APS-MITEI-MRS Workshop Critical Elements for New Energy Technologies

A Communications & Outreach Perspective

Dayan J. Anderson[1]

Although policy makers have been identified as the primary audience for the "Critical Elements for New Energy Technologies" study, the **need** for the policy recommendations that emerge must also be effectively communicated to the constituents the policy makers serve. Ultimately, these constituents will be involved, directly or indirectly, in many if not most of the decisions impacting the final feasibility of new energy technologies. Whether it be decisions to site a specific energy project, approval to develop the mineral resources required to manufacture new energy technologies, or acceptance of taxes or other policy incentives to encourage post-consumer recycling, communities and stakeholders need to understand, or at least have a broader appreciation for, the complexity of these issues and how each decision integrates into the larger solution.

There is societal "confusion" about mineral supply[2] and recyclability that needs to be corrected before society can make informed decisions about the materials it will use to sustainably meet the needs of a growing population. The comments and suggestions that follow are focused on raising society's general awareness, appreciation and understanding of materials, and the role materials will play in society's transition to sustainability.

The ability to effectively communicate complex issues to policy makers and the general public is limited by the attention-span, as well as the vocabulary, of the listener. Careful attention must be paid to word selection, and any use of technical lexicon must be accompanied with clear and consistent definitions. One approach to communicating technical content is to first frame complex issues using terminology with which the audience may have more familiarity. A suggested approach to framing the conservation about raw material supply and sustainability is offered below.

Over the past two decades, footprint metrics and accounting methodologies have emerged that represent generalized proxies of how individual, organizational or national decisions impact land, air and water as illustrated in Figure 1. Technologies to meet human needs and to lower these footprints will require diverse material sets, and production of these materials depends on a complex combination of animal, plant, mineral and energy inputs, as illustrated in Figure 2. Each footprint is linked to jobs and livelihoods in a global economy as shown in Figure 3, and although not graphically depicted, there are of course complex social impacts (both positive and negative) surrounding the production, use and disposal of these materials. Placing a solitary focus on any single footprint or emphasizing sub-sets of these footprints at the expense of others will not lead to the 'best' decisions for sustainability. Rather, increased societal understanding of the relationships *between* these footprints (i.e., how they interact, overlap and influence each other) and furthermore, an understanding of how our choices <u>reinforce</u>, <u>distort</u> or <u>sever</u> these relationships is required.

Using a simple teeter-totter to depict the concept of sustainability as shown in Figure 4, society's overall environmental footprints are currently large and "heavy" and the basic needs of most of the world's population are not being met. In other words, current patterns of consumption and production do not represent a stable system. Figure 5 suggests how society might bring this system into an acceptable, and more sustainable balance; namely, by determining how it can best **leverage** technology (and the materials sets they will require) to minimize environmental impacts

---

[1] President, Mineral Footprint Network (danderson@mineralfootprint.org ● PO Box 5080 Sugarloaf CA, 92386 ● 909.547.0780)
Additional input on market dynamics and mineral availability provided by Dr. Deborah J. Shields, Department of Economics at Colorado State University

[2] The distinction between "reserves" and "resources" does not appear to be well-understood by disciplines external to the extractive industries, as well as civil society in general.

and raise the well-being of a growing population. In short, materials produced in a socially and environmentally responsible manner act as the **fulcrum** for sustainability. However, with so many competing uses for minerals, metals and materials to meet its needs, how will society find the optimal solution? First of all, society cannot move the fulcrum to its optimal position without socially and environmentally acceptable engineering advancements. Likewise, these engineering advancements and technologies will not be affordable and feasible without reliable information about the complete mineral and material cycle. The information that society will need to make intelligent choices, from researchers and engineers, to investors and manufacturers, to consumers and policy makers is dynamic and needs constant monitoring and attention. Minerals, metals and materials information must be continually collected, managed, coordinated and disseminated as public domain data so all stakeholders can make informed decisions.

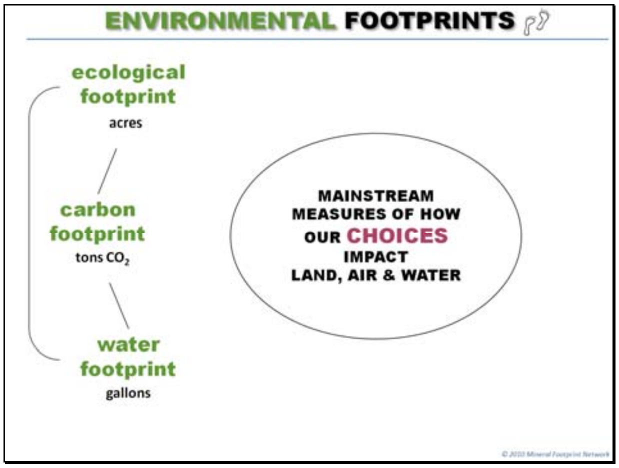


Figure 1:
Environmental Footprints

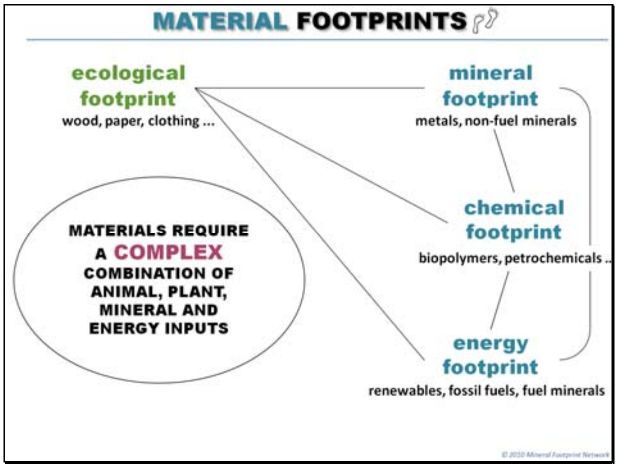


Figure 2:
Material Footprints

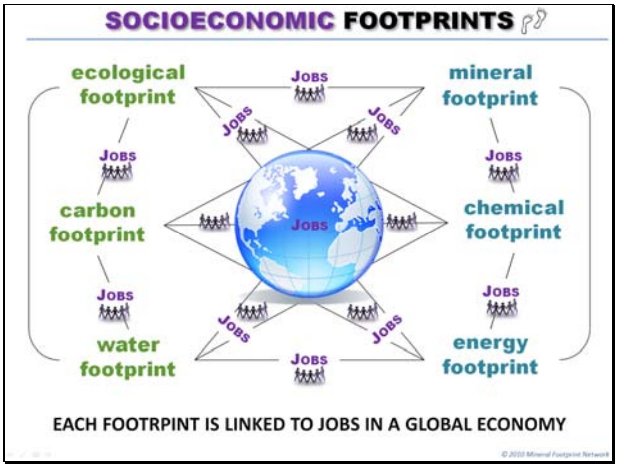
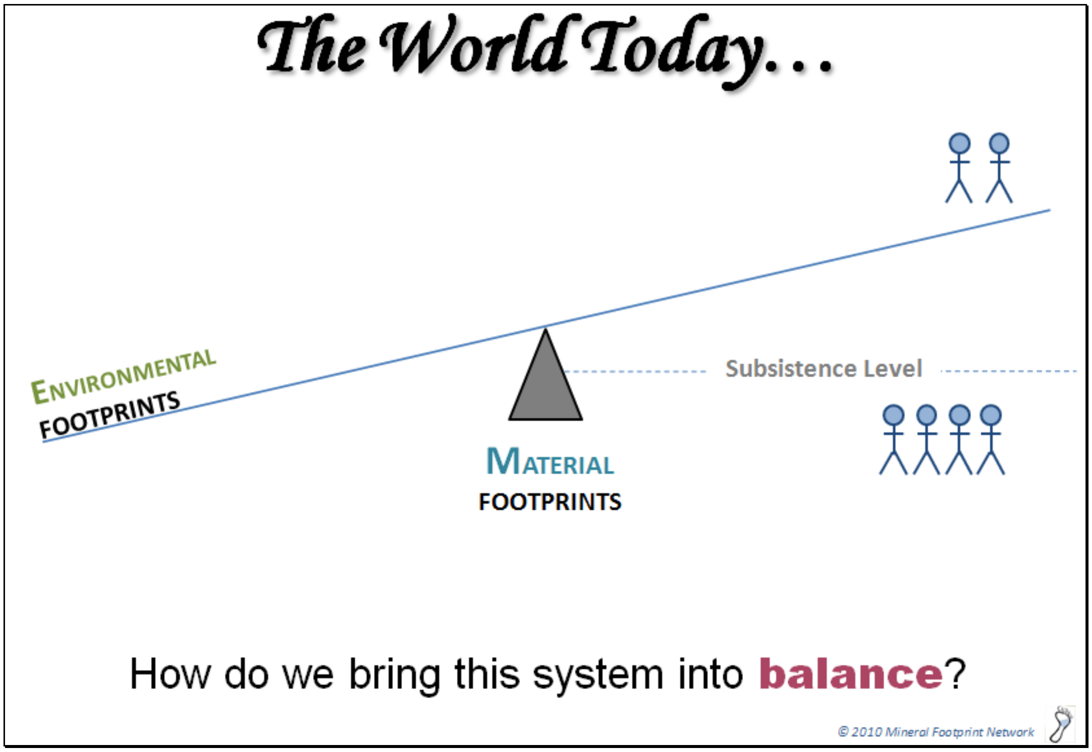


Figure 3:
Socioeconomic Footprints

Figure 4: Current Patterns of Production and Use of Materials

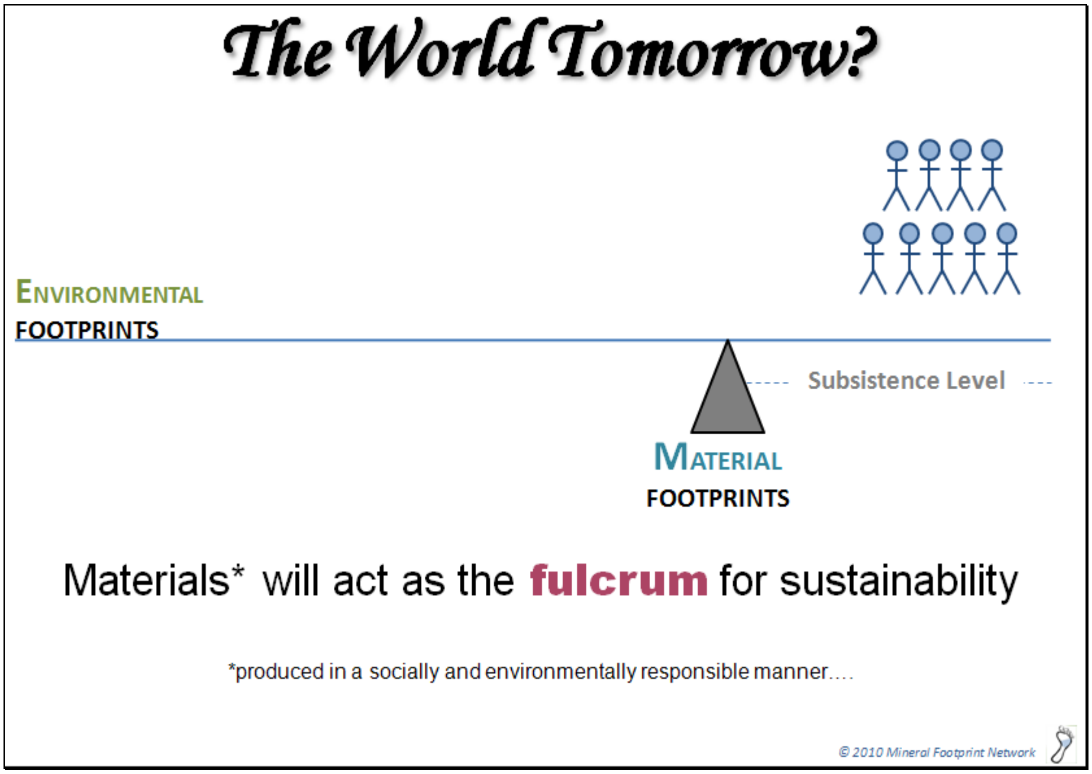


The World Today…

How do we bring this system into **balance**?

© 2010 Mineral Footprint Network

Figure 5: Sustainable Production and Use of Materials



The World Tomorrow?

Materials* will act as the **fulcrum** for sustainability

*produced in a socially and environmentally responsible manner….

© 2010 Mineral Footprint Network

Each of the case studies presented during the workshop identified various issues, market dynamics and characteristics that are common to most mineral resources. These messages collectively serve to communicate many (*but not all*) of the complexities of a global raw material supply. These issues have been grouped into key themes that must be communicated to raise society's understanding of the material footprints required to meet the needs of both present and future generations (see Table 1).

Table 1: Key Themes Underpinning the Complexity of a Sustainable Raw Material Supply

Themes	Comments
Variability & Uncertainty (Do we really know where "the limits" are?)	Not all deposits are 'equal' and our understanding of the quality and potential occurrences of these deposits vary by commodity and type. There is an important difference between a '*resource*' and a '*reserve*' and it needs to be made clear that we know a great deal about some minerals, but not all. There is still much about the sub-surface we do not know. The potential to recapture material once defined as sub-economic by previous generations must not be overlooked. *If we invest in R&D for new exploration, mining and mineral processing technologies* we have the potential to make more mineral resources available to society.
One-Size-Does-NOT-Fit-All	There are some "readily available" substitutes for some end-uses of a given element, while other applications rely on specific properties of certain elements and minerals for which there is (as of yet) no known alternatives. *Some* technologies and conservation measures can be implemented by *some* end-users, leaving resources available for other competing uses but this is not always the case.
Why Timely Information Matters	Changes in price affect different producers and end-users differently. Price volatility can be fueled by speculation, among other reasons. Speculation thrives on the absence of information, the proliferation of misinformation or dated information, as well as information taken out of context. This underscores the need for a transparent system of timely data collection, management and dissemination of information to the public.
We Need a More Complete Picture	The amount of public domain information on resources, reserves, recycling rates and other aspects/variables of the mineral life cycle is not complete. It is fragmented and in some cases, limited only to information in the United States.
There are 5 Dimensions of Mineral Availability	It needs to be made very clear that the mineral and energy 'reserves' available to the immediate market is a very time sensitive and ever-changing number that is dependent on many factors. For example, an individual firm's decision to invest in the delineation of additional reserves at any given point in time may be influenced by the availability of capital, tax implications, land tenure, etc. Furthermore, there are 5 sets of questions (See Table 2) that must be continually asked to quantify the mineral resources available to society at any given point in time.
There are 4 Dimensions of Recyclability	There are 4 dimensions of availability for secondary resources (post-consumer scrap) as shown in Table 3. The quantity and quality of recycled inputs is "the result of many decisions, made by businesses, individuals, and governments over a very long period of time."[3] The recyclability or potential for re-use of any mineral, metal or material is also a function of the end-use application.
Timing	Timing is a key issue for both primary production and secondary production. It can take 10-15 years or longer to bring a new discovery into production and the length of this cycle varies by political jurisdiction. The availability of old scrap relies on assumptions for the lifetimes of products which can be difficult to estimate. The dynamics between primary (virgin ore) and secondary (old scrap) supply is complicated and the question of whether or not to recycle should be re-framed to more effectively communicate this dynamic. In other words, it is perhaps more important for society to discuss *when* it is best to use recycled inputs and to identify measures taken today that will allow for the appropriate response at the proper time in the future. For example, many critical elements are produced as co-products or by-products of other metals and are consequently influenced by the prices of the principal commodity being developed. Other elements currently reporting to waste-streams of existing processes could be recovered as by-products with additional investment. However, if large quantities of secondary resources are used pre-maturely (as opposed to taking measures now to collect and stockpile for future recovery), the opportunity to economically capture critical elements as by-products of current primary production is compromised or lost.
We Need a Holistic Paradigm	Material supply issues must be looked at holistically due to the broad range of end-use applications and competing demands for minerals/metals/elements. In other words, policy decisions cannot be looked at in isolation. Although the scope of this study is focused on the availability of material sets required for emerging technologies, the implications of material selection on water use and emissions, as well as land and water demands associated with operating each technology choice must not be overlooked. A holistic, full life-cycle approach is needed.

---

[3] Source: "Minerals, Critical Minerals and the U.S. Economy", National Research Council (2008)

The dynamics between primary (virgin ore) and secondary (old scrap) supply is complicated and availability of each at any given point in time is a function of the respective answers to the questions summarized in Table 2 and Table 3. The answers to each of the questions raised will **change** over time. Policy makers, voters and all stakeholders in the supply chain need to understand how they might influence the answers to each of these questions and must be cognizant of the relative certainty we have in the data available at any given point in time. Furthermore, society needs to continually foster the proper expertise to interpret the data collected and to develop innovative solutions to unlock new potential resources. It must invest in research within *all related disciplines* (engineering, physical and social sciences) so future generations have the capacity and expertise to continually answer these questions. The United States needs to be cognizant of how other countries are currently addressing these questions and to what extent international cooperation will be required to ensure a reliable and sustainable raw material supply.

Table 2: The Five Dimensions of Mineral Availability

Geologic Availability	*Does the mineral resource exist?*
Technical Availability	*Can we extract and process it?*
Environmental & Social Availability	*Can we produce it in an environmentally and socially responsible manner?*
Political Availability	*How do governments influence primary availability through their policies and actions?*
Economic Availability	*Can we produce it at a cost users are willing and able to pay?*

Adapted from “Minerals, Critical Minerals and the U.S. Economy”, National Research Council (2008)

Table 3: The Four Dimensions of Recyclability

Technical Availability	*Is technology available to sort, separate and recover material, and is an efficient post-consumer collection network in place?*
Environmental & Social Availability	*Can we develop socially and environmentally acceptable waste diversion programs, and can we encourage more consumer participation?*
Political Availability	*How do governments influence secondary availability through their policy and actions?*
Economic Availability	*Are adequate economies of scale in place to produce secondary materials at a cost users are willing and able to pay?*

Adapted from “Minerals, Critical Minerals and the U.S. Economy”, National Research Council (2008)