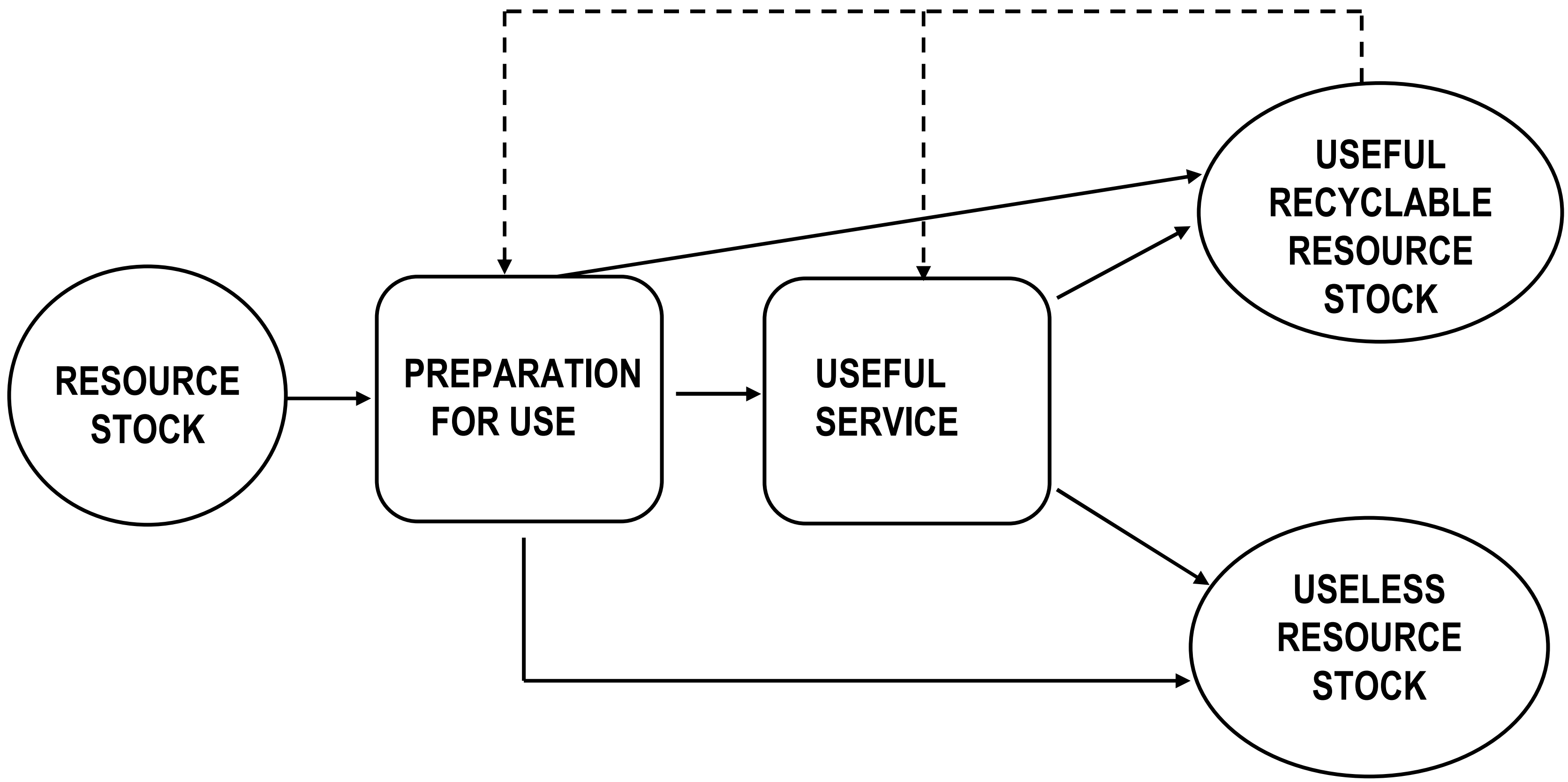
Increased improvement potential

Integrated strategy requires at least a material chain focus

expanded system boundary

entire value chain, then connected value chains



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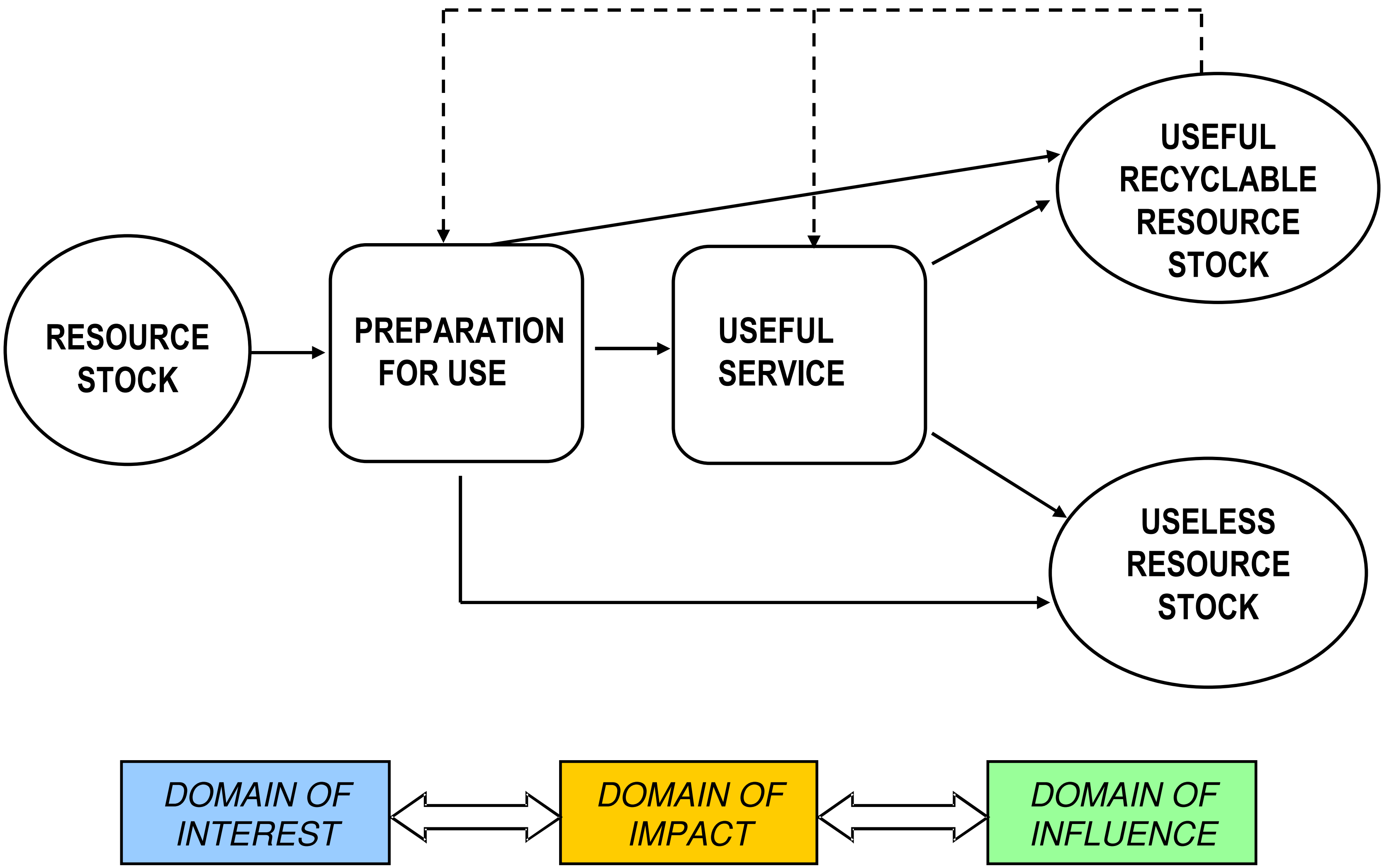


approach

link actor decisions to their impacts

Actors	*System Variables*	*System State*	*Impacts*
e.g. mining company refining company government consumer	*e.g. ore grade demand technology type recycle rate*	*system configuration through time*	*e.g. global warming economic cost*

approach

$$E(t) = \sum_{j=1}^{j'} f[P(j,t), m_j(t)]$$

Environmental Performance for each criteria through time

Specific Performance of each unit through time

Material quality
Material quantity

$$m_j(t) = g[D(t), R(t)]$$

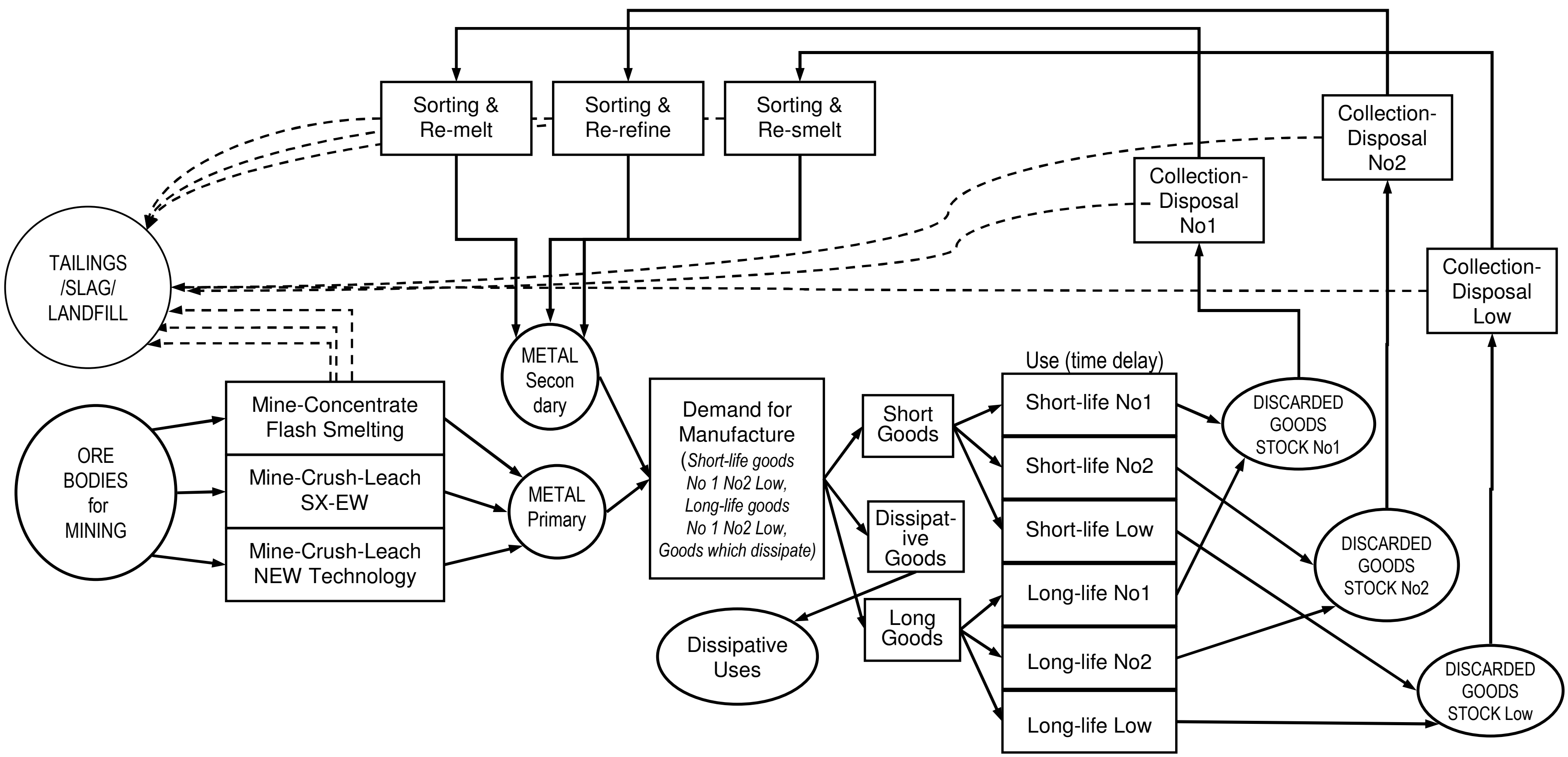
Demand

Configuration of material chain

Modelling done in Excel-based Visual Basic Environment

case study

end-use model of material value chain in USA (no imports / exports considered)



case study

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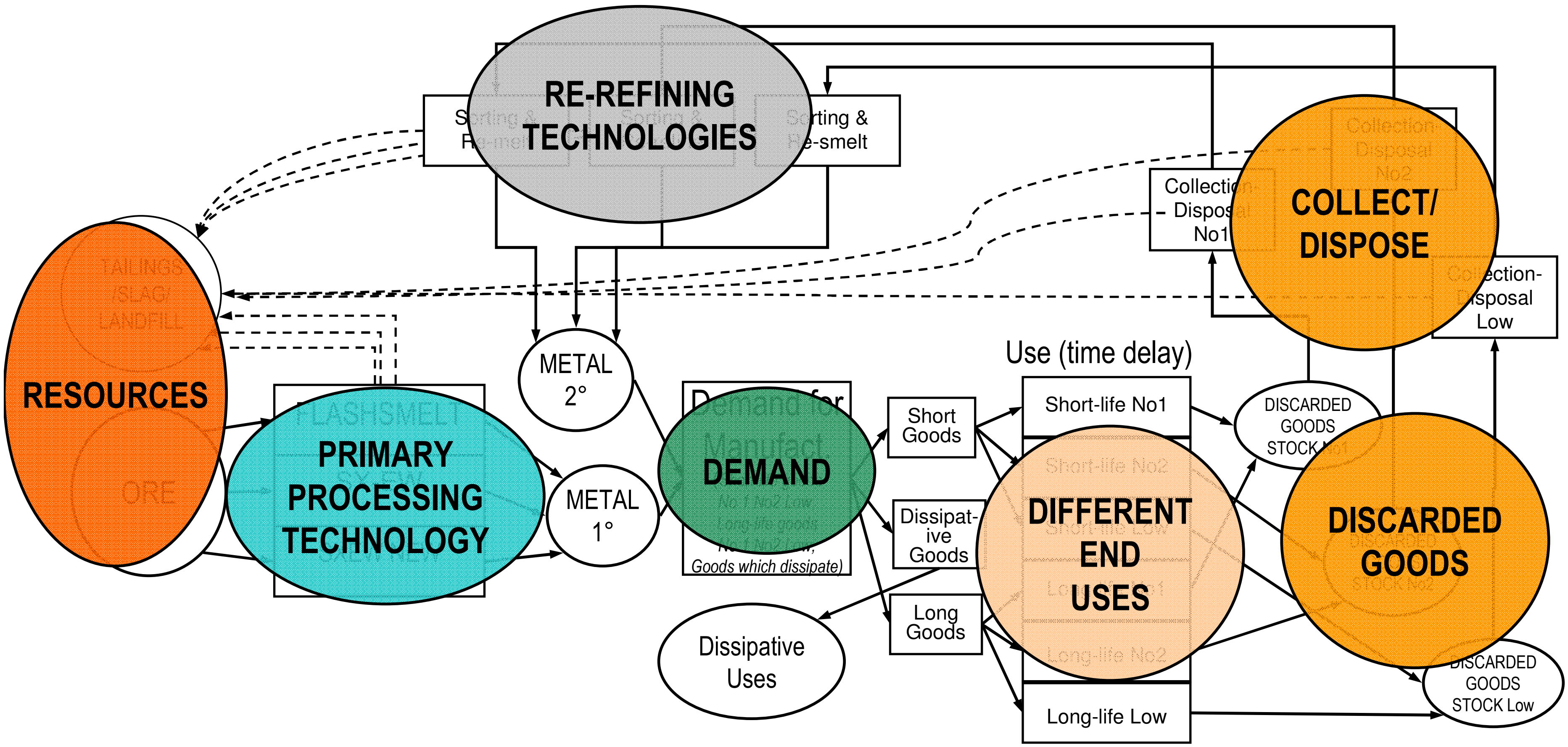
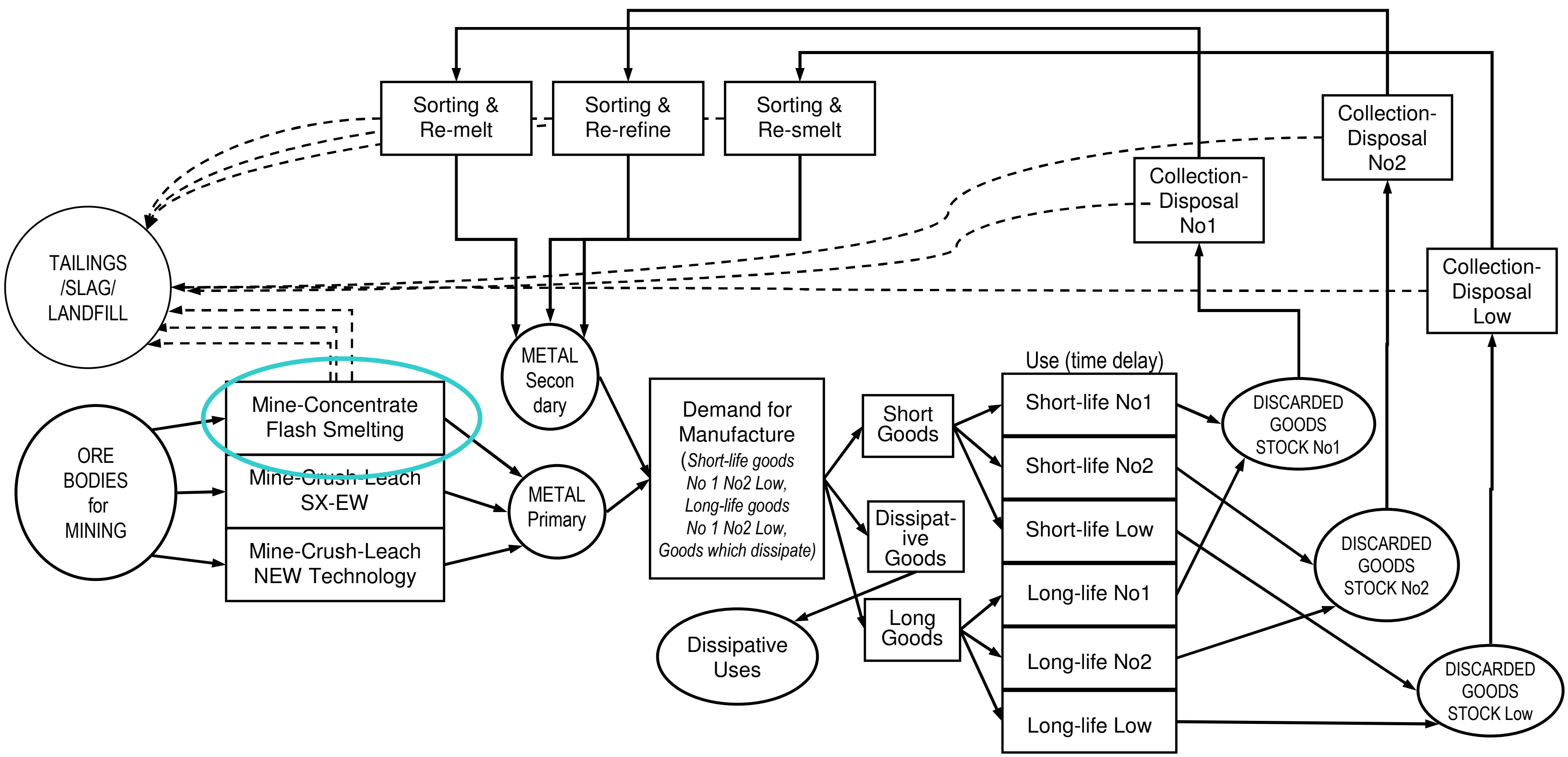
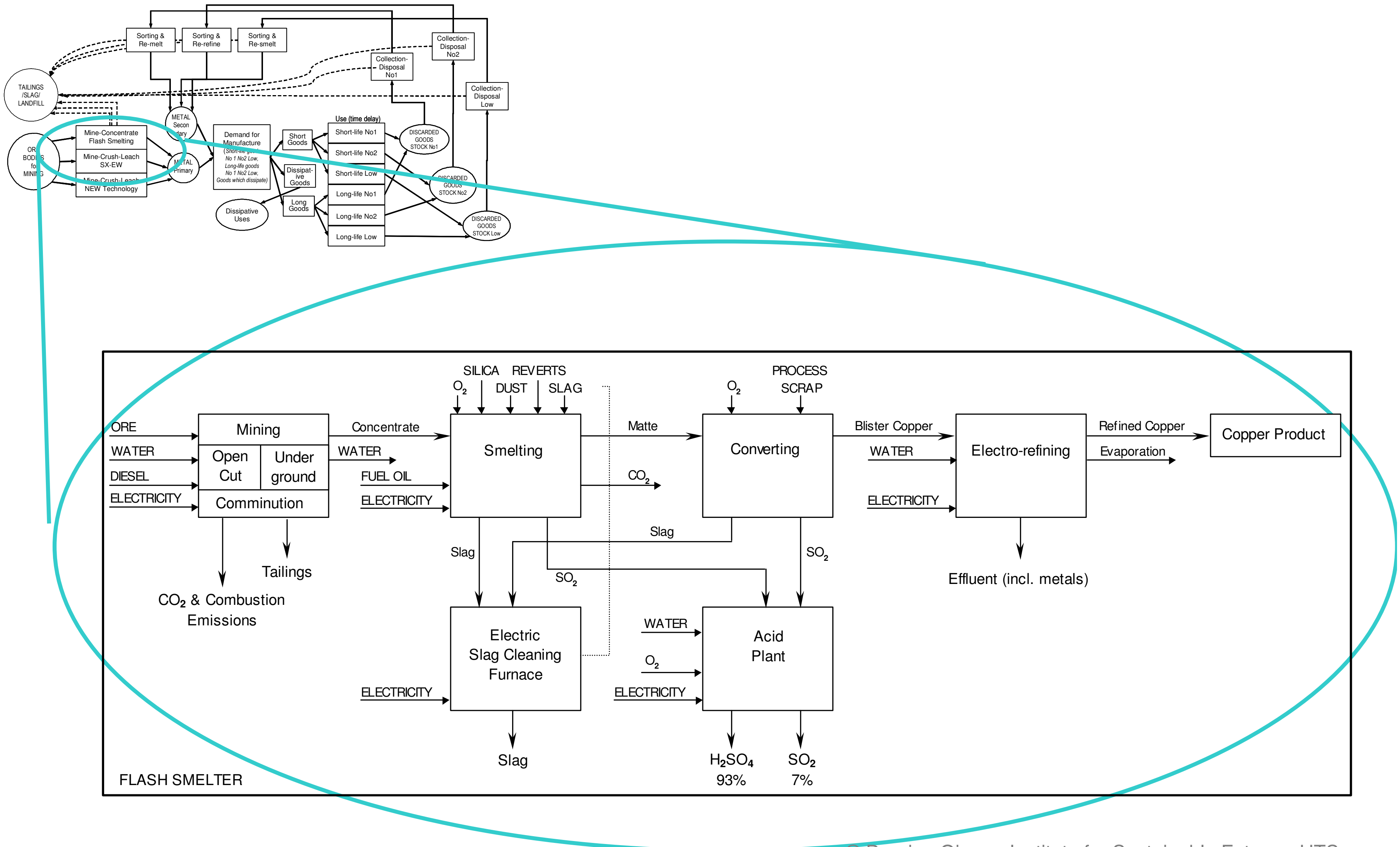


case study

options for primary processing technology



case study

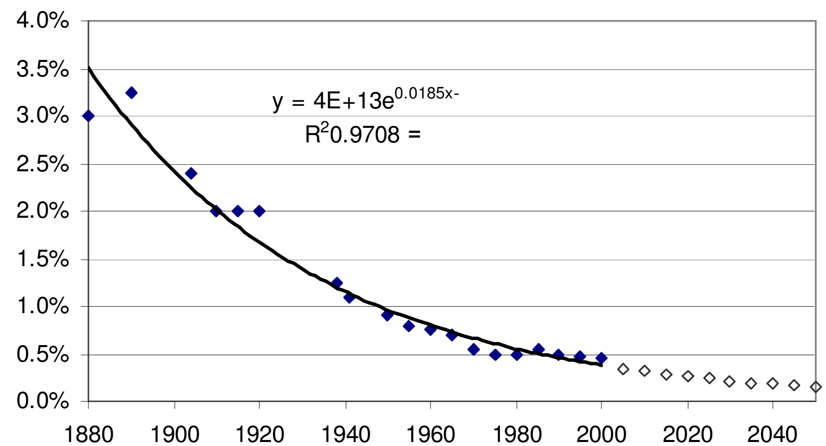

Sorting & Re-melt
Sorting & Re-refine
Sorting & Re-smelt
Collection-Disposal No2
Collection-Disposal No1
Collection-Disposal Low
TAILINGS /SLAG/ LANDFILL
Mine-Concentrate Flash Smelting
Mine-Crush-Leach SX-EW
NEW Technology
Demand for Manufacture
Short Goods
Dissipat-ive Goods
Long Goods
Dissipative Uses
Use (time delay)
Short-life No1
Short-life No2
Short-life Low
Long-life No1
Long-life No2
Long-life Low
DISCARDED GOODS STOCK No1
DISCARDED GOODS STOCK No2
DISCARDED GOODS STOCK Low
ORE
WATER
DIESEL
ELECTRICITY
Mining
Open Cut
Under ground
Comminution
Tailings
CO₂ & Combustion Emissions
Concentrate
WATER
FUEL OIL
ELECTRICITY
SILICA
REVERTS
O₂
DUST
SLAG
Smelting
Matte
CO₂
Slag
SO₂
Electric Slag Cleaning Furnace
ELECTRICITY
Slag
O₂
PROCESS SCRAP
Converting
Slag
SO₂
WATER
O₂
ELECTRICITY
Acid Plant
H₂SO₄ 93%
SO₂ 7%
Blister Copper
WATER
ELECTRICITY
Electro-refining
Effluent (incl. metals)
Refined Copper
Evaporation
Copper Product
FLASH SMELTER

assumptions: case study

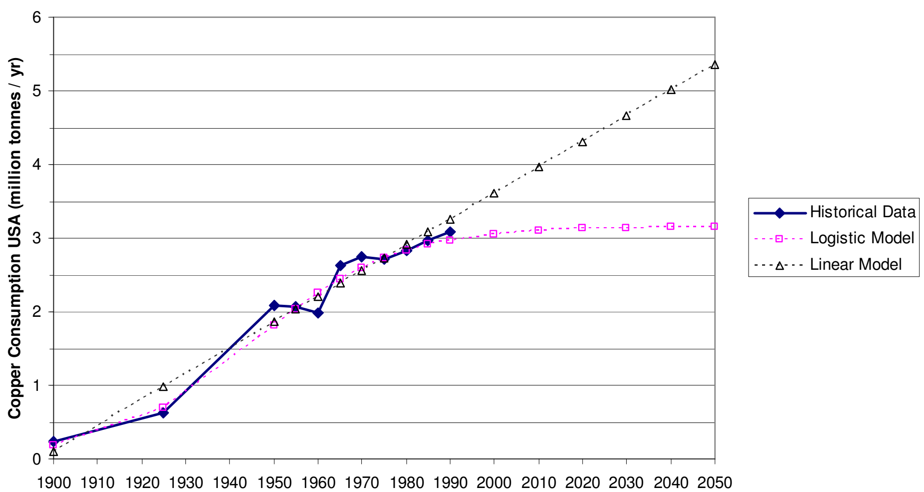
comparison of future scenarios for copper in USA: 2000 – 2050

Assumptions for base case	Base	1	2	3	4
Ore grade	0.45%	Declines in all scenarios as predicted from Figure 12			
Proportion of primary processing via Flash Smelting	65%	65%	20%	20%	20%
Proportion of primary processing via Heap Leach SX/EW	35%	35%	10%	10%	10%
Proportion of primary processing via new hydromet linked to clean energy	0%	0%	70%	70%	70%
Percent of total demand met via secondary scrap recycling, of which:	18%	18%	18%	70%	36%
Secondary - Very High Quality 'No1' scrap (99% copper)	*25%*	*25%*	*25%*	*25%*	*25%*
Secondary - High Quality 'No2' scrap (95% copper)	*37.5%*	*37.5%*	*37.5%*	*37.5%*	*37.5%*
Secondary - Low Quality Scrap (30% copper)	*37.5%*	*37.5%*	*37.5%*	*37.5%*	*37.5%*
Annual demand (t)	3 100 000	3 200 000	3 200 000	3 200 000	1 900 000
Imports / Exports	Nil	Nil	Nil	Nil	Nil

Future Ore Grades



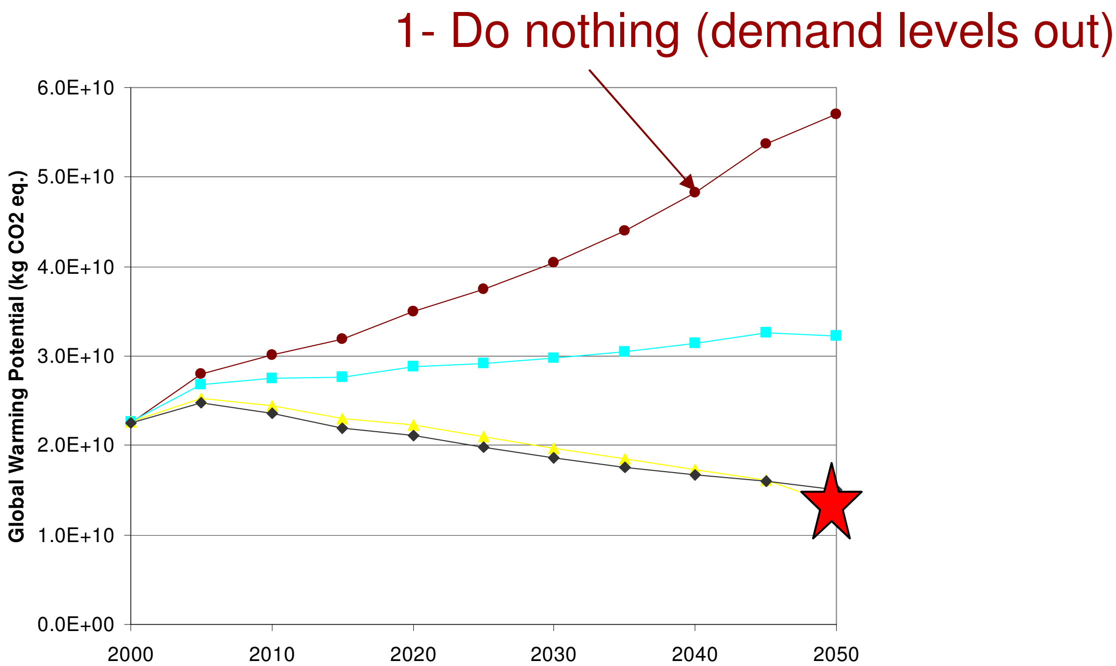
Future Demand



- **Recycling rate**
- **Technology and energy mix**

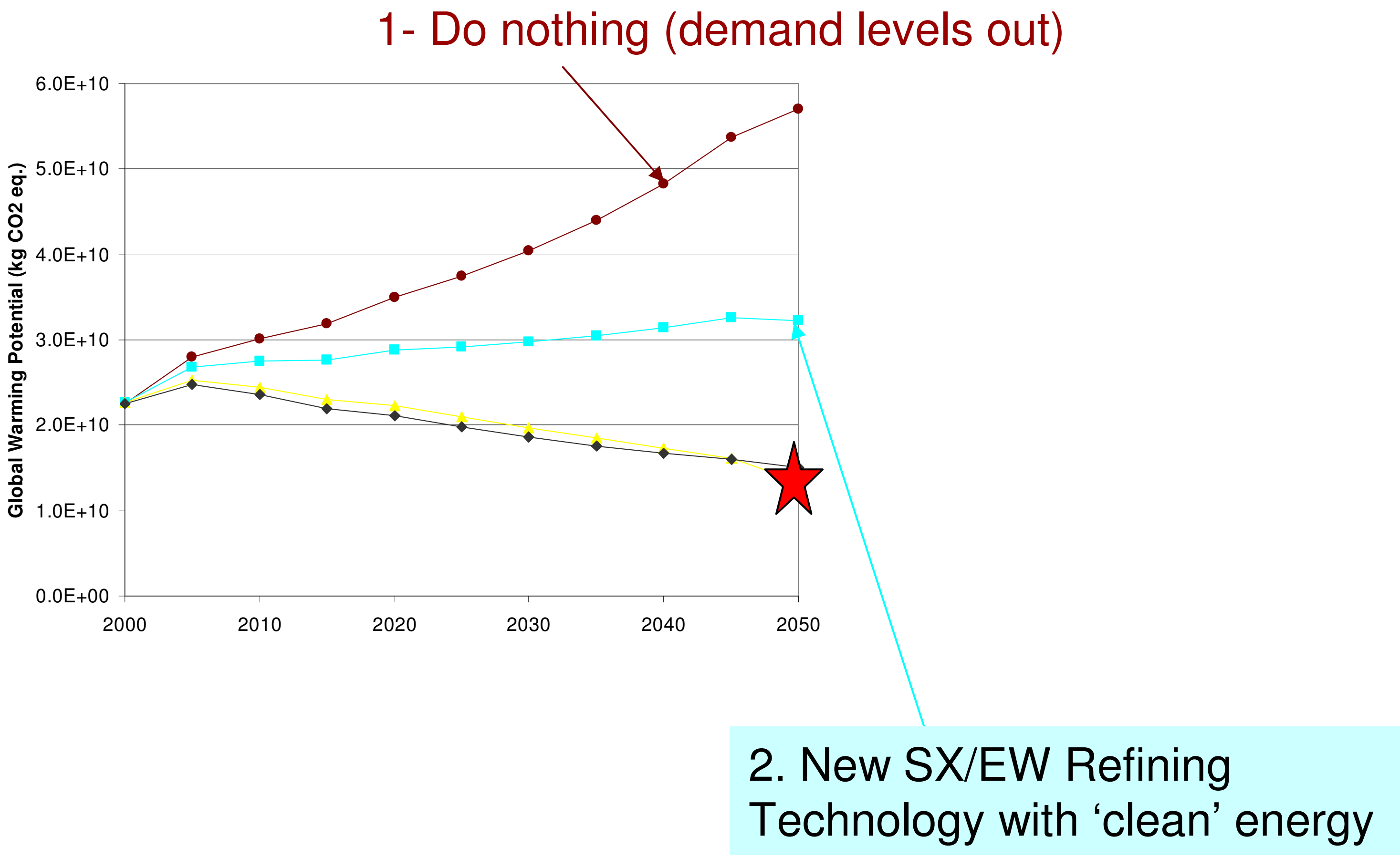
case study

Global Warming Potential

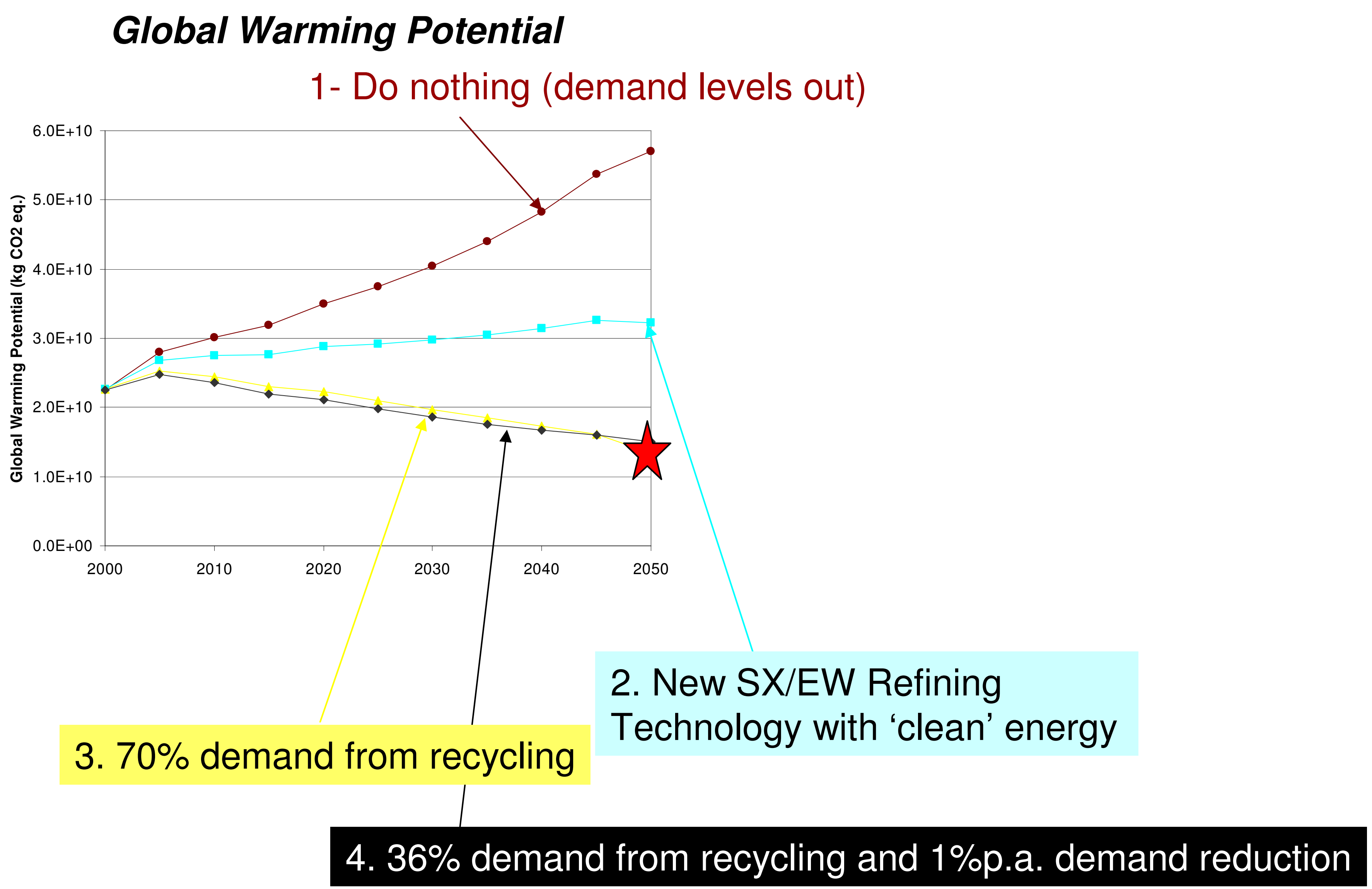


case study

Global Warming Potential

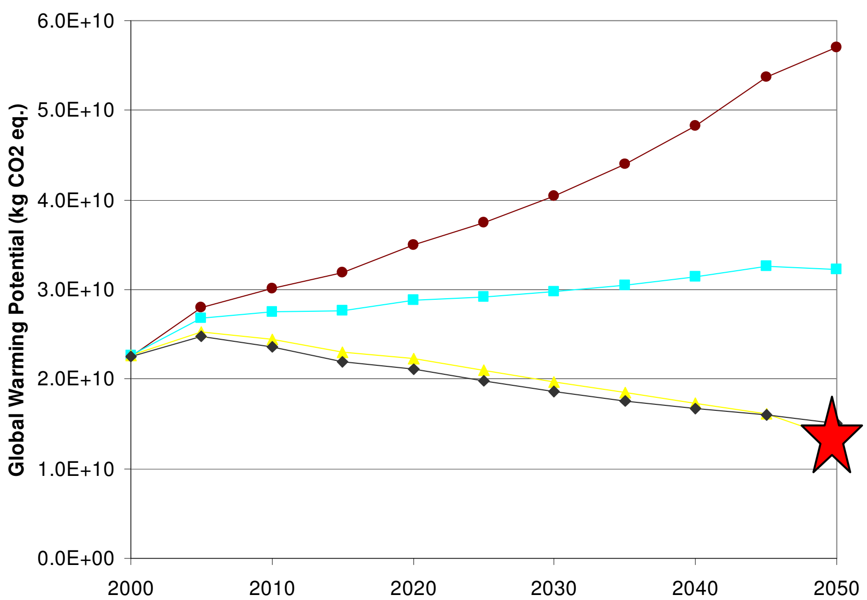


case study

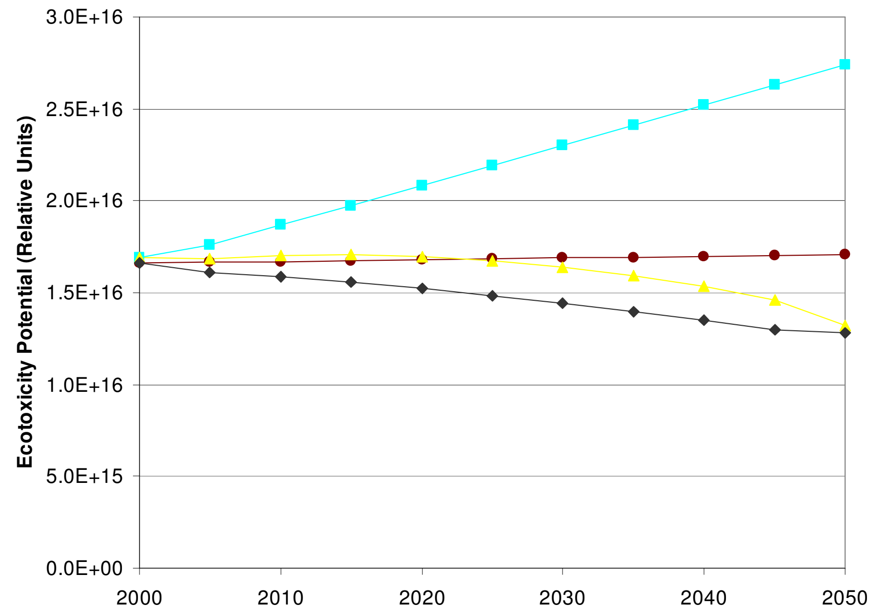

Global Warming Potential
1- Do nothing (demand levels out)
Global Warming Potential (kg CO2 eq.)
6.0E+10
5.0E+10
4.0E+10
3.0E+10
2.0E+10
1.0E+10
0.0E+00
2000
2010
2020
2030
2040
2050
2. New SX/EW Refining Technology with 'clean' energy
3. 70% demand from recycling
4. 36% demand from recycling and 1%p.a. demand reduction

case study

Global Warming Potential



Ecotoxicity



2. New SX/EW Refining Technology with 'clean' energy

3. 70% demand from recycling

4. 36% demand from recycling and 1%p.a. demand reduction

conclusions and future challenges

- new primary processing technologies will play limited role in reducing CO_2 emissions
  - alternate models for satisfying demand from recycled metals must be developed
  - technological opportunities for reprocessing

conclusions and future challenges

- transparent model for metal cycle management
  - links actor decisions to impacts
- strategies for industry uptake
  - integrate economic and environmental concerns
  - broader discussion required on acceptable levels of demand and ‘ethical’ uses for metals

END