MEETING RECAP

GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE

Diminishing Natural Resources: Recognizing Limitations, Responding to the Challenges

GUIRR Meeting: October 20-21, 2009

This meeting recap was prepared by National Academies staff as an informal record of issues discussed during public sessions of the October 20-21, 2009 meeting of the Government-University-Industry Research Roundtable (GUIRR). The document is for information purposes only and supplements the meeting agenda available online at www.nas.edu/guirr. It has not been reviewed and should not be cited or quoted, as the views expressed do not necessarily reflect the views of the National Academies or members of GUIRR.

The planet's expanding population and rising standards of living are placing unprecedented demand on finite natural resources. The objective with this meeting of the Government-University-Industry Research Roundtable (GUIRR) was to examine a number of interrelated natural materials issues, including:

- *America's consumption of core resources (rare earth minerals, metals, strategic materials) and commodities used in the development of innovative as well as legacy technologies;*
- *supply, demand, availability and cost of natural resources;*
- *where the U.S. is self-sufficient and where there may be global tensions over supplies;*
- *risk factors in the sourcing of natural material;*
- *the flow of natural material within the industrial system; and*
- *means for achieving critical materials sustainability within the United States.*

Overall participants considered how the federal government, universities and corporations can best collaborate in pursuing innovative technologies in R&D while remaining cognizant of natural resource limitations.

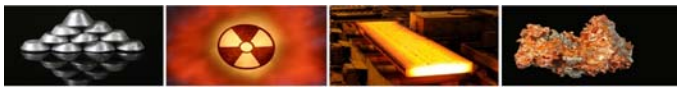
Meeting Summary

Dr. Steven Koonin, Under Secretary for Science at the U.S. Department of Energy, opened this 25th anniversary GUIRR meeting with a keynote dinner address titled "The Challenge of Sustainability", which focused on three intertwining resources: energy, food and water. He began by putting forward two theses: the first, that global development and population growth will place unprecedented stresses on resources. This he called the "big S" sustainability problem. The second thesis, which he dubbed our "little s" sustainability problem, was that these same factors will have a profound influence on U.S. domestic and global circumstances.

Koonin then focused on fossil fuels and energy innovation. Energy innovation is very different from other spheres in which we have seen great innovation in past decades, like IT and biomed, he stated; this is because energy technologies change slowly. "Anyone who tells you they are going to revolutionize the energy system in 10 or 20 years just doesn't understand scale." In thinking about energy, the country may want to more closely align basic research with development and with deployment of energy innovation hubs like those currently being pursued by the Department of Energy.

As with energy, the demand for water (for drinking, agriculture, energy) and food (note tension between food/biofuels/biomass) will also increase with development and population. Commonalities with Sustainability (big "S") in these three areas include conservation, efficiency, time, and an educated populous. The challenge in achieving sustainability, with a little "s", is that "…the rest of the world is more numerous than we are, growing faster, younger, developing faster, and newer in that they are building their infrastructure now. And, of course, they are just as smart in the rest of the world."

Government, academia and industry will need to be aware of where the U.S. is headed and the implications of the decisions we make, stated Koonin. This begins with frank conversation. One cannot fully predict the future; however, the three sectors (G-U-I) will need to work together to navigate the coming decades.



The meeting opened the next morning with a presentation entitled "Era of Insufficient Plenty" by **Mr. John Voeller**, senior vice president for Black & Veatch and, for the last six years, a fellow and consultant to the Bush and Obama administrations in the Office of Science and Technology Policy. America has enjoyed 150 years of great engineering and science where "just about anything we needed, we could get our hands on," stated Voeller. Sometimes there was a price to our consumptive behavior, he said, but not until recently have there been potential and significant barriers.

The question now is how the U.S. can withstand other consumptive communities while still maintain its competitive stance and market positions, and continue to grow. Voeller directed the group's attention to the growing GDP of China and India and their concomitant consumption of oil, water, and other natural commodities (e.g., aluminum, copper, nickel, iron, "rare earths"). Our standard definition of "sustainability" is incomplete, he suggested, because it presumes availability. Voeller touched upon what other countries are currently doing to ensure their access to needed materials, and he encouraged the U.S. to consider not only the next generation of materials but also future legal and social implications ("integrated innovation").

Next to speak was **Dr. W. David Menzie,** chief, International Minerals Section, Minerals Information Team, USGS, who addressed "Mineral Supply and Consumption – Searching for a Twenty-First Century Balance." Menzie presented a comprehensive picture of: (1) why the search is difficult; (2) the physical factors that affect mineral supply; (3) effects of institutional structure, technology, and social factors on mineral supply; and (4) economic growth and mineral consumption and development. The question of *where* the consumption is occurring, he noted, has implications about materials use and the prospects for stabilization and balance. Menzie concluded by highlighting some of the challenges that lie ahead, including increasing mineral supply (from mining and from recycling, remanufacturing and reuse), reducing consumption, and reducing the costs of production and consumption.

Yale University professor of industrial ecology and geophysics and director of the Center for Industrial Ecology, **Dr. Thomas Graedel**, followed with a "teachable moment", inviting meeting attendees to hold up their cell phones and guess the number of elements from the periodic table represented therein. In the 1980s, he noted, Intel chips were made with 11 elements. Today, in contrast, cell phones utilize roughly two-thirds of the periodic table. This upward trend in material use is not limited to electronics. Summarizing his talk on "The Criticality of Minerals", our speaker emphasized: (1) we are using everything; (2) we are using it for specific purposes; and (3) many materials appear to be "pretty un-substitutable" if we want to maintain the technological performance to which we're now accustomed. An appeal for university research funding into these criticality issues was made.

The discussion then moved to the geopolitics of strategic minerals. "Historically, mineral supply and geopolitical behavior are lock-stepped", stated **Dr. Kent Butts**, professor of political strategy and director of the National Security Issues Group, Center for Strategic Leadership, U.S. Army War College. The Paley Commission Report of 1952 was one high-level effort to draw the attention of the American people to supply vulnerabilities and the importance of international issues. Today, as in 1952, the U.S. wants "adequate and dependable flow of materials at the lowest possible cost and consistent with the welfare of friendly nations," stated Butts. "We are not in this alone." A revisit to the Paley report might prove useful in the creation of a national strategy or plan that necessarily incorporates defense, diplomacy and development.

Dr. Steven Duclos, chief scientist, General Electric Global Research Center, followed with an important case study – a "wake-up call", he stressed – on raw materials risk from the perspective of a very large manufacturing company. He shared the circumstances of GE's first realization of risk, followed by the company's pragmatic approach to (1) assessing relative risk (element by element, in terms of availability and sustainability of supply) going forward, and (2) dealing with determined risk.

To the first point, GE developed a "criticality diagram" that examines internal factors such as:

- What volume of the material is used?
- What is the impact on our products?
- What is the criticality?
- Can we do without it?
- Can we do with less of it?
- How might we reduce use and/or identify substitutions?

External factors were and are now also considered; such things as demand and supply dynamics, price volatility, geopolitical risks, co-production risk, plus environmental health and safety aspects.

To the second point, GE reportedly pursues multiple paths, including: hedging, stockpiling, new sourcing, establishing more efficient manufacturing processes, recycling, and elimination or significant minimization (through technology re-design) of at-risk material. To minimize risk, it was suggested that companies, universities, and government agencies work together to invest in a broad range of technologies aimed at minimizing materials usage and developing materials alternatives.

The last two speakers in the morning session presented a federal government and small business perspective of metals and natural material need/use/reuse, respectively. A materials engineer from a national lab now working in a policy office, **Mr. Rick Lowden** provided insight into the history behind federal stockpile legislation and the definition of strategic materials ("military, industrial, and essential"). Considered "the keepers and watchers of the industrial base", the Department of Defense (DOD) today is seeking to make the stockpile into a "living, dynamic, strategic materials security program for national security purposes."

Following Lowden was **Dr. David Spencer**, chairman and CTO of wTe Corporation, a small recycling company based in Bedford, MA. Spencer delivered a candid snapshot of the many challenges, incentives, disincentives and tight economics of plastic and metals recycling from scrap and waste, utilizing, in the case of this particular company, advanced optoelectronic technologies. Small companies like wTe cannot readily realize technological growth and cross the so-called Valley of Death – particularly if they are to function on a national scale – without support from federal funding programs such as NSF's SBIR program and NIST's ATP (now TIP) program, it was noted.

Formal presentations were capped with an engaging luncheon address by economist **Dr. Roderick Eggert,** professor and director of the Division of Economics and Business at the Colorado School of Mines. Eggert organized his comments around four specific propositions about critical minerals and materials, noting that, with his reference to "critical materials", he means minerals and mineral-based materials that satisfy two conditions: (1) they are difficult to substitute, and (2) they are subject to some degree of supply risk. This is not as narrow or precise a definition as that of the DOD.

Eggert's propositions were the following:

1. Limits on resource availability are more about cost, distribution and time frame than about tons. ("We are not in danger of running out anytime soon.")
2. Market pressures are effective in encouraging two things: investing that reinvigorates supply, and encouraging users to provide insurance against supply risks. ("Don't ignore markets.")

3. China should be a concern but not an obsession.
4. Government activities can and should involve collaboration and partnership with universities and industry.

To his point number 4, Eggert elaborated by stating that: (1) government activities should focus on undistorted international trade; (2) policies and procedures for domestic mineral development need to appropriately integrate commercial, environmental and social considerations; (3) government activities should focus on facilitating the provision of information on which private and public decisions are made; and (4) government activities should facilitate research and development (recycling falls in here).

The October 2009 GUIRR meeting closed with a stimulating dialogue among participants and the elucidation of numerous areas where the three sectors (G-U-I) can work more closely in examining risk, understanding and mitigating the challenges, shaping policy, and communicating the criticality of our nation's natural and mineral resources.

ABOUT GUIRR

MISSION

GUIRR's formal mission, revised in 1995, is "to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. This forum will be designed to facilitate candid dialogue among participants, to foster self-implementing activities, and, where appropriate, to carry awareness of consequences to the wider public."

STAFF

Susan Sauer Sloan, Director, GUIRR
Anthony Boccanfuso, Executive Director, UIDP
David Wright, Executive Director, FDP
Claudette Baylor-Fleming, Administrative Coordinator, FDP
Denise Greene, Administrative Coordinator, GUIRR and UIDP
Laurena Mostella, Administrative Assistant, GUIRR and UIDP

For more information about GUIRR visit our web site at http://www.nas.edu/guirr
500 Fifth Street, N.W., Washington, D.C. 20001
guirr@nas.edu 202.334.3486