There's Gold in Them Circuit Boards

And silver

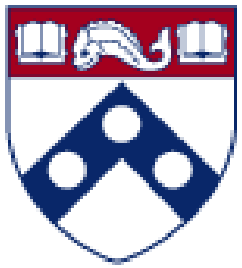
And copper

And neodymium

And...

Hi, I'm Steph!

- Sysadmin and treehugger from Philadelphia, USA
- Hackerspace organizer
- Community radio enthusiast
- Plant and bike nerd
- I got my masters in junk



Agenda

The Basics

The Stuff

The Value

The Future

The Geeks...for the win

The Basics

- What is e-waste or WEEE (Waste Electronic and Electrical Equipment)?
- Computers and cell phones, sure
- But also car parts, appliances, toys

The Basics

Typical e-waste life cycle:

- Buy a computer, chuck packaging
- Use: Most energy and materials used during manufacturing
- End of life: Support contract ends. Much later, computer dies

The Basics

Trash: **82% Landfilled in the US**

Stash: **234.6M devices stored in homes as of 2007 (EPA)**

Don**ate:** **Vulnerable data, Recipient is responsible for disposal**

Recycle: **Voluntary audits**

Reuse: **Export (**10.2 million computers from US to Asia in 2002 alone)

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The Basics

Computer afterlife:

- **Some actually recycled**
- **Exports are regularly handled badly**
- **“Donations” drive down local markets**
- **Informal recycling**

How does this happen?

How does expensive stuff end up as junk that harms people, places and markets?

Because product design, life cycle, and pricing are upside down.

The good news and the bad news

Electronic waste is

1) An environmental tragedy and injustice

2) An economic inefficiency

3) A green investment opportunity

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The Stuff

The Stuff

- So how much is there? Depends, but sales x lifespan is a good guess
- US: 24 devices/home, 3B units 2003-2010
- EU:8.3-9.1M tons in 2005. 12.3M by 2020
- Not just a rich country problem. Developing world may have twice as much as developed by 2030

The Good

Copper, gold, aluminum, steel, glass, platinum, nickel, tungsten, rare earths

Source:
Environment Canada

The Bad

The bad: Superfund metals

Antimony	Arsenic
Cadmium	Chromium
Cobalt	Lead
Mercury	Selenium

Metals in computers classified as hazardous under RCRA (Source: USGS, 2001)

The Bad, cont'd

- Guiyu, China: The soil is hazardous waste
- The pH of the water in the Lianjiang River reads near zero
- It took a year to wreck the drinking water
- Silicon Valley is incredibly contaminated

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The Ugly

- **Plastics, flame retardants, leaded glass, commingled substances**
- **Conflict diamonds? Conflict coltan**
- **Peak oil? Peak tantalum**
- **Coal mountaintop removal? Gold mining**

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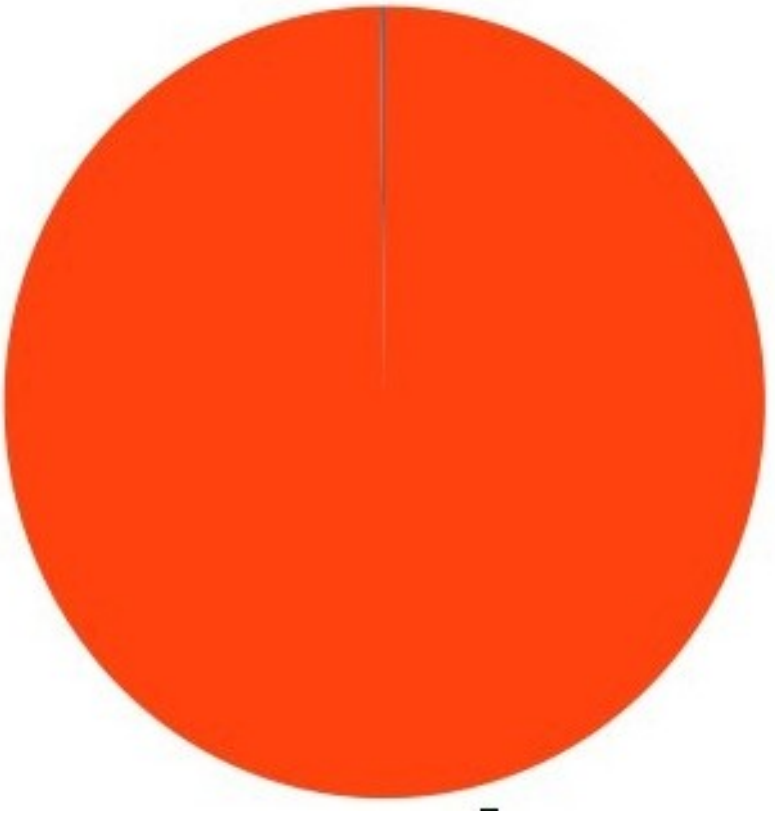
The sheer quantity of stuff

Weight of memory chip versus materials and fuel to make it (Williams, Ayres & Heller, 2002)



The sheer quantity of stuff

One gold ring: 20 tons of mining waste (No Dirty Gold campaign)

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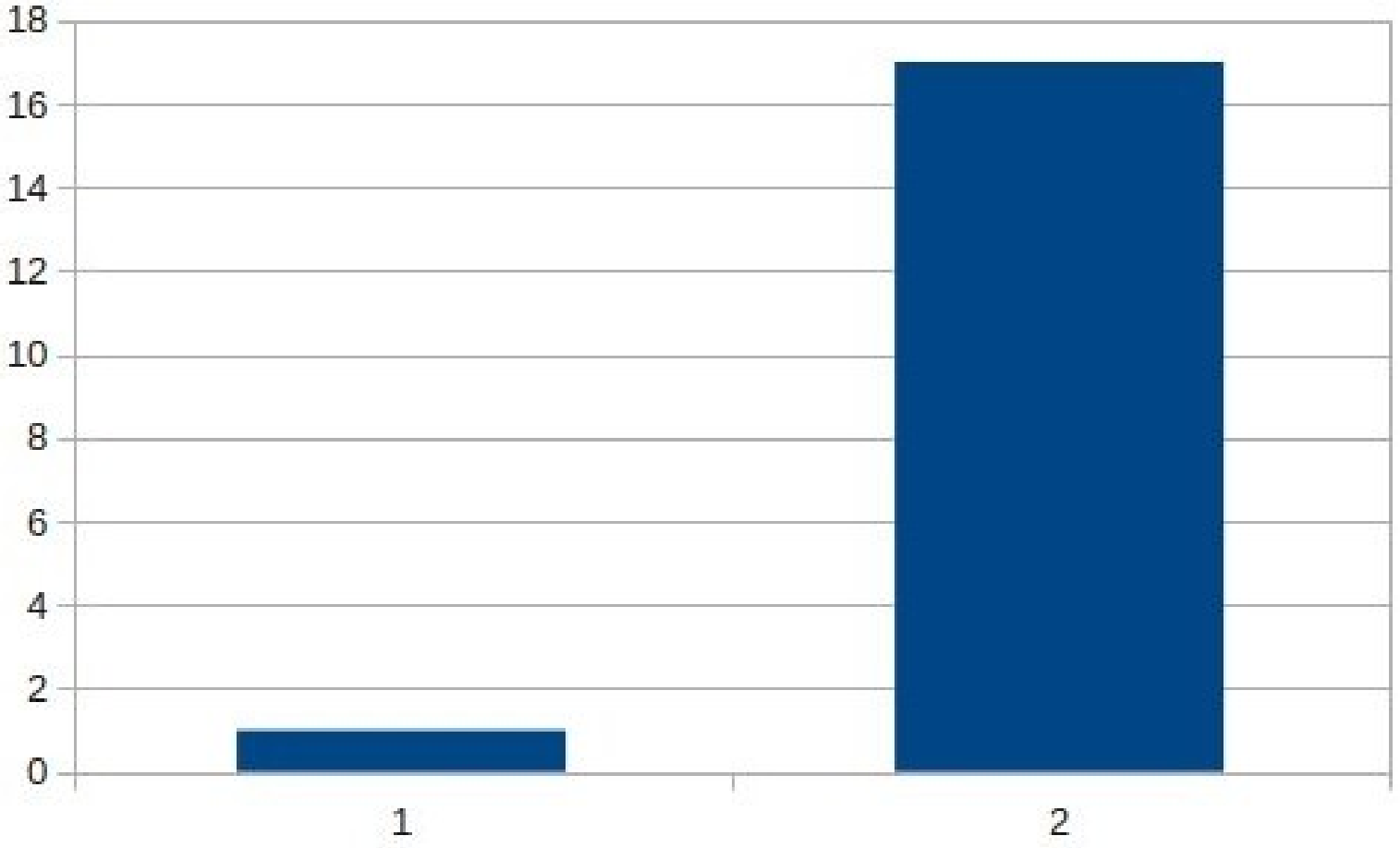
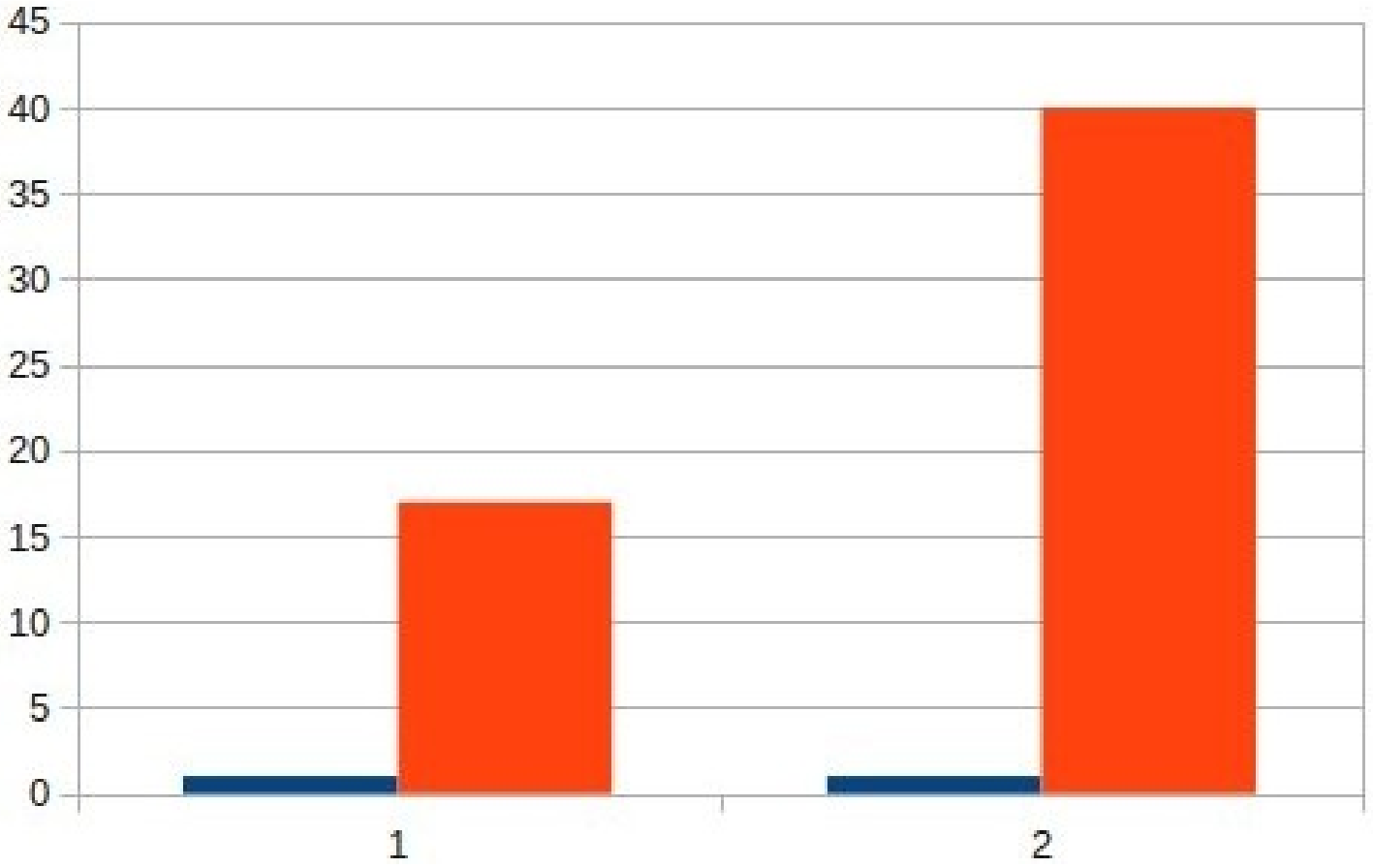
The sheer quantity of stuff



Gold richness in ore versus circuit boa

Source: USGS

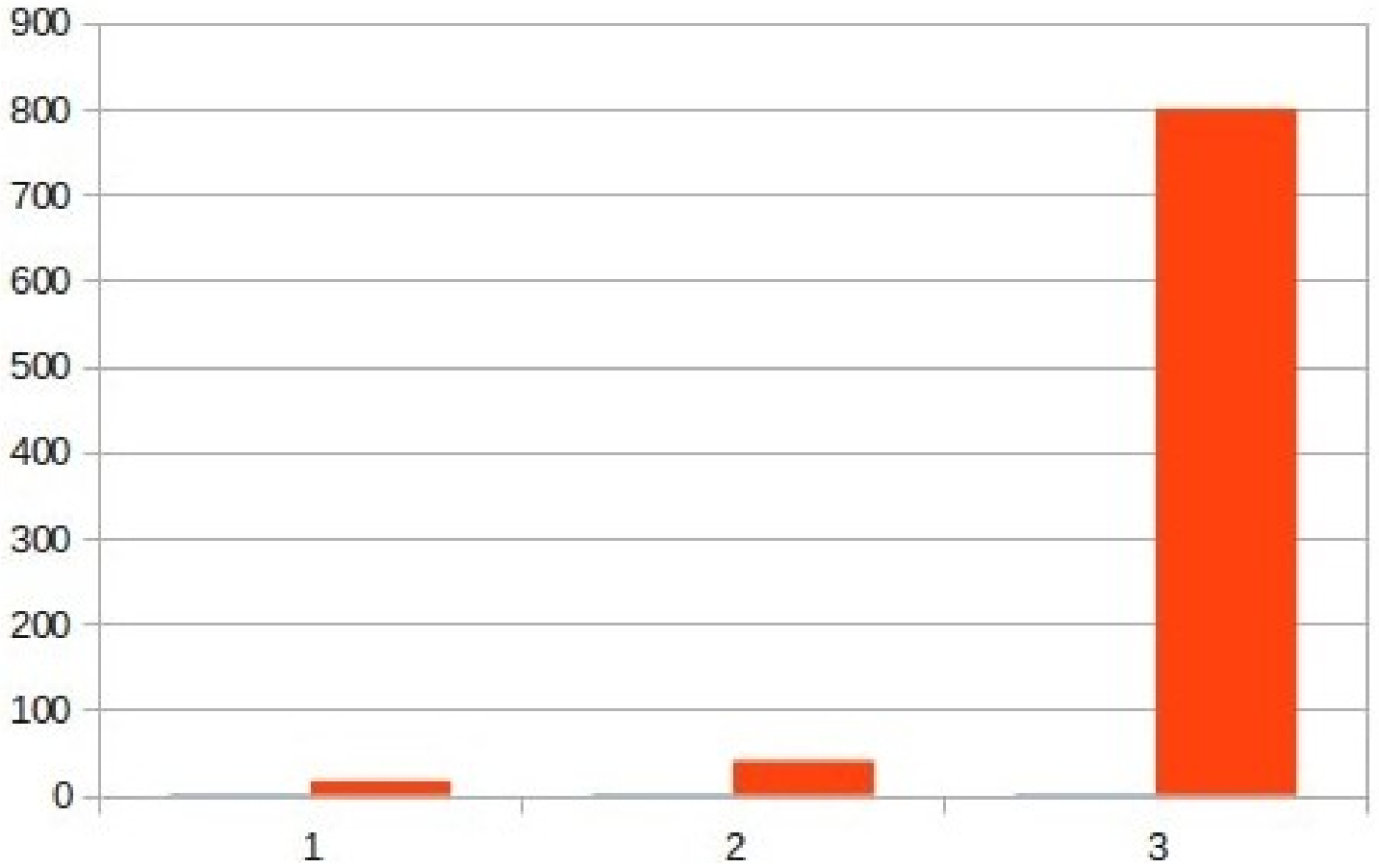
Or Maybe This...



Gold richness in ore versus circuit boa

Source: USGS

Actually, Maybe This!



Gold richness in ore versus circuit boa

Source: USGS

The Value

The Value

16% of the world's gold reserves stuck in e-waste?

“Japan’s economy has grown by gathering resources from around the world, and those resources are still with us, in one form or another.”

-Kohmei Harada, National Institute of Materials Science, Japan, 2010

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The Value

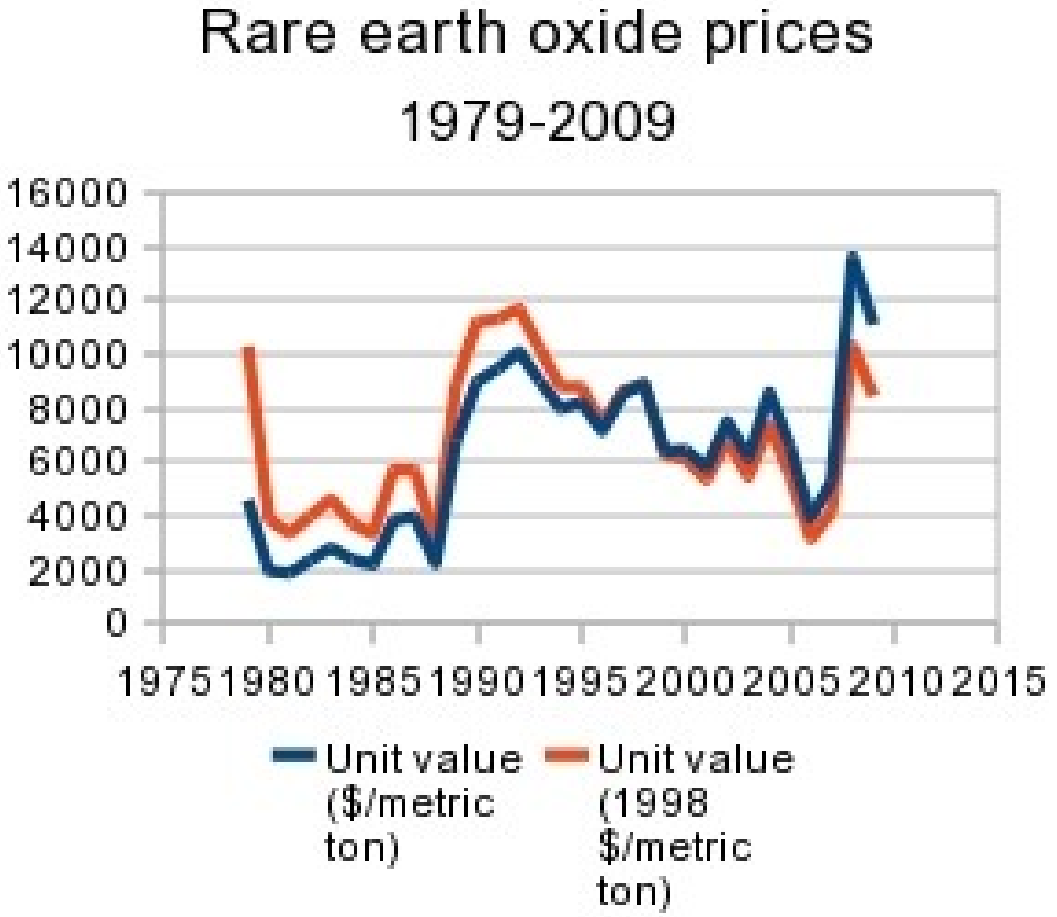
- REO feeding frenzy
- “Urban mines” or “anthropogenic ore”
- Huge data gaps
- Externalized costs

Rare Earths aren't, but...

- 15 lanthanides plus yttrium and scandium
- Common, but not in bulk
- Rare earth magnets
- Critical for everything from catalytic converters to cell phones to wind turbines
- Incredibly intensive to purify: 850 gallons of wastewater per minute!

Rare Earth Bubble

- **Prices up 12X or more in last 2 yeaı**



What Happened?

- China happened, that's what.
- Aggressive movement from 1980s
- Now, 95-97% of the market
- 2010 Embargo
- Want to decrease production while demand keeps rising

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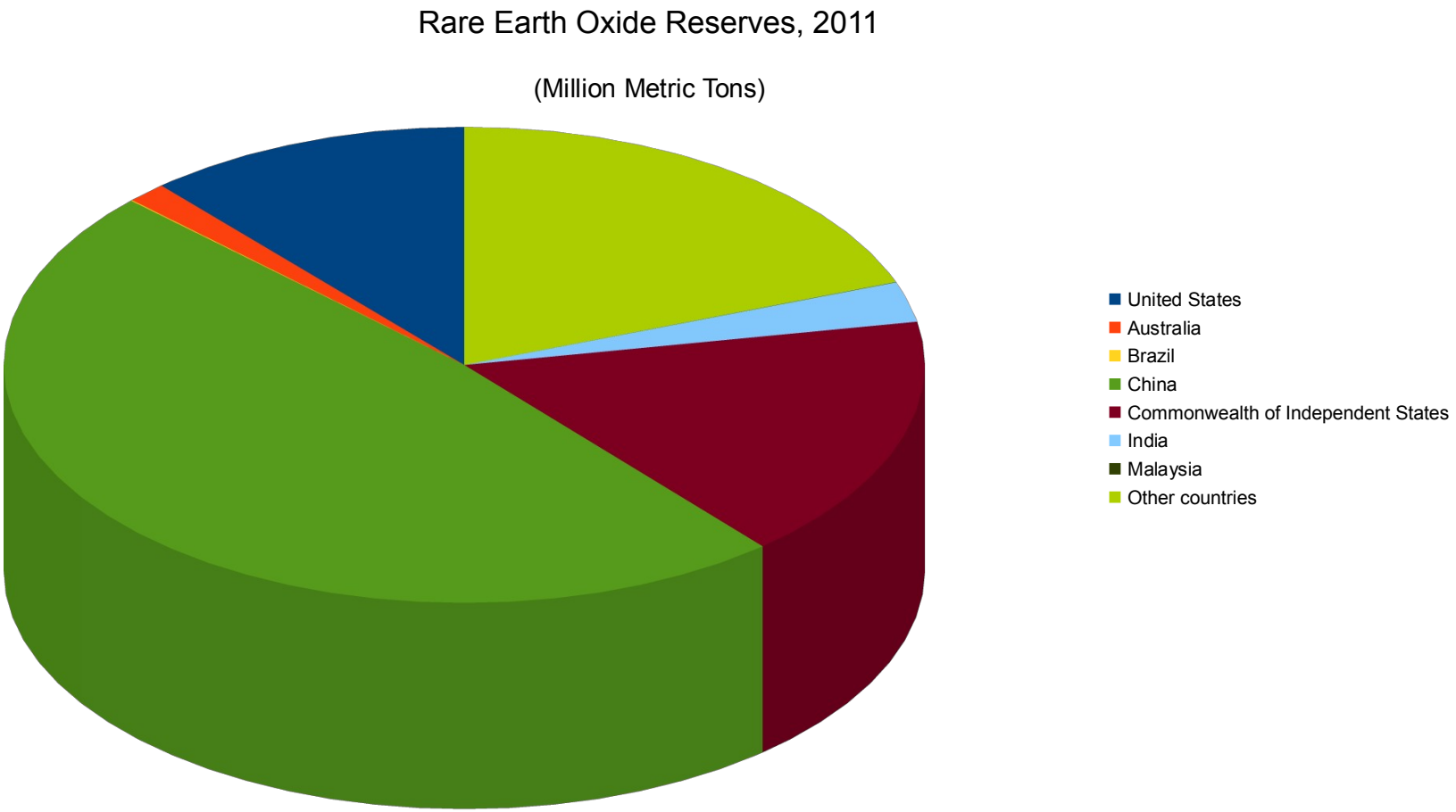
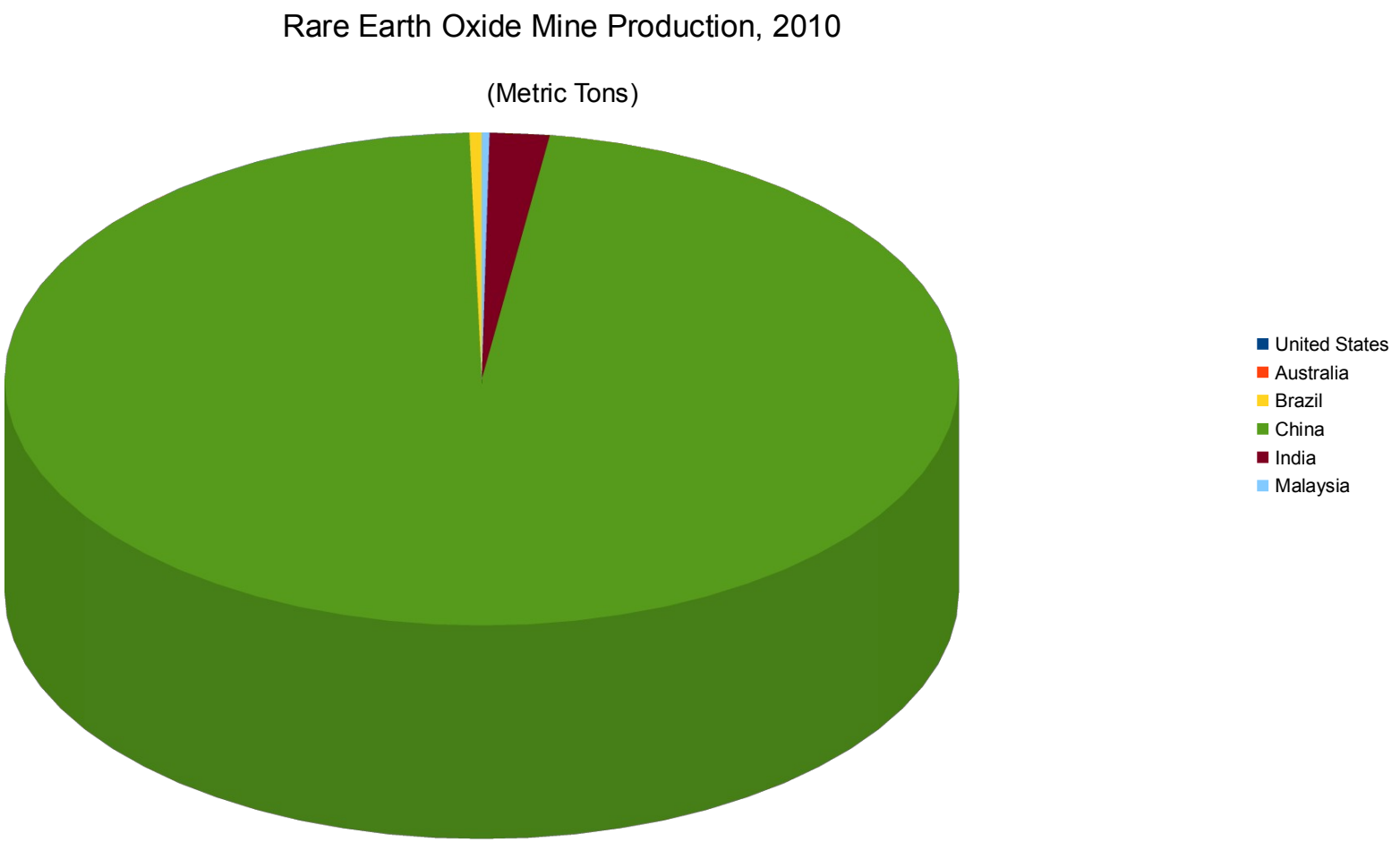
REO Reserves



Source: USGS Mineral Commodity Summaries, 2011

REO Production



Source: USGS Mineral Commodity Summaries, 2011

“Ecological rucksack”

Just one way of measuring comprehensive impact and value of a product

- **Embodied energy**
- **Virtual water**
- **Ecosystem services**

Our economics simply don't measure this stuff effectively

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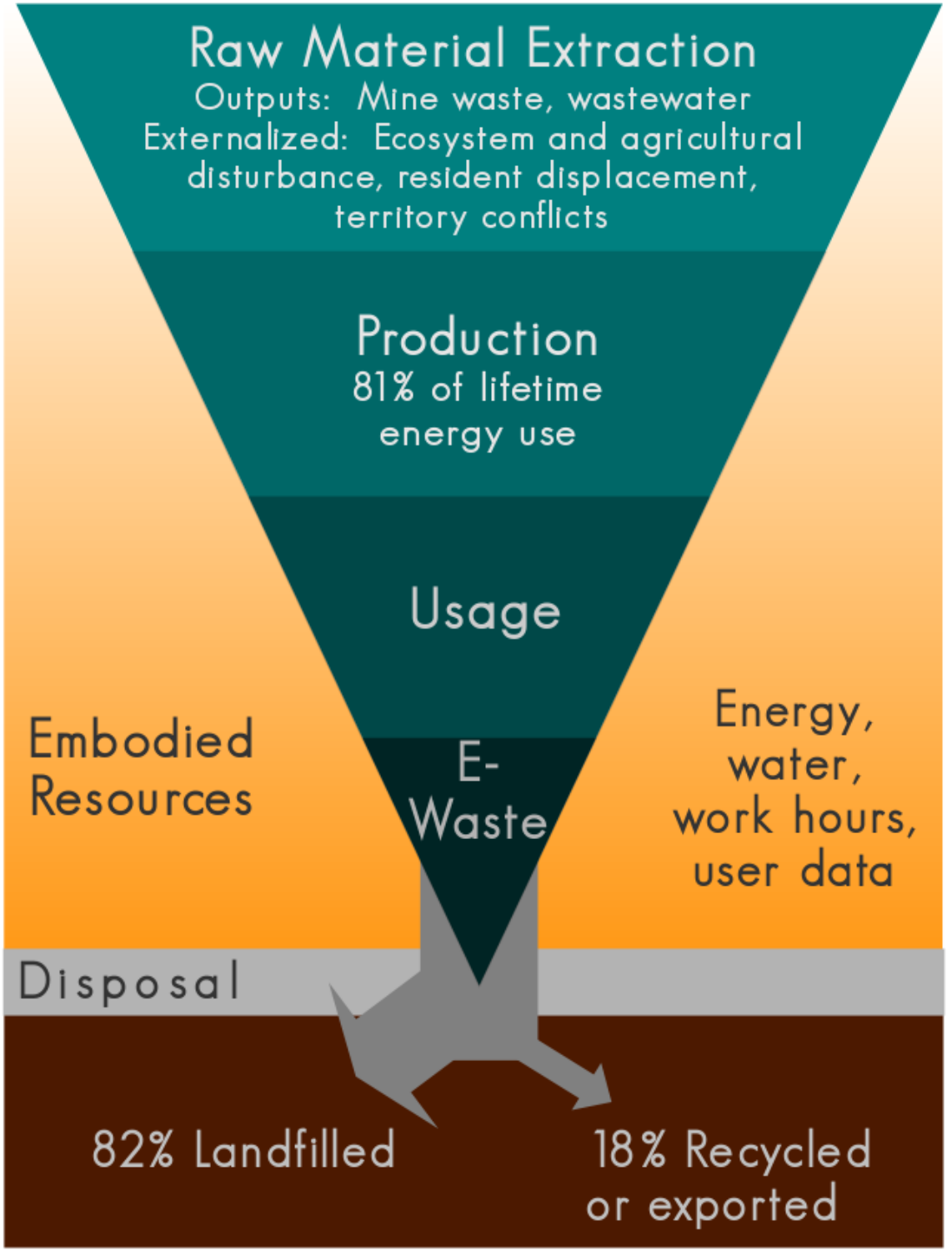
Externalized costs

- Positive and negative externalities
- Economic inefficiencies
- The “free” market is not free (gratis) as in beer!
- ...Especially if your community is being stepped on.


Raw Material Extraction
Outputs: Mine waste, wastewater
Externalized: Ecosystem and agricultural disturbance, resident displacement, territory conflicts
Production
81% of lifetime energy use
Usage
Embodied Resources
E-Waste
Energy, water, work hours, user data
Disposal
82% Landfilled
18% Recycled or exported

This stuff is getting expensive

- Enter gold and REE prices
- Human costs: mining, conflict minerals
- Litigation expenses: easily 15 years to open a mine in the US
- Why not put 15 years into recycling?

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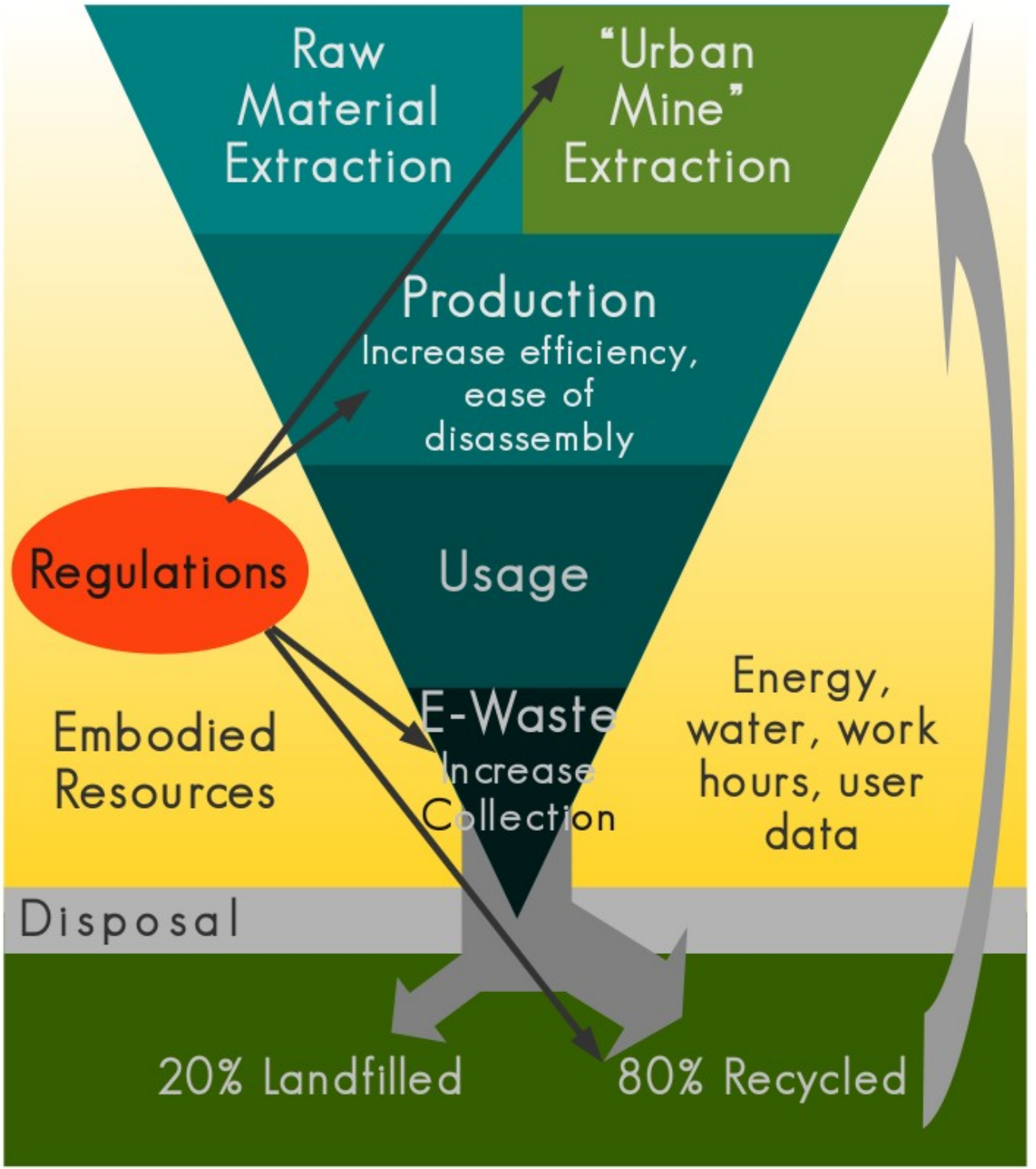
The market is amoral

- It's a bit of a sociopath, really
- The role of regulation
  - Internalizes costs: permits, pollution scrubbers, etc
  - Producer take-back
  - Design for the environment
  - Reduction of toxins (at what cost?)


Raw Material Extraction
"Urban Mine" Extraction
Production
Increase efficiency, ease of disassembly
Usage
Regulations
Embodied Resources
E-Waste
Increase Collection
Energy, water, work hours, user data
Disposal
20% Landfilled
80% Recycled

International Regulation

- **Basel Convention: making, management and movement of hazardous materials. 172 nations ratified**
- **Guess who isn't on that list?**

EU Regulation

- WEEE and RoHS
- Non-trivial complexities
- Sparked a race to the top
- Wee collection rates are 16%-65%
- Compliance is the biggest cost

US Regulation

- CRT Rule: Call before you dump!
- Totally lame. Even GAO hates it.
- Is it hazardous? Depends…

US State regulation

- 25 states have take-back laws
- Uneven, inefficient playing field

The Future

The Future

- Urban mining
- More accurate pricing
- Prices and shortages will make neodymium the new copper

There's money to be made

When you export e-waste, you export commodities.

The Future

- US investors are screaming for “domestic sources”. Sound familiar?
- But metals are recyclable…fossil fuels aren't.
- Some places are digging into e-waste recycling in a serious way
- Hitachi, Japanese researchers, China's take-back program

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The Geeks, For The Win

How To Turn It Around

We need Science!

Design!

Appropriate technology!

Economics!

Policy!

Entrepreneurs!

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We Need:

- Separation mechanisms
- Chemical separation
- Smart design
- Waste measurement tools

We Need:

- **In-field process harm reduction**
- **Policy**
- **Realistic pricing**
- **Tech workers who buy in bulk can make demands of vendors**

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Selected Sources

High Tech Trash – Elizabeth Grossman

GAO 8/2008, ***Electronic Waste: EPA Needs to Better Control Harmful U.S. Exports through Stronger Enforcement and More Comprehensive Regulation***

BAN: "Exporting Harm" and "Digital Dump"

Silicon Valley Toxics Coalition (SVTC)

Eric Williams, UNEP/UN University program

Thanks!

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- And YOU!

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