Water-Energy Nexus Challenges & Opportunities in the Arabian Peninsula under Climate Change

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Abstract

Demand for water in the Arabian Peninsula relies mainly on fossil groundwater resources and desalination. Satisfying water demand requires a great deal of energy as it treats and moves water along the supply chain from sources, through treatment processes, and ultimately to the consumer. Hence, there is an inherent connection between water and energy and with climate change, the links between water and energy are expected to become even stronger.

As part of Abu Dhabi Global Environmental Data Initiative’s Local, National, and Regional Climate Change Programme, a study of the water-energy nexus of the countries in the Arabian Peninsula was implemented. For water, WEAP (Water Evaluation And Planning system) models both water demand – and its main drivers – and water supply, simulating policies, priorities and preferences. For energy, LEAP (Long Range Energy Alternatives Planning system) models both energy supply and demand, and is able to capture the impacts of low carbon development strategies. A coupled WEAP-LEAP model was then used to evaluate the future performance of the energy-water system under climate change and policy scenarios. The coupled models required detailed data, which were obtained through literature reviews and consultations with key stakeholders in the region. As part of this process, the outputs of both models were validated for historic periods using existing data.

The models examined 5 policy scenarios of different futures of resource management to the year 2060. A future under current management practices with current climate and a climate projection based on the RCP8.5; a High Efficiency scenario where each country gradually implements policies to reduce the consumption of water and electricity; a Natural Resource Protection scenario with increased energy efficiency and phasing out of groundwater extraction and drastic reduction of fossil fuel usage in favor of solar; and an Integrated Policy scenario that integrates the prior two policy scenarios.

Water demands can mostly be met in any scenario through supply combinations of groundwater, desalination and wastewater reuse, with some regional fossil groundwater basins draw to extinction by 2060. While the analysis includes both demand and supply-oriented scenarios, the results of the analysis strongly suggest that the region will need to simultaneously pursue demand and supply side policies to achieve more sustainable uses of water and energy into the second half of the 21st century.

WEAP and LEAP are linked to improve understanding of water-energy relationships.

The Arabian Region WEAP Model

Supply Preference in Regional Model

Electric Energy Consumption by Country

LEAP Validation

WEAP Model Validation

Electric Energy Transformation in LEAP

Energy Demand Factors for Water (kWh/m²)

Electricity Demand by the Water Sector

Policy Scenarios

• Scenarios are exploratory, not specific to local policy
• Scenarios address a question such as, “What level of renewable penetration would be required to achieve national greenhouse gas reduction targets; or what level of water use would be needed to meet resource conservation objectives?”
• Scenarios are not predictions but narratives that describe plausible conditions in the region

Implemented Policy Scenarios

Key Assumption

Electricity Demand by Sector

Comparing Results Across the Policy Scenarios

RCP8.5

Electricity Demand by Water Sector

Comparing Results Across the Policy Scenarios

Modeling Methods: Climate Change

The Baseline and Future Climate are based on results from the Regional Atmospheric Modeling sub-project

Global Model

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Water, Energy, and Policy

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