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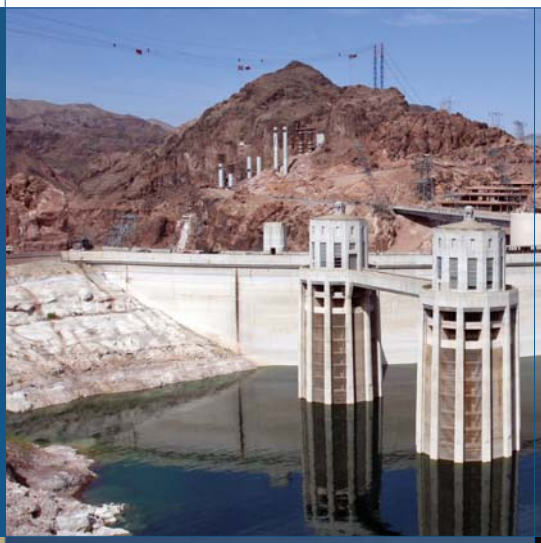
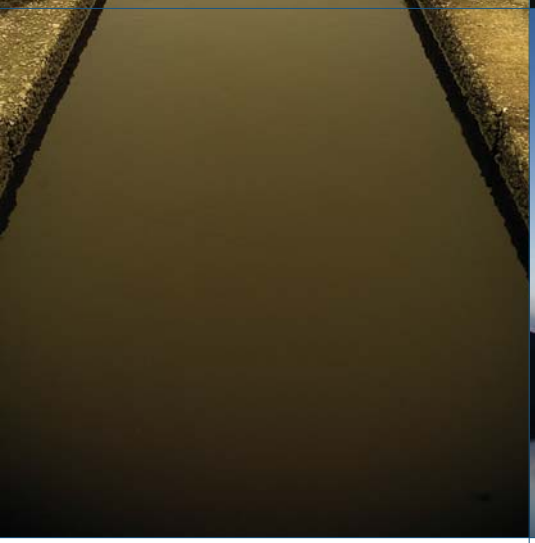
Water for Energy

Executive Summary
World Energy Council





Water for Energy

Water for Energy - Executive Summary
World Energy Council

Published 2010 by:

World Energy Council
Regency House 1-4 Warwick Street
London W1B 5LT United Kingdom

ISBN: 978-0-946121-10-6

In recent decades, the combination of more users, with more uses of water has transformed the traditional water-energy 'ladder' that underpins all human, social and economic development into an 'escalator'.

Human civilization has always rested on access to water, and, more specifically, on its utilization. This report aims to contribute to a better understanding of the critical linkages between water and energy—and the impact on both of climate change. It identifies areas of opportunity where investment and new regulations are needed, to ensure sustainable global development.

Growth, scarcity and stress

Freshwater supplies are unevenly allocated across the globe and, at the same time, countries all over the world face water scarcity and water stress. Currently, the World Health Organization estimates one-third of the Earth's population lack the necessary quantities of water they need.

Global population will continue to grow. The majority of growth will be in emerging and developing economies already experiencing water and energy security challenges. By 2050, the UN estimates that half the world's population will live in nations that are short of water. Moving water to people and controlling supply will become even bigger issues in the years to come.

Water is used in energy production and supply, and, in turn, energy is used for pumping, moving and treating water. In recent decades, the combination of more users, with more uses of water has transformed the traditional water-energy 'ladder' that underpins all human, social and economic development into an 'escalator'. As a result, as the linkages between both energy and water systems have grown more complex and interdependent, water must be viewed as a complex vulnerability of the energy system—and vice versa.

In addition, human-induced climate change is understood to be a key driver for change in energy and water availability, allocation, production and consumption. This carries significant implications for managing water and energy security challenges. Climate change impacts will likely exacerbate water stress in many countries, cities and communities, creating the prospect of greater competition between different uses, as well as individual users of water.

With the threat of water scarcity and water stress, exacerbated by climate change, two challenges have developed:

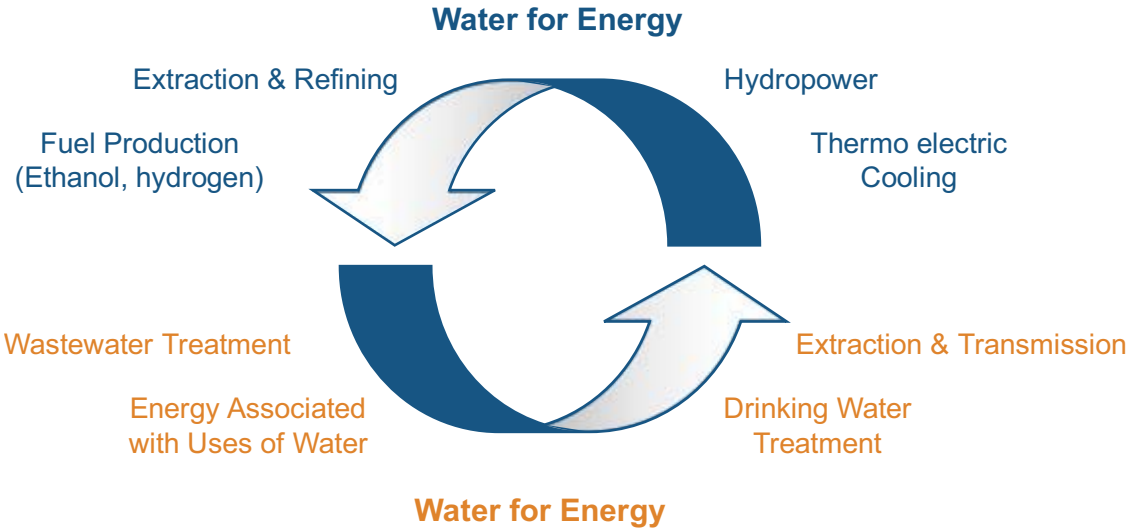
1) Water for energy

Water is needed throughout the energy sector. It is used in energy production and conversion, as well as in other processes, such as the refining of energy source products. The water requirements for producing different primary energy carriers vary; there are significant differences between different types of electricity generation. However, freshwater is required for each step—energy extraction and production, refining and processing, transportation and storage and electric power generation itself.

2) Energy for water

Modern energy supplies have been harnessed to pump water from increasing deeper groundwater reserves and to divert whole rivers large distances. With global population and global economic growth

Figure 1
Water for Energy, Energy for Water
Source: Water, Energy and Climate Change, WBCSD, 2009



set to continue, and a significant proportion of the current human population lacking access to clean water supply and sewerage services, the 'energy for water' challenge has become a significant, global scale concern.

Current needs…

A situational analysis of the current 'water for energy' contexts sets out the water needs of Africa, Asia, Europe, Latin America and the Caribbean, and North America in the context of their energy production, water withdrawal, and population. The 'water footprint' (the amount of water consumed to produce a unit of energy) of different methods of fuel production shows how water consumption for operations making primary energy carriers available vary from fuel to fuel. Analyses explore the water needs of a range of energy processes, including crude oil, natural gas, coal, uranium, and biomass. Studies of the water requirements of the respective processes for generating electricity show the water needs of different thermoelectric-generating technologies, and geothermal power-generating plants, as well as electricity from hydro, wind and solar.

…and future projections

The data for current needs, along with the WEC's scenario data from 2007 (updated 2009), provides a basis for identifying the future requirements of 'water for energy' of the different regions, for the years 2020, 2035, and 2050.

By examining the growth of global population, changes in final energy consumption and water requirements needed to produce and generate the necessary amounts of energy over the next decades, the report identifies:

i) the regions that suffer from water stress and/or water scarcity, or will do so soon; and

ii) those regions where total internal renewable water resources seem to be sufficient to meet requirements of water for energy, without competing with other basic water uses.

In light of these developments, the report highlights the impact in terms of water savings of:

i) new technologies in processing primary energy, especially in thermal electricity generation, and

ii) increased use of renewable energy and improved energy efficiency.

Although oil presently accounts for as much as 34% of the global primary production, and decreasing to 22% by 2050, it accounts for only 10% of water consumption in primary energy

Table 1
Development of population, energy consumption, and water for energy between 2005 and 2050 based on WEC Scenarios, 2007 (model updated in 2009); DOE/NETL, 2008; UNESCO-IHE, 2008; Gleick, 1994.

World	2005	2020	2035	2050
Population (million)	6290.0	7842.3	8601.1	9439.0
Energy Consumption (EJ)	328.7	400.4	464.9	518.8
Energy Consumption (GJ/capita)	52.3	51.1	54.1	55.0
Water for energy (bill m³/year)	1815.6	1986.4	2087.8	2020.1
Water for energy (m³/capita)	288.6	253.3	242.7	214.0

production now, rising to 18% in 2050. This is mainly due to the increasing share of non-conventional oil in total oil production, from 1% now to 12% in 2050 and its higher water consumption.

While oil production over the next 40 years will rise rather slowly, natural gas production worldwide will almost double, with the biggest increases in Asia, mainly in the Middle East, where it will almost triple and North America, where it will double. Energy from coal production is presently below oil but will likely become higher over the next 30-40 years (WEC Scenarios, 2007, model updated in 2009). Mining and refining coal, where refining includes washing and beneficiation, requires water at various stages as well. Estimates show that approximately 0.164 m³ of water is needed per GJ. Overall the production of coal accounts for about 1% of total water consumption in energy production.

Uranium production presently accounts for approximately 6% of worldwide primary energy production and will rise to 9% over the next 40 years, with the main producers being in Asia, Europe and North America. Africa and South America account for only 1% of the global uranium production. Mining, milling as well as the conversion and processing of uranium requires less water per energy unit than anything else. It is estimated that approximately 0.086 m³ of water is needed per GJ. Overall the production of uranium accounts for less than 0.2% of total water consumption in energy production.

Today almost 90% of freshwater used to produce primary energy is for the production of biomass, which accounts for not even 10% of total primary energy production. This relationship will change over time. In 40 years, the share of freshwater used to produce biomass will decrease to less than 80%, while at the same time the share of biomass in the total primary energy production will diminish to less than 5%.

Water consumption to generate electricity will more than double over the next 40 years. Whereas today, electricity generation per capita is on average 2.9 MWh/capita annually, ranging from 0.6 MWh/capita in Africa to 12.0 MWh/capita in North America, in 2050 the annual electricity generation per capita will almost double to an average of 5.7 MWh/capita, ranging from 2.0 MWh/capita in Africa to 17.3 MWh/capita in North America. The highest increases will occur in Latin America, where electricity generation per capita will be four times higher than today, followed by Africa and Asia, where it will almost triple. In Europe electricity generation per capita will presumably double, whereas in North America it will increase by only 50%. Although worldwide electricity generation per capita will almost double, the amount of water consumed to generate electricity is due to expected technology improvements and shifts, likely to stay at the same level or increase only slightly on a per capita basis in Africa, Europe and North America, whereas in Asia and Latin America water consumption to generate electricity will almost double on a per-capita basis.

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Conclusions and recommendations

1. **The future water needs of energy production and conversion can probably be met.** However, other uses, in particular agriculture, are stressing the supply of useable water now—and this is likely to increase in the future as populations grow. Governments must ensure that water is available for all these uses, including energy production and conversion.
2. As energy resources are stretched, increasingly unconventional sources become attractive. Many of these (e.g., oil sands, oil shales, deep gas shales) require large amounts of water, further stressing current and projected systems. **When setting policies for energy production, policymakers must consider what water supplies are available: they need to consider the needs of these technologies and their impact on other uses.** Industry leaders can be sure to include these aspects when discussing projects with policymakers and with the public.
3. The increasingly integrated world of shared resources and trade requires a **new paradigm of interregional and international cooperation-between governments (regional and national), between businesses, as well as between governments and businesses.** This also applies to water, and especially water for energy production and conversion.
4. Many existing and new technologies show promise for making water more available and its use more efficient. **Policymakers in both business and government must carefully examine policy measures and conditions that will accelerate the entry of these technologies and their benefits into common usage.**
5. **RD&D (Research, Development and Demonstration) efforts regarding water must be increased.** This will require cooperation on regional and international levels between the energy industry, governments, and independent institutions.
6. **Asia**, **with its large geographical area and population presents perhaps the largest challenge for water supply in general**, and therefore for water in energy use. At the same time the potential of hydropower in Asia is vast and relatively unexploited. The UN is supporting hydropower development and governments in the region and energy industry operating there should actively encourage and support these efforts.

The complete report is available for download at www.worldenergy.org/documents/water_energy.pdf

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ISBN: **978-0-946121-10-6**