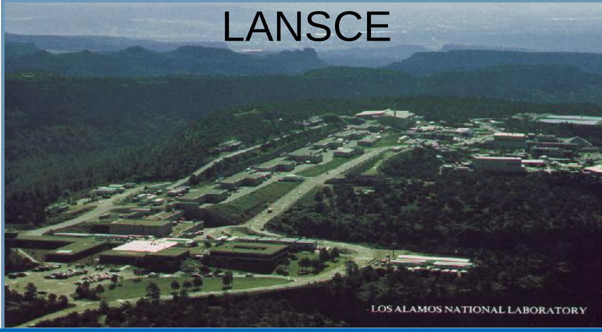
Materials Sustainability



Partnerships, Science, and Innovation for Sustainability Solutions
NAS
May 16-18, 2012

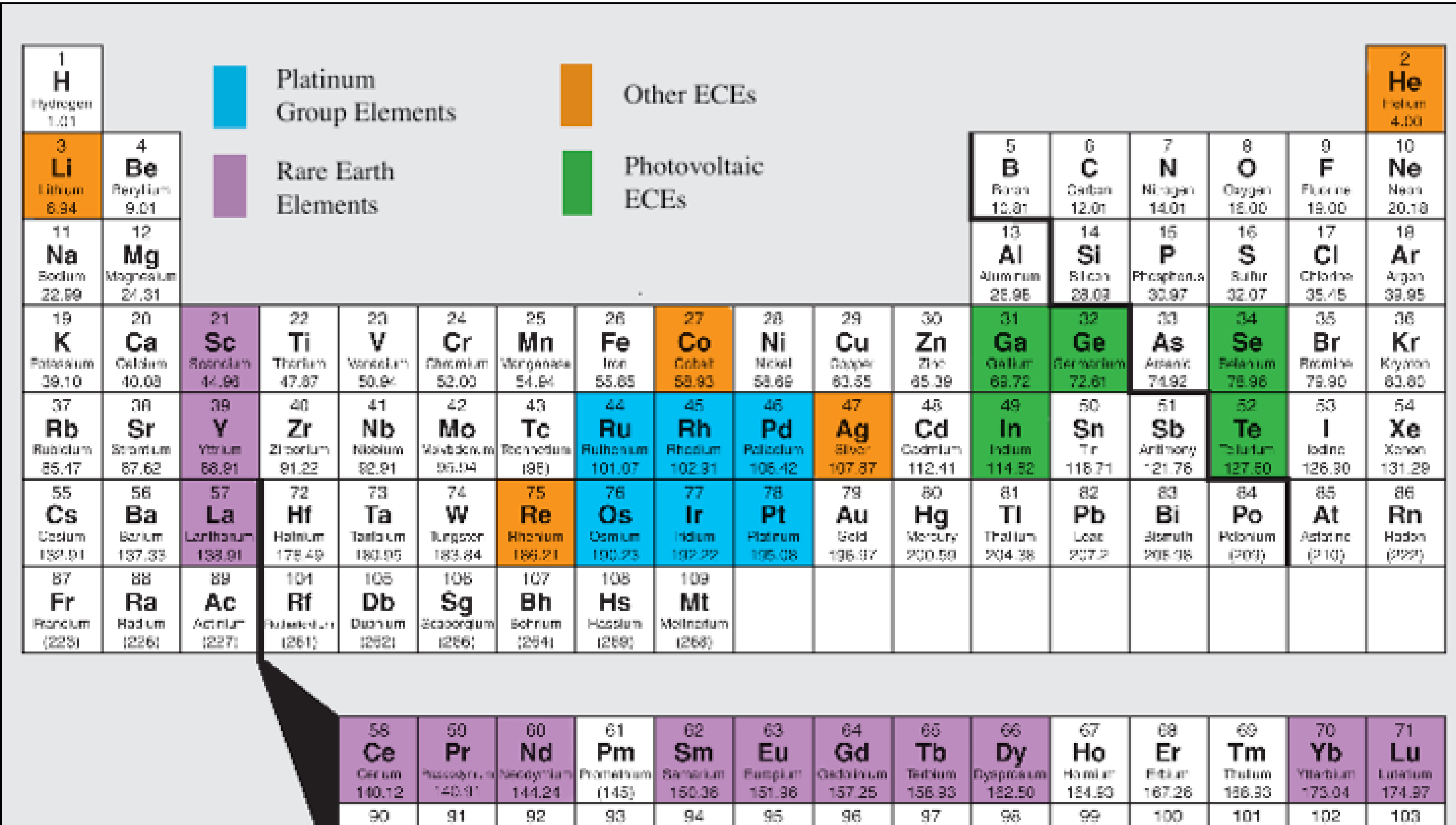
Alan J. Hurd

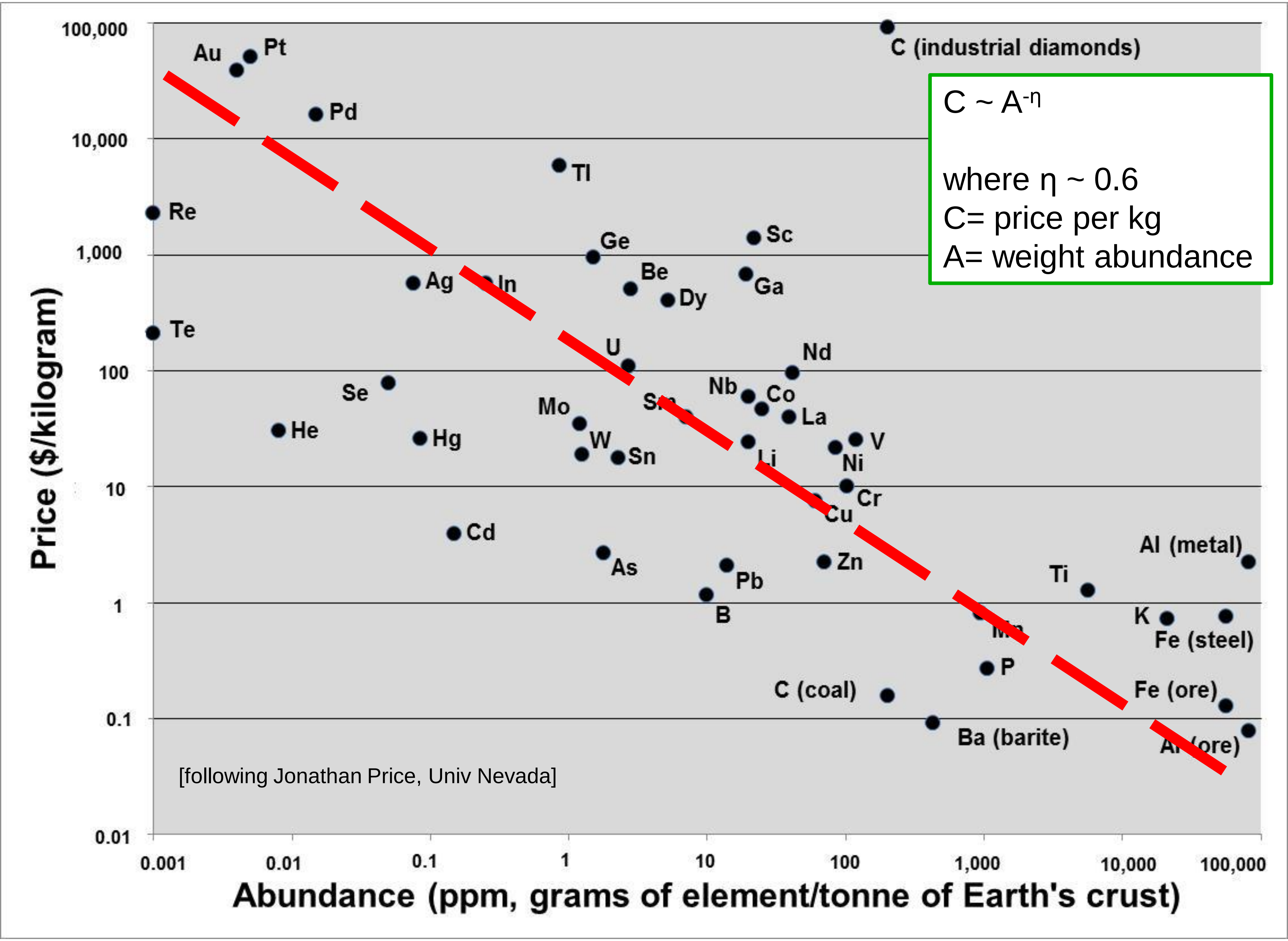
Los Alamos National Laboratory
Santa Fe Institute

The APS-MRS set of Energy Critical Elements

(American Physical Society and Materials Research Society)

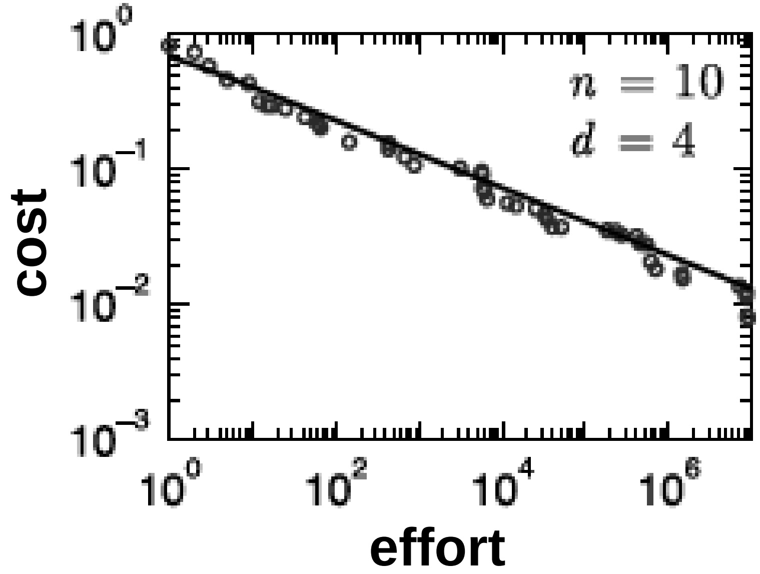
Alan J. Hurd, Santa Fe Institute and Los Alamos



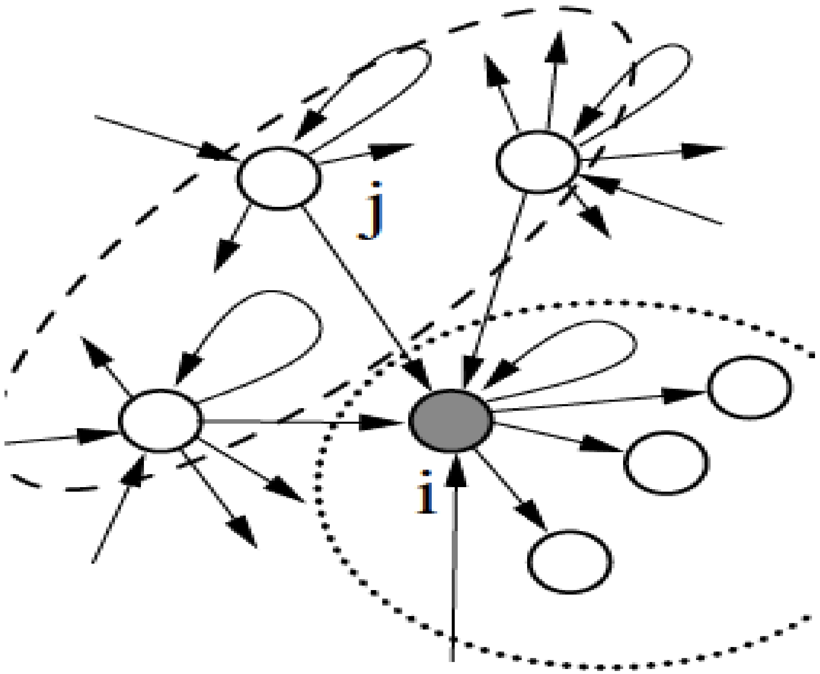


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
Abundance (ppm, grams of element/tonne of Earth's crust)
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Au
Pt
Pd
Tl
Re
Te
Ge
Be
Dy
Sc
Ga
Ag
In
U
Nd
Nb
Co
La
Se
He
Hg
Mo
W
Sn
V
Ni
Cr
Cu
Cd
As
Pb
B
Zn
Ti
Al (metal)
K
Fe (steel)
P
C (coal)
Ba (barite)
Fe (ore)
C (industrial diamonds)
C ~ A^-η
where η ~ 0.6
C= price per kg
A= weight abundance
[following Jonathan Price, Univ Nevada]

Role of design complexity in technology improvement
McNerney, Farmer, Redner, and Trancika *PNAS* **108** 9008 (May 2011)



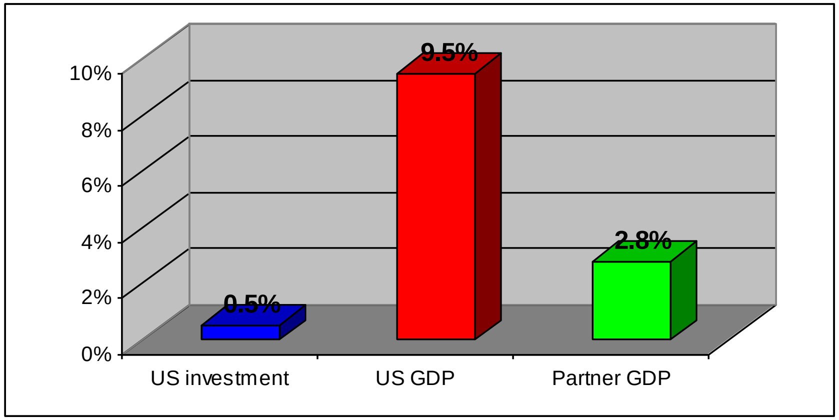
Wright's Law: Power law

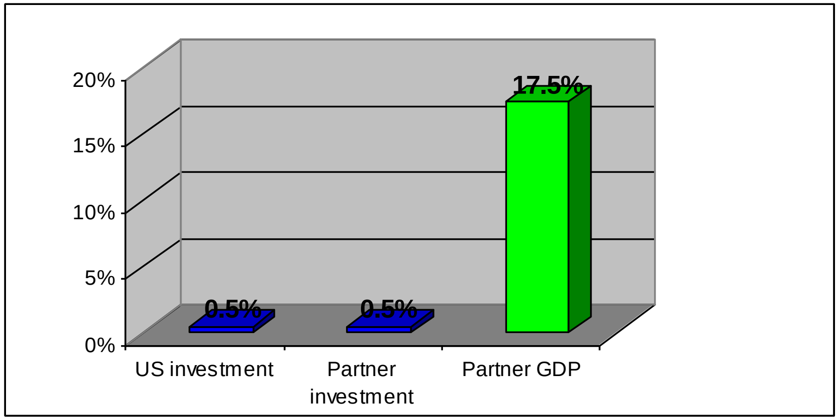


Return on Investment and Economic Spillover

- **If U.S. increases domestic R&D by 0.5% of GDP then**
  - its own GDP will rise 9.5%
  - other industrialized countries' GDP will rise 2.8%
- **If *all* industrialized countries increase R&D by 0.5% of GDP**
  - their GDP would rise 17.5%.
- **U.S. would nearly double its GDP growth compared to the scenario of "going it alone."**
- **[Coe and Helpman (1995, 1999, 2009)]**

After 15 years





World Materials Summits
2007 Lisbon; 2009 Suzhou; 2011 Washington DC

VISION

It is an inherent right of everyone on Earth to have access to clean energy and water in a sustainable way. Achieving this goal is a global endeavor that will require international coordination, cooperation and collaboration. Materials play a critical role in enabling viable solutions to these problems.

Los Alamos NATIONAL LABORATORY EST. 1943

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Back up slides

International and National R&D Directions—What's needed for S&T for Sustainability

- How is the sustainability challenge being framed and addressed in scientific research?
- What are the major sources of knowledge and information?
- Often, sustainability challenges are complex. How does research begin to grapple with that complexity?
- How much of the knowledge can be used to inform programs/policies? Who were the key partners and how did they work together?
- What does the scientific community say is needed for S&T for sustainability?
- Based on your experience, what are the key S&T needs for sustainability, and what is needed to pursue them?
- Are there institutional barriers to funding or doing research in this area? If so, what can be done to address them
- Where are we today in terms of identifying the right issues and gaps in the science and technology research being done to support sustainability? What new directions are needed in international and national R&D?

Materials research

1. Raw materials supply risk, especially energy critical elements and the sustainability challenge they present.
2. Technology improvement learning curves for sustainability development.
3. Return on investment for federally funded R&D.

Thoughts

- **Surrender the Climate Change battle**
  - Public opinion lost
  - No irrefutable logic, like the debt
  - No Sagans appeared
  - No one left has credibility
    - » Right: tainted by profits
    - » Left: tainted by questionable loyalty, scandals
  - Move to mitigation and accommodation of effects such as sea rise
  - Enjoy some new advantages such as navigation
  - Lengthen the overtime period; it will be sudden death
- **Broaden the discussion to Sustainability, a superset with CC in it**
  - Better captures the sus
  - Irrefutably depletion tech is limited.

Joe Sixpack

- **Watches NOVA**
- **Reads Sci Amer**
- **Likes awe he feels from looking at pictures that invoke spiritual feelings**
  - Hubble
  - Sun satellite
  - Rover
- **Understands the National Debt math—same as household budget**