

# Oakdene Hollins

## Economics of Rare Earths and Precious Metals

- Peter Willis, Economist
- 11<sup>th</sup> July 2012; Developing WEEE Resources – Recycling & Waste World

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# Agenda

- About Oakdene Hollins
- Policy context
- Metals: quantities and location
- Case studies on WEEE recovery:
  - Precious metals
  - Rare earths
  - Indium
- Beyond recovery to reuse:
  - PAS 141 certification scheme
- Conclusions
- Questions

# About Oakdene Hollins

- Consulting to business on sustainable products, services and clean production:

## Sectors:

- Food & Drink
- Textiles & Clothing
- Metals & Mining
- Wastes Management
- Chemicals & Materials
- Sustainable Innovation
- European & UK Policy

## Services:

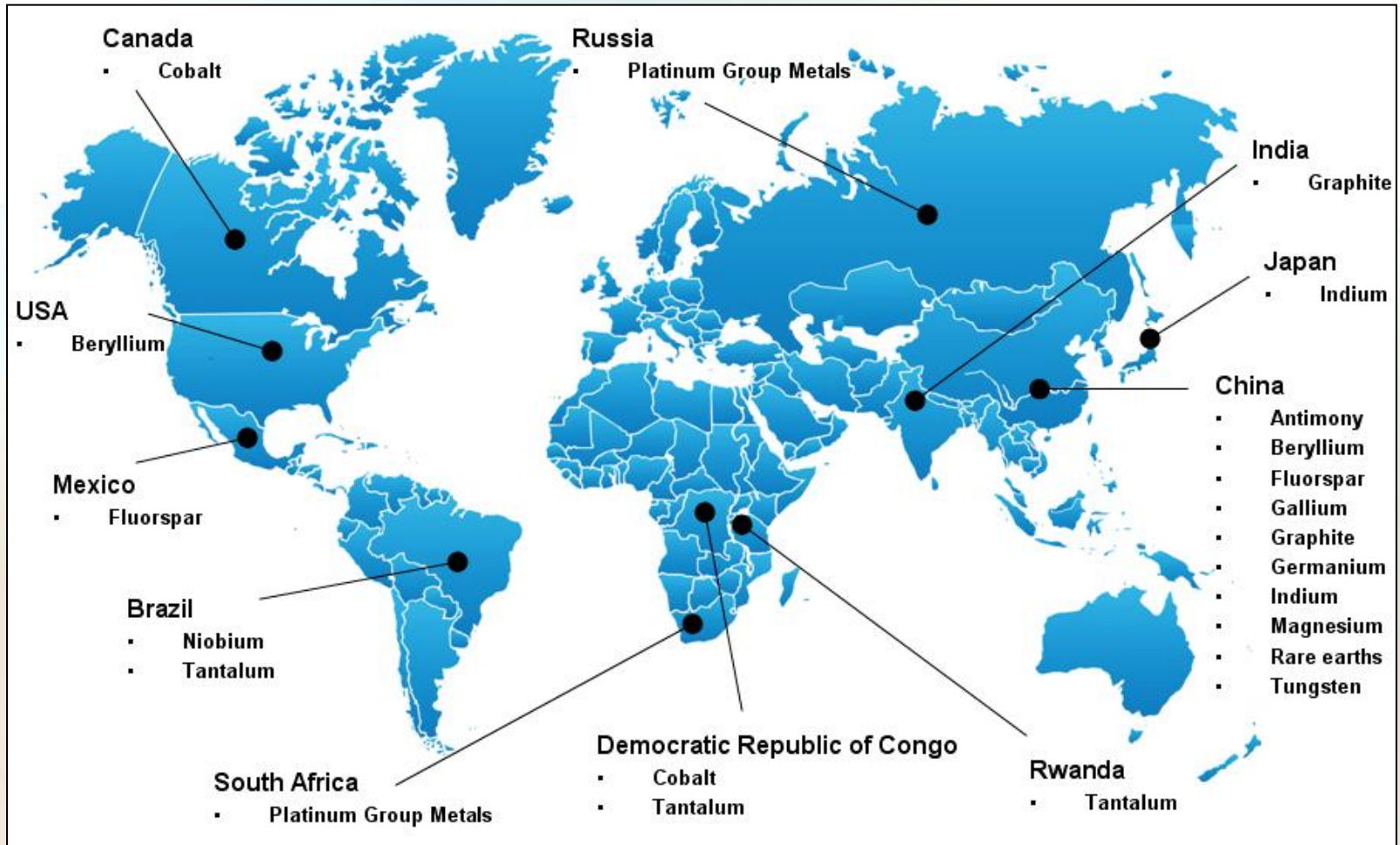
- Market Appraisal
- Technology Appraisal
- Protocol & Standards Development
- Economic Modelling
- Lean Manufacturing Projects
- Financial Impact Assessment
- Management of Research Projects
- Ecolabelling Advice
- Carbon Footprinting
- Critical Review of LCAs

# Oakdene Hollins' Materials Security Research

- Critical metals in Strategic Energy Technologies (European Commission: JRC IET, 2011 & on-going)
- Study on by-product metals (International Lead & Zinc, Copper and Nickel Study Groups, on-going)
- Study into the feasibility of protecting and recovering critical raw materials (European Pathway to Zero Waste, 2011)
- Lanthanides resources and alternatives (UK Departments for Transport & Business, Innovation & Skills 2010)
- Materials security: Ensuring resource availability for the UK economy (Resource Efficiency KTN, 2008)

*(Reports available from [www.oakdenehollins.co.uk](http://www.oakdenehollins.co.uk))*

# Policy Context



# Which metals and where?

Component	Element
Printed Circuit Boards	Antimony
	Beryllium
	Copper
	Gallium
	Germanium
	Gold
	Silver
	Platinum Group Metals
	Tantalum
Flat Panel Displays	Indium
Hard Disk Drives	Ruthenium (PGM)
	Rare Earth Elements

# How much metal contained?

- Example of mobile phone (excluding batteries):
  - 12.6% Copper
  - 0.35% Silver
  - 340g/t Gold
  - 144g/t Palladium
  - Also Iron, Aluminium, Nickel, Tin, Zinc...
- Far richer than conventional ores
- Need for improved collection



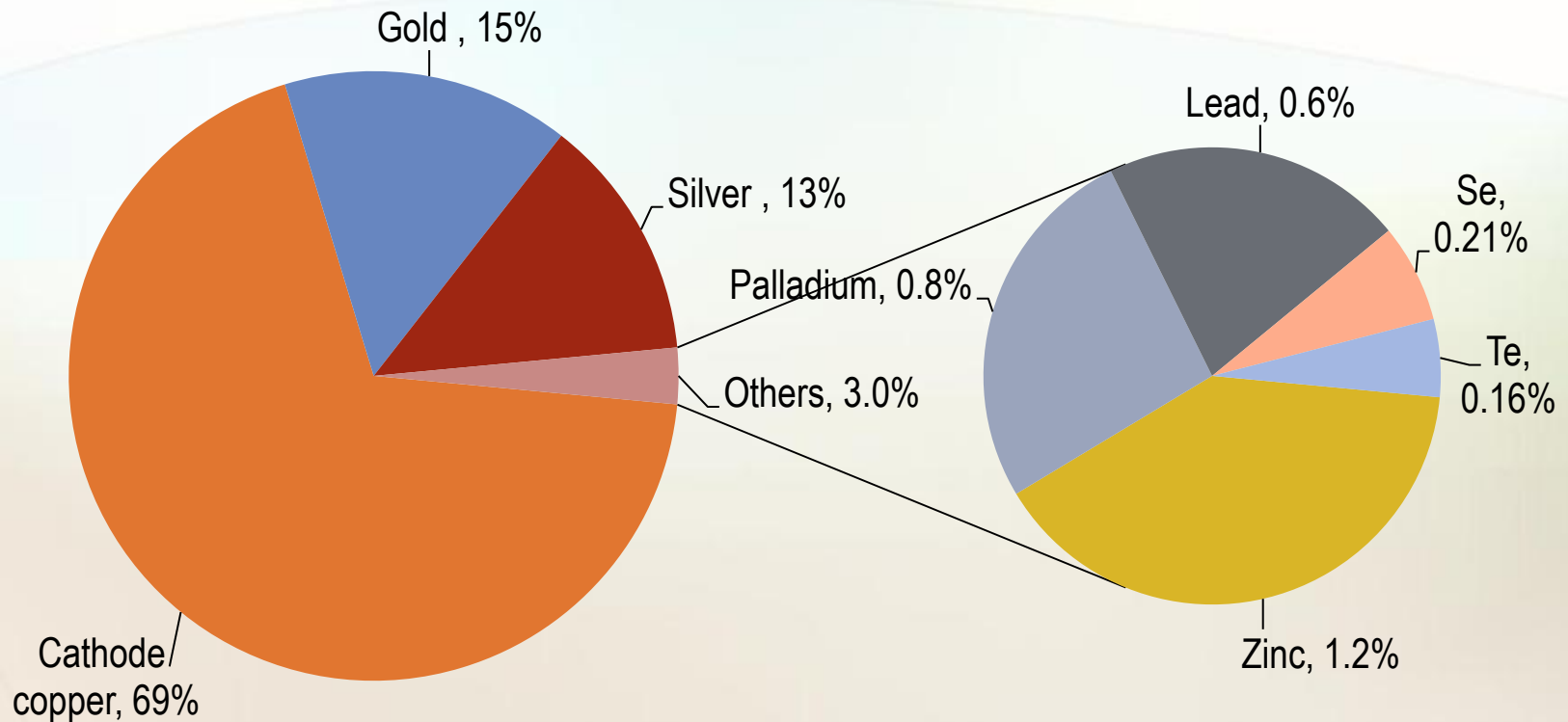
# Precious Metals: Example of Boliden

- Copper Smelters:
  - Rönnskär (Sweden)
  - Harjavalta (Finland)
- Rönnskär processed 60kt electronic scrap in 2011
- Expanding to 120kt capacity – become world's largest
- Focus on copper and precious metal recovery



# Precious Metals: Example of Boliden

## Boliden Copper/WEEE Smelting Revenues, 2011e, (\$m)

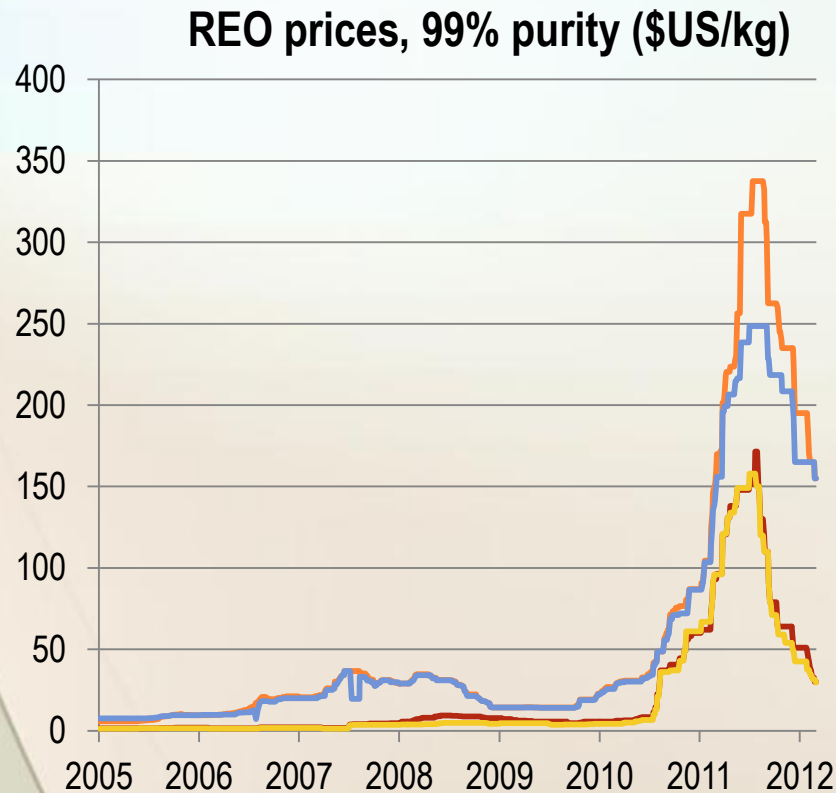


# Analysis of WEEE Recovery Opportunities

- Many metals used in very small quantities on a PCB
- Current practice of shredding for recovery:
  - Copper and precious metals already recovered
  - Rare earths lost in ferrous fraction
  - Others are quite reactive – lost in slag
- Some niche opportunities are possible:
  - Rare earth magnets in hard disk drives
  - Rare earth phosphor lighting
  - Indium in flat panel displays

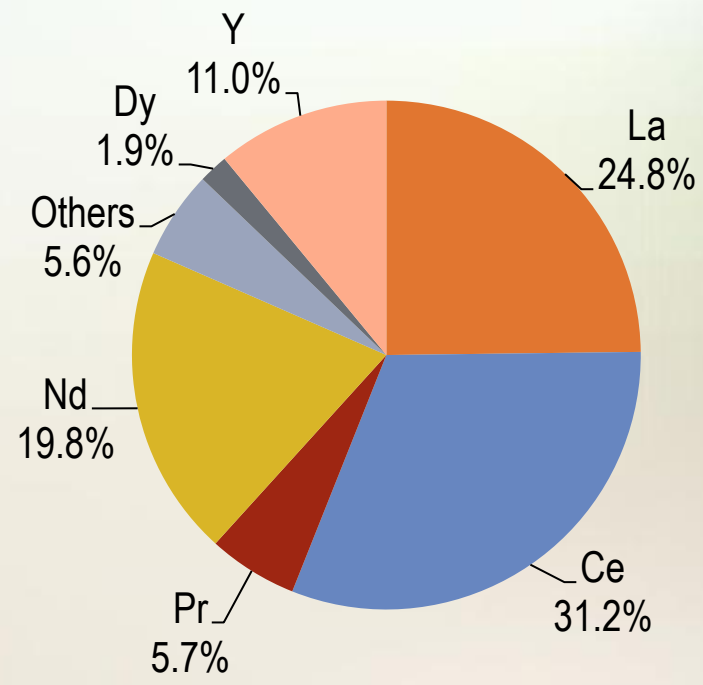
# Rare Earth Markets

- Availability & prices: lights versus heavies
- Distortion from China quotas



Sources: Metal Pages, Lynas

### Rare Earth Supply by Element



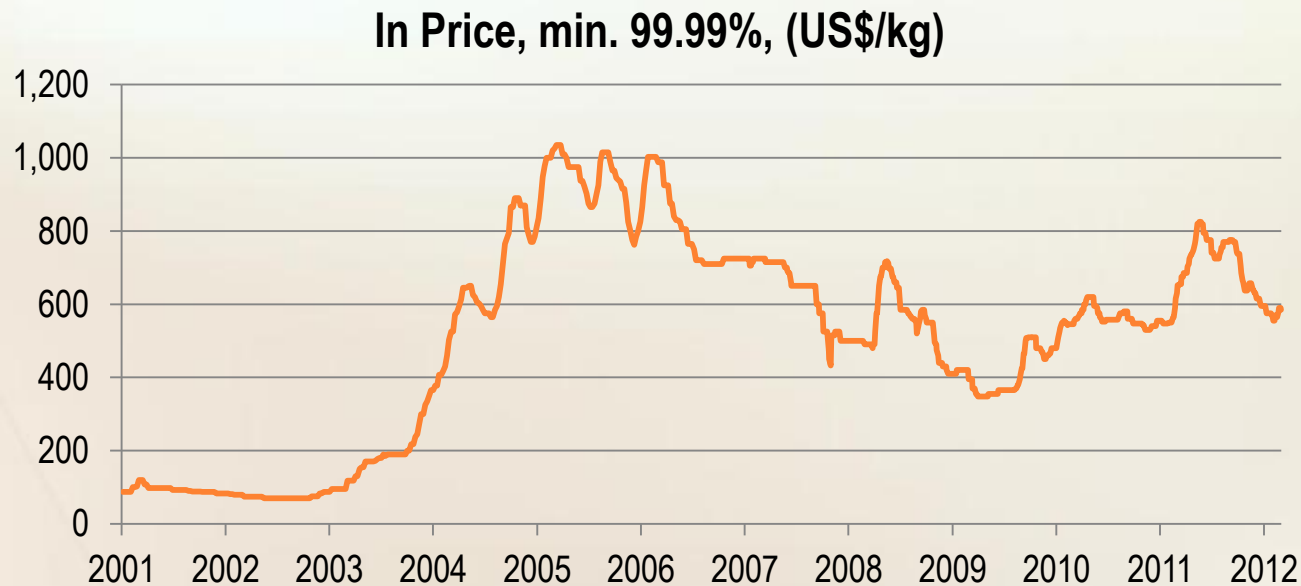
# Rare Earth Magnet Recovery

- Hard disk drives (HDD) account for 1/3 of RE magnet demand
- Processes to cut HDD & remove RE magnets for recycling
- Need to segregate, not shred with WEEE to recover RE
- Data security as economic incentive for collection & sorting
- Wind Turbines & (H)EVs in long term due to length of lifetimes



# Indium Market

- By-product of zinc refining, low recovery rate 25-30%
- Highly developed scrap reclaim industry
- Growth markets of LEDs, solar, smart phones
- Substitution discussed, but unlikely in short term



Sources: Oakdene Hollins for ILZSG/ICSG/INSG & Metal Pages

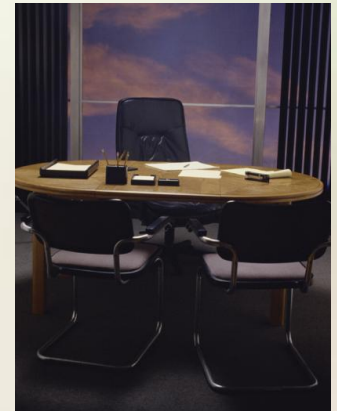
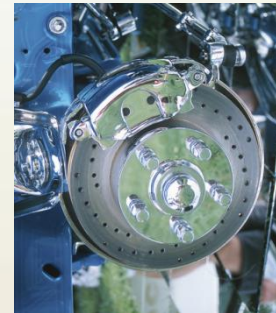
# Indium Recovery from Flat Panel Displays

- Over half of primary Indium used to make FPDs
- Recycling of Indium process waste common and efficient
- Easy to separate FPDs from WEEE as easily recognisable and need to remove mercury
- Pilot scale technologies being developed to remove ITO – dismantling and dissolution
- Medium timeframe for FPDs in waste; solar PV for long term



# Beyond Recovery to Reuse

- Resource opportunities:
  - Use of others' waste & typically low cost feedstock
  - Protect against fluctuating resource markets
  - Utilise difficult to recover materials
- Whole life service:
  - Encourages long term customer base
  - Value added business model
- Environmentally beneficial:
  - Energy, material and water costs reduced
  - Move towards zero waste to landfill – cost savings
  - Carbon savings & green consumer spend





# PAS 141 Certification Scheme

- A standard is an agreed, repeatable way of doing something
  - Provides a choice for procurers
  - Removes the need to be an expert
  - Legitimises the industry
  - Identify genuine operators
- BS8887 series
- PAS 141: electronics reuse
- A standard means little without associated certification:
  - CRR in the process of becoming certification body for PAS 141
  - Pilot audits are currently in progress



# Summary & Conclusions

- Precious metals and copper routinely recovered
- Niche opportunities for certain applications:
  - Rare earth magnets in hard disk drives
  - Rare earth phosphor lighting
  - Indium in flat panel displays
- Recycling must be economic and compete with virgin
- Reuse to utilise difficult to recover materials
  - Standards and certification (PAS141) to verify quality

# Peter Willis

[peter.willis@oakdenehollins.co.uk](mailto:peter.willis@oakdenehollins.co.uk)

Thank-you for listening!