TESTIMONY
of
Dr. Robert Jaffe
for
The Energy and Environment Subcommittee
of the House Science Committee

Dec 7th, 2011

Mr. Chairman and members of the committee, thank you for the opportunity to testify today on *"Energy Critical Elements: Identifying Research Needs and Strategic Priorities"* and comment on legislation before you. I am a professor of physics at MIT and recently chaired a study of *Energy Critical Elements* sponsored by the Panel on Public Affairs (POPA) of the American Physical Society (APS) and by the Materials Research Society (MRS). I enclose a full copy of the report for the record, but this morning I'll simply highlight a few key findings and recommendations.

THE ROLE OF ECEs

Although we are not going to run out of any chemical element anytime soon, the problem of availability of certain key elements is serious and very real. While rare earths are the "flavor of the month", a host of other elements are poised to present problems in the future.

Recently a colleague of mine had to lay-off a post-doc due a spike in the price of helium he needed to sustain the research program. A minor event? But multiplied over and over in scientific research, business, and industry throughout America, serious disruptions in innovation and investment occur when the price and availability of critical elements fluctuate wildly over a few months time.

If appropriate steps are not taken, we face potentially disruptive short-term constraints on supply of some elements that are not presently mined, refined, or traded in large quantities, but are critical to the deployment of potentially game-changing energy technologies. Casualties might range from key petroleum refinery catalysts to state-of-the-art wind turbines or market competitive solar panels. I refer to these elements as ECEs -- **Energy-Critical Elements**.

I enclose a page identifying several ECEs and their role in our nation's energy future.

CONSTRAINTS ON AVAILABILITY

Constraints on availability of ECEs would threaten the competitiveness of both U.S. industries and the domestic scientific enterprise. I'll briefly mention each of the constraints along with an example from the list of ECEs:

1) Low Abundance or Concentration
   Though not intrinsically rare, some ECEs are not mineralized efficiently by geological processes, and do not occur in viable ores.
   EXAMPLE: Although nearly as abundant as tin, germanium has limited use because it is not found in rich ores.

2) Geopolitical Risks
   By chance, in some cases, ECEs exist in only one or two large or rich deposits in the world. In other cases, complex economics and politics have led to dominance of a single or small number of countries that have particular ECEs, allowing those countries to manipulate the market.
   EXAMPLE: China has limited the export of rare earth elements.

3) Risks of Joint Production
   Some ECEs are only recovered as by-products in extraction of more common metals. This links their availability to the economics of the primary metal. While in low demand, these ECEs may be abnormally cheap, only to become far more expensive when by-production is exhausted.
   EXAMPLE: Nearly all tellurium is a by-product of copper refining.

4) Environmental Concerns
   Some countries in the developed world will not accept environmental disruption associated with extraction of particular ECEs, while other countries are willing to tolerate environmental degradation for short-term gain. Rising environmental standards and/or social unrest can disrupt supplies.
   EXAMPLE: The extraction of certain rare earth elements in South China is notoriously damaging to the environment.

5) Response times in production & utilization
   It takes 5-15 years to bring new sources online and/or research and develop substitutes.
   EXAMPLE: The supply of lithium is uncertain due to time delays in production.

APS POPA/MRS RECOMMENDATIONS

The panel I chaired made recommendations to address constraints on element availability. We focused intensely on elements critical to new technologies that have the capacity to transform the way we harvest, transport, store, or use energy. (Please note that we did not consider defense-related issues.)

It is our view that with careful stewardship by the government, coupled with the imagination of fundamental research and the initiative of U.S. industry, the problem of ECE availability can be managed for the foreseeable future.

To accomplish that, we recommend a three-component approach based on information, research, and recycling.

But first, let me say a few words about what we don't recommend.

The U.S. can't mine its way to ECE independence. Yes, we should certainly pursue domestic mining when economically and environmentally appropriate – but not with the expectation that mining alone will solve the problem. Many ECEs are simply not found here in economically viable deposits, and others are produced more efficiently – for a variety of reasons – by other countries. Free international trade with a diverse set of suppliers works to everyone's advantage.

We can't rely on stockpiling either. We found that stockpiling is a disincentive to innovation because it anchors us to the status quo. Stockpiles have proved a poor way for governments to try to moderate price fluctuations and stabilize markets, often with unintended negative consequences. (Note, however, that we did not consider defense stockpiles, which may be motivated by other considerations.)

In developing our recommendations for the most effective way to address this issue, we took a lesson from industry.

> **CASE STUDY**: General Electric has for many years tracked the market for an exceptionally rare metal, rhenium, which is critical to its advanced turbines used both in jet engines and modern natural-gas fired power plants. In 2005, General Electric projected that demand for rhenium would outpace worldwide supply within a few years. Instead of stockpiling, GE reduced its immediate need for new rhenium by a wide-ranging recycling program, and began an intensive, multiyear research program to develop an alternative alloy. By 2010 they had found, tested, and certified several new alloys that use less rhenium. Meanwhile the price of rhenium had risen 10-fold to over $10,000/kg.
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> **LESSON**: GE succeeded, but many smaller U.S. companies and university & national labs: 1) do not have the information gathering network needed to recognize an impending supply disruption; 2) can't afford to carry out substitutional research; and, 3) can't engage in extensive recycling.

Consequently, in general, we recommend the following:

1) The government should gather, analyze, and disseminate information on ECEs worldwide across the life-cycle supply chain, including resources, production, use, trade, disposal and recycling. Accurate information about availability will allow the scientific enterprise as well as investors to see beyond the price spikes and plan for the

future. This can be achieved by, among other things, elevating the federal information gathering entity to a “Principal Statistical Agency” similar to the Bureau of Labor Statistics and the Energy Information Administration.

2) The government should promote fundamental research aimed at the twin goals of increasing supplies and decreasing our dependence on ECEs. It is especially important to support fundamental research on earth-abundant substitutes for ECEs. The goal should be a broad understanding of the advantages and disadvantage of technologies based on alternative materials, in order to enable U.S. manufacturers or lab researchers to more smoothly shift to a substitute material or alternative technology in advance of supply disruptions.

3) Cell phones and iPods end up discarded in the back of sock drawers, yet they often contain ECEs in concentrations that exceed the richest ores. Those dispersed products could be gathered into a resource – an urban mine – so the ECEs can be extracted for reuse. There are various paths to achieve this: government could help increase recycling by enabling greater consumer awareness and industry could stimulate it by providing consumer incentives.

THE ENERGY CRITICAL ELEMENTS ADVANCEMENT ACT OF 2011

I believe that our report’s recommendations can be implemented with a budget-limited approach that respects the distinction between activities that belong in the private sector and those that fall to government. As a result, I’m delighted to testify today along with a Research Fellow at the Heritage Foundation.

Several House bills have been introduced to address the minerals availability issue. I’ll speak to one in particular: HR 2090 -- the Energy Critical Elements Advancement Act of 2011, introduced by Representative Hultgren.

The Hultgren bill has provisions on the full triad that we recommend: information, research, and recycling. It is also closely aligned with our view that these important actions can be addressed in a budget-limited – or even in some cases a budget-neutral – manner.

The Hultgren bill is comprehensive and recognizes the need for careful stewardship by the government without unnecessary overreach. It couples the imagination of fundamental research and the initiative of U.S. industry so that the problem of ECE availability can be managed for the foreseeable future.

Thank you for the opportunity to testify.

Energy Critical Elements: Powering Our High-Tech World

Energy Critical Elements (ECEs) are found in a myriad of high-tech, environmental and military equipment. From smart phones to solar panels to jet engine parts, ECEs play crucial roles in products affecting our daily lives.

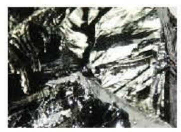





52
Te
Tellurium
127.60

TELLURIUM—brittle, silvery-white metallic element used in solar panels

32
Ge
Germanium
72.61



GERMANIUM— hard, grayish-white element with metallic luster; used in solar panels

78
Pt
Platinum
195.078

PLATINUM—silvery-white, lustrous, ductile and malleable; used in pollution control devices for cars, and in fuel cells

60
Nd
Neodymium
144.24

NEODYMIUM—bright, silvery rare-earth metal element; used in wind turbines and hybrid cars

3
Li
Lithium
6.941

LITHIUM—a soft, silver-white metallic element; used in wind turbines and lithium-ion batteries in hybrid cars

75
Re
Rhenium
186.207

RHENIUM—silvery-white metal with one of the highest melting points of all elements; used to make advanced turbines and jet engine parts

65
Tb
Terbium
158.92534

TERBIUM—a soft, silvery-white rare earth metal; used along with its fellow rare earth europium in compact fluorescent light bulbs to provide an acceptable color balance

Energy-critical element images obtained from: *http://images-of-elements.com*

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