Energy and Water Linkage: Challenge to a Sustainable Future

OVERVIEW

Needs for affordable and clean energy, for water in adequate quantity and quality, and for food security will increasingly be the central challenges for humanity: these needs are strongly linked. In some regions, the increasing demands for water in support of energy development and use pose challenges to its availability for food and other human needs and for important ecological systems. It is critically important that planning and investment in energy and water infrastructure and associated policies take into account the deep interaction between water and energy. A systems approach based on specific regional circumstances and long-term planning is essential. Viewing each factor separately will lead to inefficiencies, added stress on water availability for food production and for critical ecosystems, and a higher risk of major failures or shortages in energy supply. In almost all regions of the world, innovative ways of achieving higher efficiency in use of energy and water will be the key factors that determine whether these linked challenges can be met.

BACKGROUND

There is widely shared concern over the looming challenge of adequate food for a world population that has grown from 6 to 7 billion in the past 12 years and that will approach 9 billion within 30 years. This concern is based on current and projected needs that will require almost doubling current world food production, and doing so in situations of increasing demands for water resources. It is widely understood that considering water and energy aspects of food security is necessary, because agriculture is by far the largest user of water in most parts of the world and has enormous energy demands. A key effort in meeting the central challenge of food security will be improving efficiency and reducing waste in energy inputs to agriculture, in agricultural water use, and in post-harvest losses.

However, the direct interaction between meeting energy needs and assuring water availability and quality is less widely recognized. Major stresses on availability of energy and water are already being felt in many countries and regions and more are foreseeable. There are widespread deficiencies in existing water energy infrastructure. Continuing population growth and changes in human diets and life styles will increase demand for both energy and water (even apart from demands related to basic nutritional and household water needs). And changes in regional hydrological cycles due to climate change will add to the potential for human development crises.

ENERGY REQUIRES WATER

Energy runs modern society. In most of the world electrical energy depends on large generating plants burning fossil fuel, to a lesser degree on nuclear power, or on hydropower. Fossil-fired and nuclear power plants and solar-thermal systems, as currently operating, require large water withdrawals and some water consumption. Depending on the type of cooling system, these requirements can vary by large amounts. Energy from some renewable sources such as photovoltaic solar and wind, on the other hand, requires very little water.

Fossil fuels provide some 80% of the worlds current energy needs, including most transportation systems. Some fossil fuel sources, including increasingly important “unconventional” sources, such as tar sands, gas hydrates, and gas and oil in tight formations, have substantial implications for quantity and quality of water. Producing alternative transportation fuels, in particular biofuels, depending on the specific applications, can involve substantial impacts on water resources and water quality.

WATER REQUIRES ENERGY

Providing water quantity and quality requires, in some cases, large amounts of energy. In many countries or regions, where water must be moved long distances from sources to users, considerable energy is used to pump this water. Where water is available but contamination is extensive, the solutions for improving water quality, including waste- water treatment, depend on energy. The extreme case is desalination, which requires large energy inputs.

WATER STRESS AND SCARCITY

Water quantity and quality issues carry serious implications for human welfare, health, and for ecosystems. Current data and a range of projections of demand over the coming few decades (population, demand for water-intensive foods, standards of living, sources of energy and end-uses) indicate that a growing number of areas of the world will be in situations of water stress or scarcity, or will not be self-sufficient in food production. Regional-scale projections for the continuation and acceleration of climate changes and impacts on the hydrological cycle indicate intensified water stress and scarcity in some parts of the world, and uncertainty as to exactly where that will occur. While much of the world depends on precipitation, surface water, and rechargeable aquifers, the extensive dependence of some areas on non-renewable ancient aquifers, or on withdrawals that are much greater than recharge rates on other aquifers, presents a special case of foreseeable serious increase in water stress and scarcity.

RECOMMENDATIONS

Water in a sense is both a regional and a global challenge: each country or region has its own specific situation with regard to water quantity and quality, current uses and needs, future projections, and uncertainties in those projections. Food security and water supply for human consumption are local, but also regional and global challenges. The extensively globalized market for food, energy, and other goods constitutes large trade in "virtual water", which globally alleviates but can locally increase, water stresses. For many, food security alternatives, and better water management and technological alternatives are necessary. Regional water cooperation is, in many cases, essential.

Energy options are a complex mix of local resources (if any), global supply, and available/affordable technological options. The wide range of local circumstances means that the world needs a wide range of clean energy technology options, whose impacts on water need to be well understood and taken into account in the decision processes.

Thus, we Leaders of Academies of Sciences, recommend that governments:

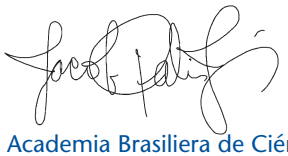
- Ensure that programs in energy and water are fully integrated and that solutions are developed with a systems approach that takes into account their interdependencies. Especially important will be energy efficiency, water efficiency and recycle, and demand management for both. This integration must also successfully deal with the close linkages to food production and sustainability in land use and maintenance of ecosystems.

- Invest in integrated scientific research and innovation in energy optimization and the sustainable use of water, and in further development of systems analysis approaches for dealing with these challenges.

- Establish effective governance structures and clear policies to facilitate the integrated management of energy, water, and agriculture systems. This may require explicit estimation of indirect costs of energy programs, including consumption or degradation of water, and the reflection of these costs in prices.

- Develop systems, which monitor and make freely available key basic data on water and energy.

Each of these actions requires building local and regional human and institutional capacity for the necessary research, data-gathering, evaluation, planning, governance, technology adaptation, and long-term maintenance. This capacity must be built on a public recognition of the need for long-term planning and the importance of efficiency and conservation. Global cooperation will be essential, including development assistance to many of the most vulnerable countries, building capacity to plan and implement integrated national energy and water programs.



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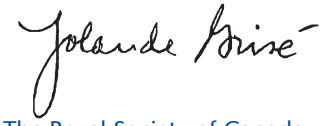

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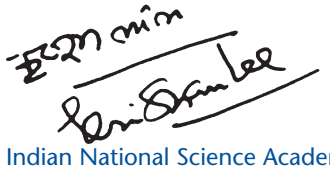

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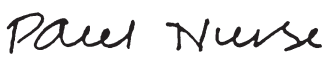

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