Defining Mineral Scarcity: implications for sustainable development

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Shields
Make solar energy economical

Provide energy from fusion

Develop carbon sequestration methods

Manage the nitrogen cycle

Provide access to clean water

Restore and improve urban infrastructure

Advance health informatics

Engineer better medicines

Reverse-engineer the brain

Prevent nuclear terror

Secure cyberspace

Enhance virtual reality

Advance personalized learning

Engineer the tools of scientific discovery

Source: National Academy of Engineering
Engineering Solutions for Sustainability: Materials and Resources


The American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), co-sponsored the American Society for Civil Engineers (ASCE) and the American Institute of Chemical Engineers (AIChE).
Participants represented academia, industry, government, and non-governmental organizations. Their expertise was in mining, minerals, geology, metallurgy, materials, petroleum, civil, electrical, chemical, physics, and environmental engineering disciplines, as well as economics. Participating organizations included IEA, WFEO, WHO, PATH, GM, Boeing, NTSB, Schlumberger, Lawrence Livermore Labs, British Geological Survey, USGS, US EPA, and Lifewater.
The workshop explored potential ways that the engineering profession can aid in addressing the needs for societal sustainability through technological, educational, and public policy solutions.
Definition of Sustainability in Engineering

- **economic**, the engineered system is affordable;
- **environmental**, the external environment is not degraded by the system;
- **functional**, the system meets users’ needs over its life-cycle. This includes users’ needs for functionality, health and safety;
- **physical**, the system endures the forces associated with its use and accidental, willful and natural hazards over its intended service life;
- **political**, the creation and existence of the system is consistent with public policies; and
- **social**, the system is and continues to be acceptable to those affected by its existence.
The workshop also addressed what materials and resources are integral to meeting basic societal needs in critical areas such as transportation, energy, recycling, housing, food and water, and health.
Keynote speakers addressed sustainable engineering (Dr. Brad Allenby), human capital needs (Dr. Diran Apelian), and mineral supply challenges (Dr. Andrew Bloodworth).
Multiple experts in each of the 6 fields then presented their ideas, focusing on the engineering answers for cost-effective, sustainable pathways, the strategies for effective use of engineering solutions, and the role of the global engineering community.
Topical Breakout Sessions on Human Needs, Infrastructure, and the Resource Cycle
Participants were asked to address:

- What does sustainability mean for this sector and why should we care?
- What engineering approaches exist and/or are being used now?
- What advances are feasible within 10-15 years?
- What materials and resources do existing approaches use and what will advances require?
- What advances in environmental, petroleum, marine, mining, minerals, and materials engineering will be required to sustainably produce these resources?
- What happens if we do nothing?
Common themes emphasized need for:

- A 'living definition' of sustainability
- Resiliency, flexibility in design of technologies, systems
- Designing for recyclability - simplify materials choices (e.g., fewer alloys, recyclability index)
- Mineral resources to implement new engineering approaches
- Responsible resource use/resource-efficient design
- Life-cycle assessment and costing
Some participants argued that adequate energy and mineral resources are available for the foreseeable future to support existing and emerging technologies, albeit at a cost.
Other participants argued that physical, situational, political, or social scarcity could, and in some cases already have, limited the availability of certain energy and mineral resources needed for existing and emerging technologies.
There was agreement that recycling, reuse and remanufacturing can provide a stream of minerals and materials to society, but minerals from primary sources will continue to be needed for the foreseeable future. Further, ensuring an adequate supply of minerals and materials for emerging technologies will require significant effort and contributions from the research community.
RESOURCE availability dictated by price, and/or some form of scarcity, implies the need for:

• Alternate resource development options for the same application to provide resiliency to price, availability and disruptions, and

• Design for recyclability
RESOURCE availability dictated by price, and/or some form of scarcity also implies the need for closing the loop of material production systems.

• Direct reuse
• Reusable components
• Reprocessing of recycled materials
• Extracting primary materials
• Energy from waste
Next Steps

• UN CSD18 participation
• Whitepaper reporting meeting content and outcomes, with technology and materials recycling matrix
• Follow-on meetings
• Student competition
• .....
One Final Take-Away Message

A sustainable future will only be achievable through cooperation and collaboration. We must move away from our ‘Silo Mentalities’ and embrace a multi-disciplinary approach to the societal challenges we face.
Disclaimer

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