Addressing the Energy-Water Nexus through R&D Planning and Policies

Executive Summary

INTRODUCTION

On 28-29 May 2018 Delegates to the IEA Experts' Group on R&D Priority Setting (EGRD) held a workshop to gain further understandings of the issues of the energy-water nexus and to highlight best practices and opportunities. Technology experts from research entities, academia, and leading agencies across the world offered a wide range of perspectives and insights. The European Commission in Brussels hosted the event.

RATIONALE AND BACKGROUND

Energy access, energy security or the environmental impact of energy use may be affected by water availability. Fossil fuels require water for extraction, transport and processing. Thermal power plants (nuclear, fossil-fuels, bio-based fuels and concentrating solar) require water for cooling, and hydropower plants require robust river currents. Feedstock production for biofuels may depend on water for irrigation. The availability of clean drinking water and sanitation services would simply not be possible without energy, whether in developed or developing countries. This includes pumping ground and surface water, treating and transporting water to end-users, and cleaning wastewater.

> **Energy-Water Nexus**
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> *"A set of interactions, comprising important drivers for the use of resources. Natural resources serve as direct input in the production processes of another resource or they can substitute the use of another resource. Indirect effects related to the specific use of resources also have to be taken into account because claims for a particular use of one resource can compete with other demands".*
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> -Bleischweitz and Miedzinski (2018).

However, energy and water systems have been developed, managed and regulated independently and so have the technological solutions. In some cases the interactions between energy and water are considered, though largely on a regional or technology-by-technology basis. Therefore, examining the interplay – the "nexus" – between energy and water enables a holistic management of natural resources and a systemic view of the complex and critical issues. Both technology-specific and systemic approaches are needed to address the issues, including developing new technologies and integrated approaches to efficient use of energy, water, or both. These inter-related issues are acute in populations that lack access to both energy and fresh water.

ISSUES ADDRESSED

Experts from Europe, Japan and the United States shared best practice, highlighting areas for further research. Four presentations focussed entirely or in part on research activities of the IEA Technology Collaboration Programmes (TCPs).[1] Contributions addressed a wide range of issues:

- Frameworks for international co-operation
- Governance and regulation
- Integrated management of natural resources
- The important role of technology – for both energy and water
- Data collection and analysis

Understanding the energy-water nexus and the implications for an integrated energy system is in the exploratory phase - we are beginning to understand the stress-points, trade-offs and synergies as well as direct and indirect benefits. The energy-water nexus provides a holistic approach to address the Sustainable Development Goals (SDGs), for which energy is part of the solution to the water scarcity and water is part of the solution to a low carbon energy system. Yet each sector uses different technologies and involves different stakeholders and institutions which makes policy- and decision-making very complex. In addition the issues of the energy-water nexus are broader and more complex, interrelated to land use, food, materials and eco-systems.

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[1] The TCP on Bioenergy, the TCP on District Heating and Cooling (DHC TCP), the TCP on Greenhouse Gas R&D (GHG TCP), the TCP on Solar Heating and Cooling (SHC TCP), and the TCP on Concentrating Solar Power (SolarPACES TCP).

Technology development

The various technologies that support energy-efficient water systems or water-efficient energy systems are at various stages of research, development, demonstration and deployment (RDD&D). Technologies cover smart water management for heating, water recovery and alternative cooling systems. Energy-efficient technologies include river thermal management, use and reuse of water in carbon capture and storage (CCS), reduced water use and recovery in households and industry, and saline sludge discharge from bioenergy processing. Cooling is a growing area of research. For example, cooling power plants with air is a promising technology in development, though further research – and funding - is needed.

Water-efficient systems include smart, low-temperature heating systems, efficient technologies to recycle industrial process water as well as new wastewater treatment technologies, in some cases resulting in the plant becoming a 'prosumer'[2] of excess heat and other resources as well as a producer of co-products, such as recovered energy, fertilizer.

Institutions, governance and regulation

Public-private partnerships (PPPs) play an important role in scaling up technologies from pilot to large-scale applications, but more could be done to accelerate the process, for example through innovation-driven public procurement. Technology push options should be combined with market pull options, at least at the more developed stages.

Proper management of river basins is a challenge and is the concern of one or several governments and the power sector. The early stage assessment of the Sava River Basin offers important lessons learned, highlighting the need to improve information about the nexus and relevant sectors. Cooperation in transboundary basins is challenging and time-consuming, but nonetheless necessary to improve overall resource use efficiency. Providing evidence for proper river basin management in a truly transboundary way is possible by integrating the natural, technical and life sciences in the social science context.

Data and analysis

Policy- and decision-making related to the energy-water nexus concerns many levels - regional, national, local (including islands) and even a single plant. Modelling and data analysis can provide much-needed scientific-based evidence to support these efforts provided they are driven by user-needs. The idea is not to develop a comprehensive energy-water nexus model but rather to link different models (directly or indirectly) while carefully balancing model complexity and reliable results. Access to reliable and valid data is a challenge in particular in the water sector and the non-power sectors. Sound decision-support tools go beyond modelling and data analysis and could include quantitative and qualitative scenarios, stakeholder analysis, and risk assessment. Open-source data and models facilitate knowledge creation and diffusion, making it easier to validate results and develop common standards and statistics.

RECOMMENDATIONS [3]

- *For both energy and water the availability of the other is critical. To effectively manage resources, analysis of integrative policies and their impact are needed.*
- *Applying multi-disciplines/multi scale treatment of technical applications, power production, water treatment, water savings and cooperate internationally to avoid overlap and create synergies.*
- *Sharing best practices, knowledge exchange and governance at different scales, being cities, industries, regions or cross-border river basins.*
- *Improving modelling work and data quality related to the nexus by striking a balance between fundamental advances and needs-driven outcomes. International cooperation in the field is essential.*

[2] Prosumers are consumers that produce electricity (e.g. residential rooftop solar photovoltaic panels) for resale into the electricity network.

[3] All presentations are available on the workshop web page.