CAETS

International Council of Academies of Engineering and Technological Sciences

Global Natural Resources – Management and Sustainability

A CAETS Statement

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The 2009 CAETS Convocation, hosted by the Canadian Academy of Engineering, addressed the grand challenges and opportunities associated with the sustainable management of natural resources. Resource activity worldwide is increasingly impacting society in both positive and detrimental ways. Demand for resources threatens to outstrip supply in many areas; extraction, refinement and utilization are contributors to greenhouse gas (GHG) emissions and climate change, and affect water supplies and the land base. Society faces an urgent need to reduce the demands on all kinds of raw materials and energy. New approaches are required to managing global resources and the supply chains they feed, to ensure that humanity's needs are fulfilled for current and future generations. A balance must be struck between economic gain derived from resource exploitation and utilization, and the impacts on society and the environment. Issues related to energy, water management, forestry, and mining/minerals must be considered in an integrated approach and in harmony with nature, which examine their interdependencies and tap the cross-sector opportunities for novel strategies, processes, technologies and solutions.

Overarching Recommendations

1. Industry and government must consider sustainable development, stewardship, conservation, recycling, re-use, substitution and responsibility to local inhabitants when assessing the present and future management of our natural resources base.
2. Engineering design as well as industry and government evaluation of a product's sustainability must account for its entire life cycle, including processes for manufacture, services for use and disposal.
3. Adaptations to climate change must be robust against uncertainty, informed by data and research, integrated across sectors and consistent with climate change mitigation policies.

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ENERGY

A major global challenge of the 21st century is mitigating and adapting to climate change while assuring an affordable, clean and secure energy supply and end-use technologies to meet the needs of an expanding population for higher living standards, especially in the developing world. Cleaner, more efficient fossil fuel extraction, production and utilization are needed, as are renewable technologies for power generation to reduce GHGs. Carbon capture and storage must be developed at the commercial scale required to deal with continuing coal-fired generation. Investment in clean energy must be complemented by an equal commitment to energy efficiency, demand-reduction technologies and policies, incorporated in a systems approach. Biomass and gas from hydrates offer potential for cleaner fuels. Nuclear fission will be an increasing source of power in India, much of Europe and the U.S., but less likely in Germany, where renewables now account for nearly 15 percent of the electricity supply, or Australia. Fusion offers potential for the long term. However, more trained personnel are necessary to ensure the continued development of nuclear energy.

The intermittencies of renewable technologies such as solar Photo-Voltaic (PV) and wind power will require large installed base capacity as well as cheap storage, to replace coal-fired energy. Modern transmission and distribution (T&D) systems, including DC transmission, are urgently needed to integrate renewables, reduce storage requirements and accommodate distributed and self-generation sources, demand-response technologies and electric vehicles.

Implementation costs will be challenging. For example, the investment to reduce Australia's total GHG emissions by just 10 percent by 2020 ranges from US$37 billion for wind power to US$140 billion for solar PV. Modernizing the electric power T&D systems in the U.S. will cost US$225 billion and US$640 billion, respectively (20% more than 'business as usual'), over the next 20 years. On a global scale, with electricity growth at ~1.9% a year, the International Energy Agency projects an investment of US$16.5 trillion in new technologies is necessary to achieve global reduction of GHGs by 50% from current levels by 2050.

Energy Recommendations

4. Governments must adopt policies to encourage the investments required – supported by engineering assessment – to transition over the next 20 years to clean energy systems; to increase the supply of renewable energy; to establish connectivity among smart grids; and to implement effective energy efficiency and conservation technologies and programs.
5. Governments must adopt environmental protection rules and climate change initiatives, including carbon pricing, which support a long-term market view and ensure a level playing field for all countries and resource sectors.
6. The global community needs to support increased technology transfer of clean energy systems and services between developed and developing countries.
7. Governments must adopt international safety standards and enhance public understanding of nuclear power generation.

FORESTS

As petroleum became the world's major source of fuels and chemicals, the global forest industry continued to prosper by producing building products and a wide variety of paper products. The industry is currently undergoing a dramatic repositioning. Increasing demand for forest products is being met by high-growth plantation forestry in South America (e.g., Uruguay's US$2 billion for new paper mills is the largest investment in the country's history), Indonesia and southern Europe. The industry is establishing a new balance between its traditional products and an array of new eco-friendly, high-value products. Production of renewable and carbon-neutral biofuels and chemicals presents an economic opportunity for the industry, while decreasing use of nonrenewable resources.

Forests act as a major sink for carbon dioxide and generator of oxygen, so sustainable forestry plays a crucial role in controlling GHGs. Forests also help maintain watersheds, prevent erosion and desertification, support biodiversity and provide wildlife habitat and recreation. Within the forest ecosystem, many social, economic and ecological elements, including fire and pest control, are linked through multiple relationships acting across different scales. Integrated forest management recognizes this complexity and utilizes new institutions and processes for effective decision making.

Forests Recommendations

8. Government, industry, engineering and environmental groups should jointly develop a framework for assessment of the benefits that society derives from forests to foster a balance between the economic, ecological and recreational values of this resource.
9. Industry must develop improved forest management practices that will enhance the benefits of this resource to our global environment.
10. Industry should develop recyclable, reusable, high-value products that use the full potential of raw materials from trees to reduce depletion of non-renewable resources.

WATER MANAGEMENT

The world population tripled in the last century, while the use of fresh water grew six-fold. Agriculture consumes about 70 percent of the world's water; with a population forecast to grow 40 to 50 percent in the next 50 years, much more water will be needed to produce food and supply drinking water, particularly in heavily populated regions. The volumes of fresh water needed to support the growth in energy production (including biofuels, nuclear energy, hydropower and non-conventional oil and gas) are not available with today's water management policies and practices. Aging water-delivery systems compound these issues.

On the supply side, climate change presents important challenges for local and global water resource management. Rainfall levels in many regions are already impacted, evidenced by increasing frequency and severity of floods and droughts that also have a serious impact on the aquatic ecosystems that support the sustainable supply of food and fresh water. The capability of global climate models to predict precipitation is poor, and the understanding of regional catchment scale impacts remains highly uncertain. Water management policies and practices at the catchment scale must be adaptable and must ensure the protection of watersheds and groundwater aquifers for future water supply and conservation of ecosystem function.

Water conservation and management solutions must reflect local conditions of supply, demand and environment and include water recycling, re-use storage, redistribution and regeneration. Tools used should include: regional watershed management and drought response plans; on- and off-stream storage; trading systems to promote reallocation among uses; incentives to employ new technology for conservation or use of non-fresh water; groundwater aquifer development; and inter-basin water transfers. The application and success of these strategies depend on the engineering community working with national and regional governments to integrate social, environmental and economic factors into locally appropriate policies and practices.

Water Management Recommendations

11. Climate change modeling must inform regional watershed planning; government funding should focus on making models usable for local decision making.
12. Government policy must support local management of strategic water resources, under a broad mandate of water conservation, environmental protection and sustainable economic development, integrating new technology, security provisions, policy development and appropriate changes to legislation/regulation.
13. Water is a key input for food and energy production, and significant energy is used to process and deliver water; this interlinked water-energy-food system needs to be better understood to make appropriate trade-offs for future social and economic development.
14. Government policy must support investments in building and refurbishing infrastructure for delivery of clean drinking water and handling of waste water all over the world.

MINING AND MINERALS

In the mining industry, extraction processes are changing rapidly to reduce GHG emissions, reduce water requirements and cut the volume of tailings and slags. However, these advances are challenged as the quality of the deposits exploited continues to decline. The pressing need for new technology is made difficult by the capital-intensive nature of the industry, the long-term investments required in an often volatile global commodities market, and the poor record of technology breakthroughs succeeding in the marketplace. Natural resource industries rely heavily on civil infrastructure.

Compounding these mining and mineral challenges is the general infrastructure crisis, especially in developed countries, which lowers private sector productivity, a country's real income and international competitiveness. An estimated US$1.6 trillion will be needed in the next five years to alleviate potential problems with the civil infrastructure in the U.S. In Canada, the current infrastructure deficit is US$110 billion and growing annually by US$1.7 billion – six to 10 times the level of all annual government infrastructure spending.

Mining and Minerals Recommendations

15. International collaboration in R&D and policy development, especially on large-scale projects that demonstrate best available environmental technologies and practices, must be encouraged and supported.
16. Development of novel technologies and processes that reduce GHGs, water utilization and energy used in extraction, production, utilization and recycling needs to be promoted by industry and incentivized by government.
17. Sufficient investment in new materials and technologies, supported by government leadership and sound policy, is required to build and renew public infrastructure.

CONCLUSION

The engineering challenges associated with sustainable resource management are indeed vast – but the opportunities are likewise enormous. With rapidly depleting natural resources, many non-renewable, we must harness the power of engineering to develop new solutions, supported by clear policies and regulatory frameworks and with appropriate consideration of the necessary social implications. To succeed in meeting these challenges, the engineering profession will work with society, industry, public organizations and politicians.

The 2009 CAETS Convocation examined the transition to sustainable resource management on a global scale. The CAETS academies are committed to bring engineering knowledge and skills to lead and accelerate this transition, and to design and deploy the innovative technologies, systems and organizations needed for sustainability in a changing world.

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