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Environment Notes

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The Water-Energy Nexus:

Opportunities for Integrated Environmental Management

Horse and carriage, love and marriage — water and energy are as intimately linked in all phases of their existence as any other couple, with important implications for USAID development goals and programs. ***Separately,*** water and energy have much in common. Each is an essential input for productive, comfortable and healthy human societies. Both are also derived from natural resources, and their use by humans creates a series of impacts on the sustainability of ecosystems.

Together, water and energy are also closely connected, based on two fundamental truths:

Energy is Required to Make Use of Water: For humans to take advantage of water resources, energy from some source is needed – to lift, move, process and treat the substance at every phase of its extraction, distribution, and use. Mechanical or electrical energy derived from all fuel types, renewable and non-renewable, is often employed, while human or animal power serves to move, use or reuse water in other cases.

Water is Needed to Make Use of Energy: Water is also used in the generation of most forms of traditional turbine-produced electricity. Sometimes water is a direct input to the generation process, for example in the case of hydropower or geothermal energy. Much more often it plays a role at various intermediate phases of electricity generation. Thermal generation, for instance, makes great use of water for preparing and transporting fuel (e.g. coal washing or slurries), as well as for plant cooling processes in oil, gas or coal-fired plants. Nuclear energy also requires huge amounts of water for cooling.

The Water - Energy Nexus: Vicious Cycles

In many places, it is clear that 'vicious cycles' of inefficiency in the management of either water or energy resources exacerbate shortages, waste and unsustainable patterns of use in the other.

In the **consumption of energy to use water**, unreliable electricity service leads to coping behaviors that waste both water and energy resources. In the agricultural sector, many farmers who pump groundwater use oversized motors to avoid burnout from poor electricity quality, leave on pumps 24 hours a day to compensate for irregular service, and operate supplementary fossil-fuel powered generators. Urban dwellers with unreliable piped water systems run individual generators to pump water to rooftop storage tanks or to extract additional water from low-pressure municipal systems. Industrial consumers also invest considerable additional resources in backup power and water systems in order to ensure continued production levels. Moreover, the current lack of emphasis on preventing water pollution increases the expenditure of energy either to treat water downstream, or to access uncontaminated supplies (groundwater or distant surface sources).

In the **consumption of water to generate electrical power**, power plant inefficiencies or lack of mitigation measures result in wasted water and energy, and greater degradation of water and other

environmental resources. Significant water pollution problems arise from inadequate environmental controls at all stages of the power generation cycle including fuel extraction (e.g. mining, oil and gas drilling), generation (e.g., acid deposition, dam construction), and plant waste disposal (e.g., fly ash).

Sustainability Through Co-Management

USAID programs can break vicious cycles of waste and environmental degradation by understanding the key driving forces, feedback relationships and impacts associated with vicious cycles of water and energy use and management. There are numerous opportunities to be more efficient and sustainable in the use of both resources through joint assessment, planning and action within and across all sectors of use.

In **energy for water use**, interventions can help:

- improve reliability and quality of water and energy services to reduce the need for wasteful coping behaviors;
- encourage demand-side management approaches for both energy and water conservation;
- promote cleaner production practices, environmental management systems, pollution prevention, and water reuse in industry and municipal settings;
- foster a system-level, integrated approach to planning for water resources at the basin scale, and energy resources at the grid scale, that includes special consideration of the cross-cutting implications of various management choices.

In **water for energy generation**, activities can help:

- reduce the inefficient use of water resources in thermal power plants, and ensure that water quality – including temperature changes as well as pollution – is not impaired in power generation;
- provide technical assistance for the appropriate scaling, siting, multi-purpose project planning, and adequate participatory governance and environmental controls for hydropower facilities.

In all cases, creating the proper pricing, policy and regulatory environment is critical to encourage changed behavior, and ensure that the use of both water and energy is sustainable. Adequate pricing promotes the full inclusion of 'upstream' and 'downstream' effects in both resource chains. Water and energy sector reform including cost recovery also fosters private sector participation investment in the building and maintenance of infrastructure. Finally, stronger regulatory and policy frameworks promote rational allocation of resources and help protect water quality.

Promoting Integration in USAID

USAID energy, urban or water programs have already adopted several of the above practices. Design of interventions that explicitly take into account both sectors, however, can yield even greater combined benefits to developing countries.

USAID India is the first Mission to examine the linkages between water use and the energy sector as they relate to a range of economic development, human health and poverty alleviation concerns. Recommendations have been developed for combined water-energy interventions in the agricultural, municipal and industrial sectors that are being considered in current Mission strategic planning. Lessons learned from this analysis may be useful as other Missions consider ways to promote economic stability and protect the environment through a more integrated approach to resource management.

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