DEDICATED TO MAKING A DIFFERENCE

Water, Energy and Climate Change

A contribution from the business community

World Business Council for
Sustainable Development

A Message from the World Business Council for Sustainable Development (WBCSD) Water Project

Water, energy and climate change are inextricably linked. If we truly want to find sustainable solutions, we must ensure that we address all three in a holistic way. They are pieces of the same puzzle and therefore it is not practical to look at them in isolation.

This paper is only a first step in fitting some of the pieces of that puzzle together. The search for solutions is complicated because water, energy and climate change are each complex. Examining their interrelationship further complicates the discussion but we must if we are to take the next step toward a sustainable society. They also touch all parts of our culture and are interconnected with other issues, such as our values, ecosystems and livelihoods.

To make meaningful progress, we must acknowledge this complexity and use it to our advantage. When you have an energy problem, you most certainly have a water problem. It works the other way, too. And if you are concerned about climate change, you are actually concerned about both energy and water – whether you know it or not.

Just as the issues are interconnected, so too are the solutions. For example, we know that municipal wastewater is not waste at all. The water can be reused, and the solid waste can be used as a source of energy and fertilizer. By taking a holistic view of the situation, we can find solutions that address both water and energy concerns.

The business community is committed to this effort. Many leading companies around the world are already hard at work trying to find solutions to water and energy challenges. We are innovating and researching, developing technologies and looking for new approaches. But in order to succeed we need support and collaboration from legislators, policy-makers, civil society and academics.

This is a call for more research and increased knowledge-sharing between the many experts now working separately on water and energy issues in universities, non-governmental organizations, industries and government. Together we can break down the silos and develop solutions to some of the world's most pressing problems.

Our special thanks go to Shell, who has been active in the Water Project for many years and who led the development of this particular paper. We would also like to thank the many organizations that have provided valuable input to our work and to this publication, such as the International Union for Conservation of Nature (IUCN), the International Water Association (IWA), the European Water Partnership (EWP), World Resources Institute (WRI), the World Water Council, AquaFed and the World Meteorological Organization (WMO).

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Acknowledgements

We would like to thank the numerous WBCSD Water Project Working Group members who provided valuable input, insights and case studies for this document. In particular, we would like to thank Joppe Cramwinckel and Malek Abu-Ruman from Shell for their leadership in developing this paper. We would also like to thank a number of external individuals for their valuable suggestions and comments, namely Nadine McCormick and Katharine Cross, IUCN; Piet Klop, World Resources Institute; Masahiko Murase, World Meteorological Organization; Agnès Vaillier, European Water Partnership; Marloes Bakker, Co-operative Programme on Water and Climate (CPWC); Stéphane Simonet, World Water Council; Adriana Hulsmann, KWR and Xavier Maitrerobert, AquaFed.

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Previous WBCSD Water achievements include:

- *Sanitation – It's Time for Business to Act* (2008)
- *Global Water Tool* (2007)
- *Business in the World of Water: WBCSD Water Scenarios to 2025* (2006)
- *Water Facts and Trends* (2005)

About this publication

This publication was initially developed for the 5th World Water Forum in Istanbul, Turkey (March 2009). Members of the World Business Council for Sustainable Development (WBCSD) have come together for this important event to provide a business contribution to this critical debate.

This document is composed of four parts:

1. Key messages from business

The rationale for linking water, energy and climate change issues

2. Policy directions

Key policy directions recommended by business to policy-makers

3. Business implications in practice

Real-world implications of the linkages between water, energy and climate change for business

4. Facts in a nutshell

Quick facts on the interconnections between water, energy and climate change

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Context

Why this issue matters now

"Climate change is expected to exacerbate current stresses on water resources.[…] Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate through the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows [in some regions]."

Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report

Recently, there has been increased understanding of the links between water, energy and climate change. Research and knowledge have expanded and discussion progressed within technical circles. Some places in the world have successfully integrated both water and energy into planning, from investment to institutional decision-making. For example, in December 2008, the US Environmental Protection Agency announced an inter-agency agreement between the offices of Air and Water to collaborate on energy and climate efforts at water utilities. Nevertheless, there is still a significant gap in communications addressing the linkages at a global scale. In particular, only a limited number of publications, scenarios and perspectives about energy and climate change currently also address water issues.

- *Global primary energy demand is projected to increase by just over 50% between now and 2030.*[1]
- *Freshwater withdrawals are predicted to increase by 50% by 2025 in developing countries, and 18% in developed countries.*[2]

Today's financial crisis presents an opportunity for us to revisit the way we manage risk. We need to learn to consider critical issues such as water, energy, climate change, food, land, development and ecosystem services together.

Boosting water and energy use efficiency through investment in relevant technologies and infrastructure are critical pathways to achieving the Millennium Development Goals. It is essential that the current financial crisis not lead to a drop in this support.[3]

*Note: The use of the word "water" mainly refers to **fresh**water.*

Key messages from business

The rationale for linking water, energy and climate change issues

1. Water and energy are inextricably linked

- Both water and energy are essential to every aspect of life: social equity, ecosystem integrity and economic sustainability.
- Water is used to generate energy; energy is used to provide water.
- Both water and energy are used to produce crops; crops can in turn be used to generate energy through biofuels.

2. Global energy and water demand are increasing

- Energy and water demands increase with income. At low income levels, energy and water are used for basic needs such as drinking, cooking and heating. But as income increases, people use more energy and water for refrigerators, swimming pools, transport, watering and cooling that meet their new lifestyle and diet needs.
- In an increasing spiral, demand for more energy will drive demand for more water; demand for more water will drive demand for more energy.
- Business, along with all parts of society, needs to continue to improve its water and energy efficiency to enable sustainable growth.

3. Both water use and energy use impact and depend on ecosystems

- Industrial, agricultural and domestic water and energy uses can have adverse impacts on ecosystems, including loss of habitat, pollution and changes in biological processes (such as fish spawning). Such ecosystem impacts also affect the amount of water or energy supplies available.
- Maintaining environmental flows is critical to ensuring river systems can supply water to business and ecosystems.
- Water, energy and ecological footprints cannot be addressed in isolation.

4. Climate change will affect availability and use of both water and energy

- Climate change acts as an amplifier of the already-intense competition over water and energy resources.
- Mitigating climate change (i.e., reducing CO_2 emissions) as well as adapting to inevitable climate change risk (i.e., becoming better able to cope with an uncertain future) need to be considered together.
- Impacts from climate change on both regional and global hydrological systems will increase, bringing higher levels of uncertainty and risk, with some regions more impacted than others.
- There is not only one appropriate mitigation or adaptation strategy – each situation will require the appropriate and sustainable use of water and energy resources locally.
- Adaptation can come at a mitigation cost, such as building more robust infrastructure that is climate resilient but can emit more greenhouse gases.

5. Technology, innovation, a sense of shared responsibility and political will are factors that bring real solutions as we strive to keep pace with increasing needs from a growing population

- Resolving growing issues surrounding water and energy priorities will require better and integrated policy frameworks and political engagement to address them satisfactorily for all stakeholders within and across watersheds.
- Leadership from all parts of society is a condition for change to happen.
- We need:
  - i. To get more energy out of each drop of water, and we need to get more water out of each unit of energy.
  - ii. Diversified energy mixes and alternative water supplies, e.g., industrial wastewater recycling, municipal wastewater reuse, desalination, even though these are energy-intensive.
  - iii. More natural infrastructure, such as rehabilitating wetlands and mangroves to mitigate flooding, thus reducing the impacts of climate change in optimal combination with the cost of engineered infrastructure.

Policy directions

Key policy directions recommended by business to policy-makers

Water and energy policy need to be interlinked. Good governance and institutional capacity are needed, and business is willing to partner with policy-makers, legislators, researchers and others to help achieve these recommendations. Below are five areas where business recommends policy interventions. Please note that these policy directions refer *specifically to water, energy and climate change linkages*, **rather than some of the broader key recommendations around water issues, such as water value and pricing, ownership and equitable allocation, to name but a few.**

1. Provide reliable climate change risk data, models and analysis tools

In brief: **Business needs reliable water, energy and climate change data, models and analysis tools in order to assess risk and make informed decisions or plans. Reliable meteorological and hydrological data should be collected at national, sub-national and watershed levels. The tools and systems used to collect and analyze these data need to be consistent.**

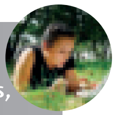
- Existing efforts around climate-risk data and models, such as the World Meteorological Organization's (WMO) World Hydrological Cycle Observing System (WHYCOS), United Nations Development Programme (UNDP) Climate Change Country Profiles, Water Information Systems for Europe (WISE) and the UN-Water Task Force on Indicators, Monitoring and Reporting, have made significant progress over the years. However, gaps still remain.
  - > **Data:** There is a need for both in-situ (via data collection) and satellite observations. This must include a key assessment, both in the short-term and long-term, of the impacts of climate change, not only on water quality and quantity, but also water timing, (e.g., seasonal or monthly data, in addition to annual data).
  - > **Models:** Better predictions and early-warning systems about the effects of climate change at a regional scale are increasingly needed. This includes greenhouse gas (GHG) effects on the hydrological cycle and precipitation patterns, which means understanding the complexity of the water cycle and aquatic ecosystems and how these react to climate change.
  - > **Analysis tools:** Interim management tools, such as scenario building, are necessary to be able to deal with the complexity of variables including climatic, economic, demographic and regional changes.

2. Integrate water and energy efficiency in measurement tools and policy

In brief: **Water and energy efficiency are linked, and this needs to be expressed clearly in measurement tools and policy. A comprehensive, common approach to water and energy efficiency – or "footprint" – measurement is needed. Also, policy on water efficiency should include energy efficiency, and vice versa, because trade-offs and synergies do exist between the two.**

- **System design:** The design of future water and energy systems needs to take into consideration the trade-offs and synergies between both resources. For example, a reduced water footprint (or impact) may, in one given case, result in a reduced energy footprint, but in another case may result in an increased energy footprint.
- **Measurement:** A globally accepted measurement tool that quantifies water and energy efficiency throughout the life cycle would enable society to make more informed decisions about trade-offs. Such a tool would need to incorporate complex variables such as type and sustainability of the water withdrawal, as well as an understanding of the cost and benefit of different options. For example, the Water Footprint Network is developing a common management practice linking water and energy footprints.
- **Policy:** Policy needs to be long-term and flexible to allow for the use of the most appropriate approach, depending on local conditions. For example, in a water abundant region it might be appropriate to reduce the energy footprint at the expense of increasing the water footprint, if this cannot be avoided. There is therefore a need for integrated river basin management that better takes into account energy and GHG emissions, as well as environmental values.

3. Ensure institutional capacities can deliver common management practices, education and awareness raising



In brief: **Institutional capacities should be built to increase awareness about water-energy linkages, leading practices for energy efficiency and water conservation, as well as the effects of climate change. This should include developing and promoting products and services that not only improve well-being, but also reduce water and energy impacts.**

- **Business skills:** Businesses can contribute their experience and knowledge about these linkages, and can also share their skills in marketing, communicating, capacity building and training.
- **Increased understanding:** Water resource managers need to better understand energy and ecosystem linkages; likewise, energy producers need to better understand water and ecosystem linkages.

4. Integrate and value ecosystem services into trans-boundary decision-making

In brief: **The economic and social value of ecosystem services should be integrated into decision-making around water, energy and climate change issues. In order to maintain and maximize flow to all users, water should be managed at a watershed level, which requires trans-boundary cooperation and special care when allocating and distributing the resource.**

- **Ecosystem balance:** Ecosystems, such as well-managed river basins and forests, control run-off and siltation and provide natural purification processes and regulate water flows.
- **Energy security:** There is very little (if any) information on how to ensure energy security while preserving ecosystem integrity in the face of climate change impacts.[4]
- **Market mechanisms:** Market mechanisms, such as payments for ecosystem services, trading systems or certification standards, can be powerful complements to existing strategies for conserving ecosystems, if used in the right way.
- **Ecosystem valuation:** We are currently losing ecosystem services worth approx. 1.35-3.1 trillion (10^{12}) EUR/year. By 2050, the cumulative cost from not avoiding ecosystem losses is estimated at 33.3-95.1 trillion EUR.[5] To address this, we need further uptake and implementation of valuation tools that support decision-making that integrates the economic and social value of ecosystem services that are for now provided for free by nature. This is a key objective of The Economics of Ecosystems and Biodiversity (TEEB)[6] project, which is expected to highly influence and shape international political processes, policies and regulation around ecosystem valuation, as well as payments in the near medium-term future.

5. Encourage best practice through innovation, appropriate solutions and community engagement

In brief: **Business can contribute to finding cost-effective and efficient ways of reducing water and/or energy consumption, e.g., reusing and recycling municipal and industrial wastewater by using energy-saving treatment processes. Such best-practice approaches should be encouraged and/or recommended by policy-makers.**

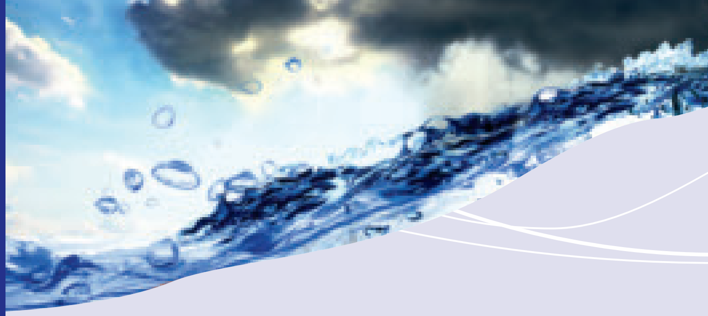
- **Partnership:** Business can bring research, technology and innovation to the table. However, these efforts are only fruitful when supported by science, government, civil society and legislation.
- **Efficiency:** Significant water and energy efficiency gains can be achieved by minimizing water losses in water supply systems, due to not only wasting the water itself, but also the energy used to pump and distribute it. Energy can be recovered in water and wastewater transport and treatment systems – heat, cooling and energy production. Efficient irrigation schemes can be used to save water, e.g., by reducing losses due to evaporation and run-off through drip irrigation. New cooling systems can be designed in power plants to have an optimal trade-off between water and energy requirements and impacts (e.g., parallel condensing systems that combine wet and dry cooling systems).
- **Renewable energy:** Renewable energy use can be encouraged for water treatment processes, as well as wastewater plants.

Business implications in practice

Real-world implications of the linkages between water, energy and climate change for business

Leading companies are already tackling water, energy and climate change issues in different ways, and will increasingly do so in the future. This section highlights the challenges that companies face, and how some have responded in practice.

Please see *http://www.wbcsd.org/web/casestudy.htm* for complete versions of many of these case studies.



Reduced water availability and increasing energy demand

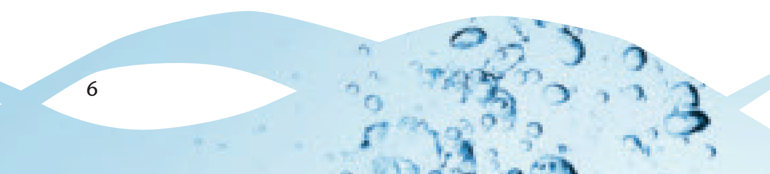
External challenges

Reduced water availability (of a certain quality and quantity, and at a given time, place or flow) **and increasing energy demand**

- Constraints on water withdrawals, consumption or use through stricter regulations, limited supply
- Energy supply will struggle to keep pace with increasing demand linked to increasing population and affluence
- Constraints on energy efficiency and reduced emissions
- Increased competition from different users
- Need to consider energy and water impacts or footprints together

Business implications

- Pay for increased operational costs
- Save water and energy
- Treat and recycle own water and wastewater (with associated energy costs)
- Recover and reuse water and energy (e.g., using steam or heat, recycle other industrial and municipal wastewater)
- Develop new markets for water- and energy-saving technologies and services
- Measure water and energy impacts
- Engage with communities to reduce potential for conflict and risks to license to operate
- Identify best approach depending on local conditions, for example, in water scarce countries



Case studies

Water and wastewater efficiency

- At **Shell**'s manufacturing sites, process effluents have to be disposed of according to increasingly stringent legislation, working towards a continuous reduction of water intensity with zero liquid discharge (ZLD) as the ultimate goal. ZLD is being applied in the Pearl Gas-to-Liquids (GTL) project in Qatar. Like any large project, Pearl GTL requires significant amounts of water, approximately 1,300 m^3 per hour, and the desalination of seawater is energy intensive. However, a GTL plant – due to the Fisher-Tropsch chemical reaction on which it is based – also produces water. At Pearl GTL, this is around 1,400 m^3 per hour. This has enabled Shell to design an integrated water management scheme based on the full reuse of wastewater. Over the full life cycle of Pearl GTL, Shell will achieve a neutral or better balance between freshwater intake and water produced in the plant itself, meaning local water sources will not be depleted or affected.

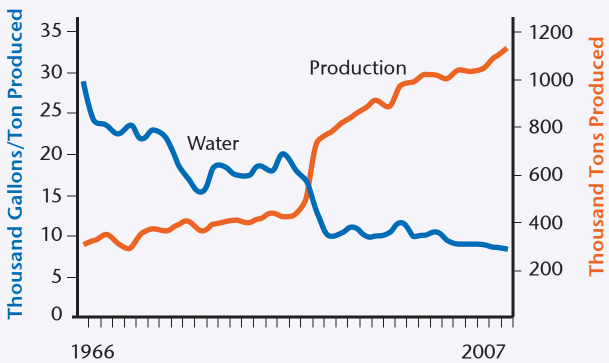
- In the last 5 years, **PepsiCo**'s water initiatives have enabled PepsiCo India to reduce water use in manufacturing plants by over 60%, and in the last two years alone, it has saved over 2 billion liters of water. Over the last 3 years, PepsiCo India has conducted trials of various rice varieties in farmers' fields and used a seeding machine, which together have demonstrated water savings of 30%.

- **BP** has chosen to develop biofuels that are particularly water efficient – using rain-fed sugar cane and temperate sourced crops including non-food energy grasses. BP is further investigating biodiesel from *jatropha curcas*, a shrub that tolerates periods of low rainfall. Investment planning requires environmental and social impact assessments and stimulates mapping of water basin management which otherwise may not take place.

Water efficiency and increasing production

- Water conservation has been a basic principle of good business for the **MeadWestvaco Corporation (MWV)** Mahrt paperboard mill since its startup in 1966. Exploding population growth in the southeastern US and years of acute drought continue to increase water demands on the Chattahoochee River and its associated reservoirs that stretch across the southeastern US. The mill, located on the Chattahoochee River, has proactively implemented sustainable water use reduction improvements while increasing its production over the past 40 years. In recent years, MWV joined multi-state stakeholder groups to collaboratively address the area's water supply challenges.

Figure 1: Water use in paper production
(MWV Mahrt mill, 1966 – 2007)



Note: Some case studies may be relevant to more than one challenge or implication.

Case studies

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Water, energy efficiency, CO_2 reduction

- **Dow Chemical**'s site in the Netherlands uses household wastewater that is converted into industrial water to be used as feed water for several plants. In turn, wastewater from these processes is treated and used as feed water for the cooling tower. Three million tons of water per year that were previously discharged into the North Sea are now used two more times, resulting in 90% less energy use and a reduction in CO_2 emissions of 1,850 tons/year. From 1994-2005, Dow reduced wastewater by 38% (per pound of production) globally.

- Desalination is expected to increase about 15% per year due to the demands of a growing population. **GDF SUEZ**'s Perth, Australia desalination plant, one of the biggest in the world, produces 140,000 m^3 of drinking water every day, enough for the whole area. The electricity needed for the process is entirely produced by 35 windmills located 260 km from the plant. CO_2 emissions reductions are estimated at 200,000 tons compared to traditional desalination plants.

- **TEPCO**'s high-efficiency heating and cooling system for Sony Corporation's new headquarters in Tokyo uses waste heat from a public sewage treatment plant. The result is a reduction of approximately 3,500 tons of CO_2/year and 92% less water used compared to a common office building.

- **Veolia Water** has implemented a 100% energy self-sufficient wastewater treatment plant in Germany. The quality of the incoming wastewater is monitored, which guarantees the quality of the sludge produced. The quantity of sludge is then reduced through thermophilic digestion and provides 60% of the plant's electricity (other energy sources include biogas from landfill). The digested sludge and treated wastewater are used as irrigation and fertilizer in nearby fields.

- Mechanical polishing (i.e., grinding off) is a water-intensive step in the semiconductor manufacturing process where excess metal on a silicon wafer surface is removed using a chemical slurry. To reduce the need for polishing of wafers, **IBM** engineers found a way to improve the precision of metal deposition. By better controlling the thickness of the metal deposition, they reduced the metal deposited by 40%, causing a corresponding reduction in metal source use and the length of the subsequent chemical mechanical polishing (CMP) step. The improvement in the process reduced water use in this step by 14% (90,000 liters per year), chemical use by 28%, and cycle time for metal deposition and CMP by 42%. The reduction in cycle time produces a corresponding reduction in energy use.

Providing the right technology

- One of the biggest US wastewater treatment plants, the metro plant for the twin cities of Minneapolis/St. Paul, gathers and treats, on average, 250 million gallons per day (about 950 million liters) of the municipality's wastewater. To lower energy costs and improve treatment efficiencies, the municipality replaced the existing inefficient, coarse bubble aeration system with over 320,000 ceramic and membrane fine bubble diffusers from **ITT**. Retrofitting all treatment tanks at the wastewater plant has resulted in a power savings of 25%, creating annual savings of approximately US$ 1.9 million per year in energy costs.

- **GHD**, working with Foster's Brewing, developed a water recycling scheme for the brewery that allowed them to augment the size of their Yatala brewery while reducing its water and energy footprint. The upgraded brewery reduced water use from 3.9 liters to 2.1 liters of water per liter of beer produced. Significant energy savings were achieved by not having to treat and transport water to the site and then treat and remove waste from the site.

- At an Abbott Laboratories pharmaceutical plant in Ireland, one particular water pump was causing maintenance headaches. A life cycle cost assessment found that the pump was "over-specified" and was running at a greater speed than was required, causing poor performance and large energy bills. **ITT**'s technology both fixed the maintenance issues and created energy savings – approximately 52,000 Euros per year.

Note: Some case studies may be relevant to more than one challenge or implication.

External challenges

Environmental & social constraints

- Negative environmental or social impacts due to excessive freshwater abstractions (either groundwater aquifers or surface water bodies) or greenhouse gas (GHG) emissions
- Need to balance social, financial and environmental interests to maintain regulatory approval and the social license to operate.

Business implications

- Protect reputation and consumer trust
- Remain a competitor in market
- Keep license to operate
- Have long-term vision that impacts will eventually affect business
- Sustainable operations yield regulatory certainty and social license to enable continued operations

Case studies

Water-use planning

- **BC Hydro** spent seven years leading water-use plans on the 23 watersheds where the company has hydro-electric generating facilities. Water-use planning is a decision-making process that engages stakeholders in developing options for achieving a sustainable balance among social, financial and environmental interests. The Ministry of Environment used the water-use plans as the basis for water license requirements that formalize the hydro-electric operations and provide for regulatory certainty. BC Hydro funds and participates in the more than 200 studies (e.g., monitoring salmon populations) and physical work projects (e.g., improving salmon spawning channels) that are underway.

- As an energy company, **Petro-Canada** is responsible for providing safe and reliable energy in the form of hydrocarbon products. Appropriately managing their water footprint can positively impact the energy and natural resources they require to make their products. Petro-Canada has corporate water principles that provide guidance on how they expect to manage water-related risks and opportunities consistent with their corporate policies, responsible investment and operations principles and business strategies. The principles focus on four key areas: employing responsible water practices, reducing water impacts, measuring and reporting performance, and building capacity with local communities.

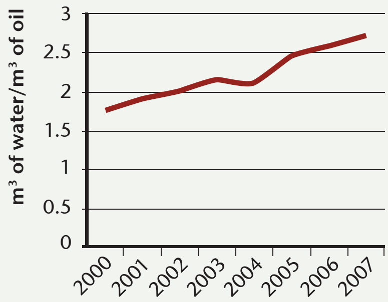
Water and wastewater efficiency

- In order to reduce the sulphur content of its refined diesel fuel to 15 parts per million and be in line with new federal regulations, **Petro-Canada**'s Edmonton refinery (Alberta) needed additional hydrogen and steam. Making more hydrogen and steam would have required an additional withdrawal of up to 5 million liters of water per day from the river. Instead, Petro-Canada partnered with the municipality to install enhanced treatment capability and built a pipeline to the refinery to supply it with municipal wastewater as feed water for the plant, thus eliminating the need for additional freshwater withdrawal.

Wastewater, energy and CO_2 efficiency

- Increasing production and disposal of water are critical issues in **Shell**'s upstream business (see figure 2). Whenever possible, Shell looks at innovative technologies to minimize its operational water footprint. In the Middle East, Petroleum Development Oman is committed to using biofilters (reed bed technology) to clean up 45,000 m^3 of saline water (approx. 8 g/l) produced per day, by far the largest application of this technology. Instead of using deep subsurface disposal, this water is then reused for the production of biomass, reducing the overall CO_2 footprint.

Figure 2: Water use in oil production
(Shell Oman, 2000 - 2007)



- The international pulp market is increasingly competitive and demanding in terms of product quality and environmental performance. At the Richards Bay Pulp Mill, **Mondi** implemented new technologies that led to environmental improvements, including water use reductions of approximately 13,000 m^3 per day, CO_2 emissions reductions of 50% and wastewater volume reductions of over 25%.

Adapting design to climate change

- The 2003 heat wave in France meant high air temperatures (leading to increased demand for cooling, including air conditioning), as well as high water temperatures in the rivers used for cooling nuclear power plants (thus leading to limited production for environmental reasons). This resulted in an estimated 300 million Euros in global costs. **EDF Group** put together a climate change action plan that included cooling system design modifications, water issues (such as water flow management from hydropower), improved weather forecasting (including river water temperatures) and improved understanding of climate change impact on facilities (R&D project). Regarding hydro, EDF Group redesigned its sub-glacial water intake in Chamonix (Mer de Glace) due to the glacier's accelerating retreat – it has lost over 80 meters in thickness over the last 20 years. The new water intake will be located 800 meters upstream, under the glacier.

Innovative technologies for water savings

- **Eskom** uses about 1.5% of South Africa's total freshwater consumption annually while supplying more than 95% of the country's electrical energy and over half of the electricity used on the African continent. Innovative technologies (e.g., dry cooling, desalination of polluted mine water for use at the power stations) means that 200 million liters of water are saved every day compared to other, more common practices. Eskom also influences customers to get them to use electricity in the best way – for every kilowatt-hour of electricity that is saved, approximately 1.26 liters of water is also saved on average. Eskom continued to increase its energy production between 1993 and 2004 (by 43%), but with less water consumption (by 27%).

- **GHD**, working with GOLD Coast Water, developed a robust scheme serving a 150,000 person urban development to adapt to climate change by integrating water supply, sewerage and storm water services. The scheme has reduced the amount of water imported to the development by more than 80% and reduced discharges to the receiving environment by more than 70%, all with a lower energy footprint than conventional schemes.

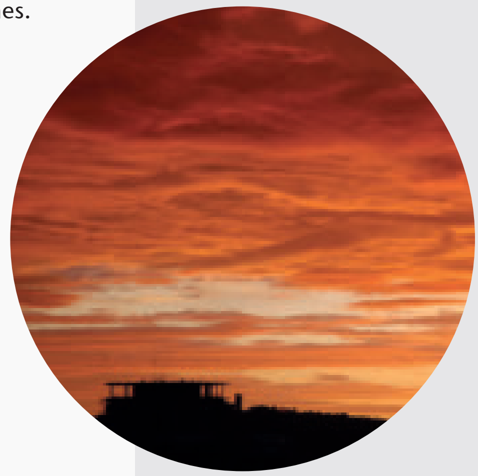
External challenges

Climate change

- Increased risk and uncertainty regarding water and energy resources, as well as climate change impacts
- Insufficient data on available resources, climate information and predictions, as well as toolkits for action

Business implications

- Reduce vulnerability, by ensuring resilience in operations
- Measure insurance costs vs. mitigation costs
- Have several options for adaptation strategies that integrate the assessment of their ecological, social and economic potential, benefits and costs
- Understand causal links between emissions, climate change, physical, ecological and socio-economic impacts



Note: Some case studies may be relevant to more than one challenge or implication.

Issues related to local geographical conditions

External challenges

Issues related to local geographical conditions

- Small islands and coastal mega cities as critical hotspots
- Rapidly changing local conditions in supply and demand
- Temperature rise and the impact of melting snow
- Globally rising sea levels
- Changes in precipitation patterns and extreme weather events

Business implications

- Understand local situation
- Apply integrated water and energy solutions appropriately
- Deal with rising seas that penetrate aquifers and could impact physical assets (cause for increased insurance costs, supply chain interruptions)
- Prepare for potential supply disruptions or infrastructure upgrade costs due to water and wastewater system flooding
- Redesign facility to minimize water use and improve resilience and address contingency planning and emergency response preparedness

Case studies

Adapting to local availability

- **Rio Tinto** mining operations in northern Australia use water in a very specific way due to geographical conditions. Based on stakeholder engagement, there is a hierarchy of different water sources that the company uses – first recycled or reused water, then rainfall runoff that has been captured, and then aquifers.

Participatory activities to manage water locally

- With the objective of conserving each drop of rainwater in the region, Ambuja Cement Foundation (ACF), a division of Ambuja Cements Ltd. (**Holcim Group**), in India addresses water and related issues through innovative and participatory activities. The network of interlinking water bodies and the creation of several structures has resulted in over 30 million m^3 of water harvested, benefiting an area of 21,000 hectares containing over 8,000 wells and 10,000 farmers.

Forecasting the effects of climate change

- In the UK, **Veolia Water** studied the impact of climate change in the long-run on the two main aquifers supplying water to the South-East of England, in particular the greater London area, providing 70% of the raw water treated by the company. Specialists implemented new tools allowing the Three Valleys Water company to apply the results of the Inter-governmental Panel on Climate Change's Global Climate Models, to adapt them to the regional scale, and to generate the forecasted impacts on the evolution of the groundwater resource in 25 years time.

Note: Some case studies may be relevant to more than one challenge or implication.

Consumer water and energy efficiency

- **Procter & Gamble**'s "Sustainable Innovation Products" include Ariel "Turn to 30" (wash clothes at 30°C), a line of products that saves energy and water through new formulations, product compaction and packaging innovations. Up to 85% of the energy used by laundry products is done so by the consumer to heat the water in the washing machine; only very little is used in the product's manufacturing. Efforts in communication and reassurance to the consumer have been successful in changing consumer behavior, getting them to reduce water temperatures.

Awareness raising and collaboration

- **Borealis and Borouge** created *Water for the World*™ (*www.waterfortheworld.net*), a pioneering program that fosters local knowledge and partnerships throughout the value chain to provide sustainable solutions for the availability of safe water and sanitation.

External challenges

Education and awareness of consumers

Business implications

- Develop new markets for energy efficient water-saving technologies and services
- Develop products and services that are more sustainable
- Influence sustainable consumption
- Respond to consumer demand
- Contribute to development of tools or footprint methodologies

Facts in a nutshell

Quick facts on the interconnections between water, energy and climate change

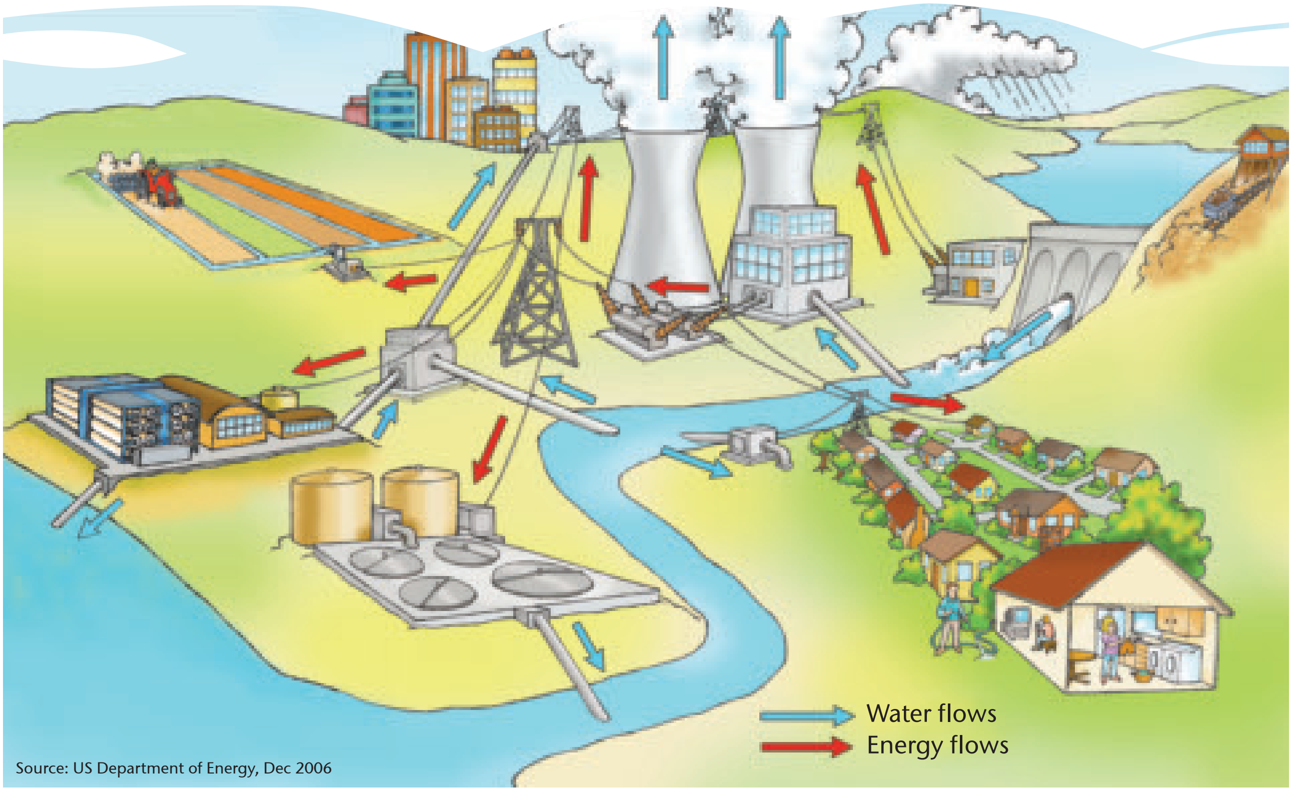
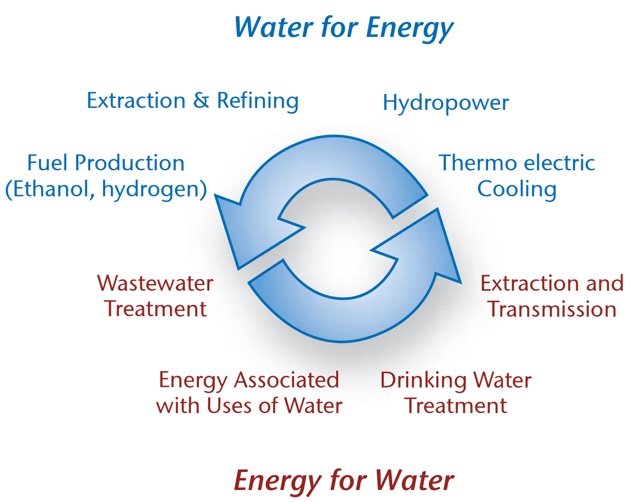


Figure 3: Examples of interrelationships between water and energy[7]



Source: Paul Reiter / International Water Association

Figure 4: Water for energy, energy for water

Warning: The diagram below is illustrative and does not incorporate critical elements such as the distance the water is transported or the level of efficiency, which vary greatly from site to site. For example, water transfer over 350 km (horizontally) uses 3.6 kWh/m³, or the same amount of energy needed to desalinate one cubic meter of seawater. The appropriate and sustainable source of water or energy depends on each situation.

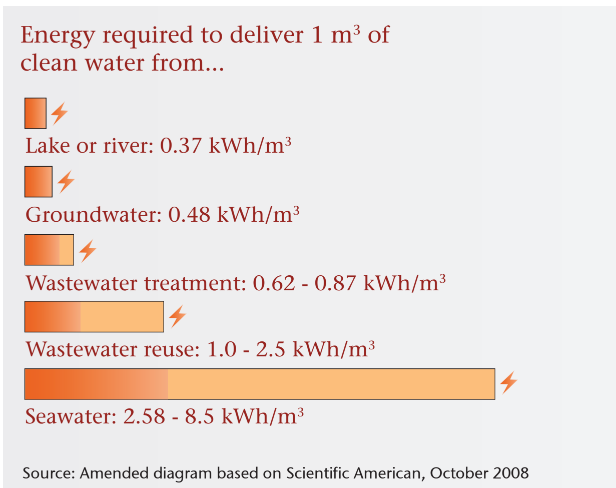


Figure 5: Energy required to deliver water[8]

How much is 1,000 GJ?

In 2005, 1,000 GJ represented the annual average energy consumption of:

5 individuals in a developed country…

…or 24 individuals in a developing country.[9]

1. Energy in water

- Pumping freshwater from groundwater aquifers can have a high energy footprint.
- Estimates of energy requirements for pumping freshwater range from 540 KWh per million gallons from a depth of 35 meters (equivalent to 0.51 GJ per 1,000 m^3 of pumped water), to 2,000 KWh per million gallons from 120 meters (equivalent to about 2 GJ per 1,000 m^3 of pumped water).[10]
- These energy needs will increase in the areas where groundwater levels are decreasing.

2. Water in different energy types

a) Renewable energy

Hydropower

- Hydropower produced 89% of the world's renewable electricity in 2006, and 16.6% of total electricity generation worldwide. Two-thirds of worldwide economic potential remains unexploited – this resource is concentrated in the developing world.[11]
- 25% of dams worldwide are used for hydropower and only 10% have hydropower as their main use. Most of them are used for flood control or irrigation, or for multiple purposes.[12]
- Hydropower uses and releases water instantaneously or with a delay but does not consume water. Their main losses stem from evaporation when air temperatures are high.
- Energy output from hydropower is dependent on sustainable upstream water use as well as hydrological patterns, and is therefore susceptible to climate change impacts.
- Hydropower reservoirs store both water and energy and are becoming increasingly important for the management of climate change.

Solar, wind and ocean energy

- Solar thermal power plant water consumption is about 1 m^3 of water per 103 kWh (electric) or 277 m^3 of water per 1,000 GJ.[13]
- Wind energy and photovoltaic cells that produce electricity directly from sunlight are considered to have negligible water use.
- Wave energy is still a largely untapped source of renewable energy, which, like hydropower, uses water but does not consume it.

b) Crude oil

- As easy oil is used up, pumping oil from reservoirs is now associated with more water production per amount of oil produced than ever before (due to aging reservoirs and increased oil recovery operations). The volume of water produced worldwide from the oil and gas industry is still increasing at a rate of about 10% per year. Water to oil ratios ranged from <1 to up to 40 depending on maturity of the field with the lowest ratios generally observed in the Middle East.[14]
- Between 2 and 8 m^3 of water per 1,000 GJ have historically been required to extract oil, including water for drilling, flooding and treating.[15] However, when thermal steam injection or enhanced oil recovery is included in the process, this number can increase, on average, to 1,058 m^3 per 1,000 GJ.[16]

c) Oil refining and gas processing

- Consumptive water use for processing and cooling in traditional refining facilities in industrialized countries ranges from 25 to 65 m^3 per 1,000 GJ.[17] Please note this figure is only illustrative, as it does not specify if it refers to wet or dry cooling.
- For about 800 million gallons of petroleum products refined daily in the US,[18] 1 to 2 billion gallons of water are consumed per day.

d) Biomass for conversion to biofuels

- An illustrative range of average water footprints for biomass production is 24 m^3/GJ (24,000 m^3 per 1,000 GJ) in the Netherlands to 143 m^3/GJ (143,000 m^3 per 1,000 GJ) in Zimbabwe.[19]
- Large differences in crop water requirements exist among countries due to different climates.[20] Also, the amount of water used does not reflect water sources and whether the crop is rain-fed or irrigated.
- Water is not only required for biomass production, but also for its conversion to biofuels.

e) Coal

- More electricity is generated from coal than from any other fuel – 39% of world generation in 2002.[21]
- Open pit coal mining requires 2 m^3 of water per 1,000 GJ of energy in the coal, while underground mining operations require 3-20 m^3 of water per 1,000 GJ.[22]

f) Nuclear

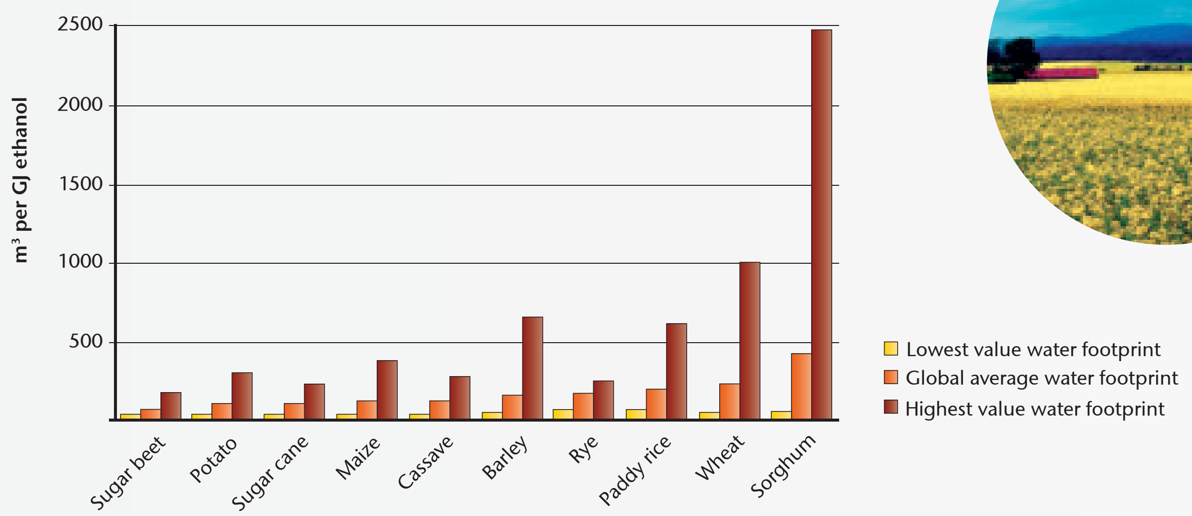
Power generation[23]

There are two types of cooling systems for nuclear power plants:

- **Open-loop water cooling**, where water is withdrawn from a river, lake or the sea, and then returned to it after cooling. The average amount of water consumed is approximately zero and the water required and then returned is approx. 160 m^3/MWh (equivalent to 44,444 m^3 per 1,000 GJ).
- **Closed-loop water cooling**, where water flows into a closed circuit and part of it is evaporated through a cooling tower into the atmosphere. The average amount of water consumed (through evaporation) is approx. 2 m^3/MWh (555 m^3 per 1,000 GJ) and the water required and then returned is approx. 6 m^3/MWh (equivalent to 1, 666 m^3 per 1,000 GJ).

Uranium mining and milling

- Uranium mining requires water for dust control, ore beneficiation and revegetation of mined surfaces.
- The quantity of water required for mining and milling ranges from 2 to 8 m^3 per 1,000 GJ energy in the ore, depending on the type of the mine (e.g, underground or open pit), the geology, and the region.[24]



Source: Gerbens-Leenes, et al., Aug 2008

Figure 6: Water footprint for energy for ten crops providing ethanol

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24. Figures based on average values provided by AREVA.

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) brings together some 200 international companies in a shared commitment to sustainable development through economic growth, ecological balance and social progress. Our members are drawn from more than 37 countries and 22 major industrial sectors. We also benefit from a global network of some 57 national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues.

Our objectives include:

- Business Leadership – to be a leading business advocate on sustainable development;
- Policy Development – to help develop policies that create framework conditions for the business contribution to sustainable development;
- The Business Case – to develop and promote the business case for sustainable development;
- Best Practice – to demonstrate the business contribution to sustainable development and share best practices among members;
- Global Outreach – to contribute to a sustainable future for developing nations and nations in transition.

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ISBN: 978-3-940388-40-7
Printer: Atar Roto Presse SA, Switzerland. Printed on paper containing 40% recycled content and 60% from mainly certified forests (FSC and PEFC). 100% chlorine free. ISO 14001 certified mill.

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