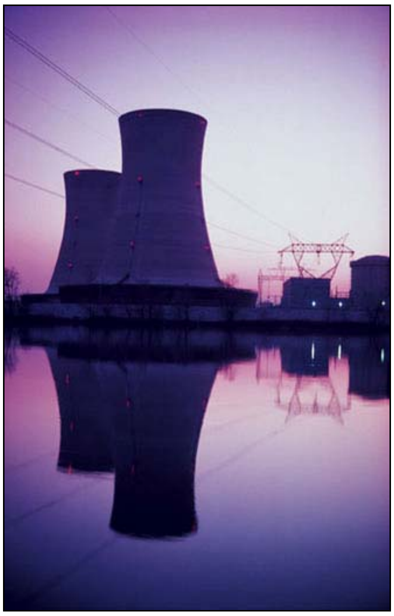
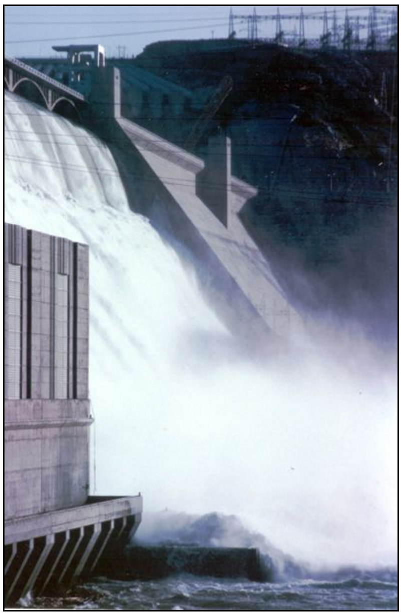
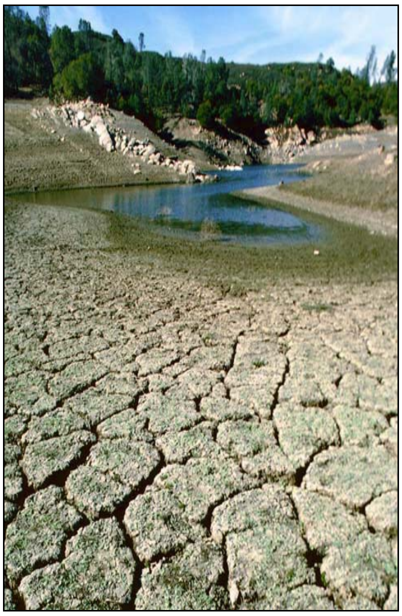
Linking Water, Energy & Climate Change

A proposed water and energy policy initiative for the UN Climate Change Conference, COP15, in Copenhagen 2009

Draft Concept Note







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1 Introduction

Water is indispensable for all sorts of life. It is a limited resource that is required in large quantities in most human activities, i.e. domestic, agricultural, industrial, service and waste water treatment. Sustainable and equitable management of the resource therefore requires integrated and coordinated approaches, which take into account ecosystems needs.

Energy is a key requirement for development (poverty alleviation, socio-economic and economic development and human well-being). Most energy production today is based on non-renewable resources (fossil fuel, i.e. coal, natural gas and oil) although a range of renewable energy production types are available (i.e. wind, wave, solar, water, bio-fuels etc.).

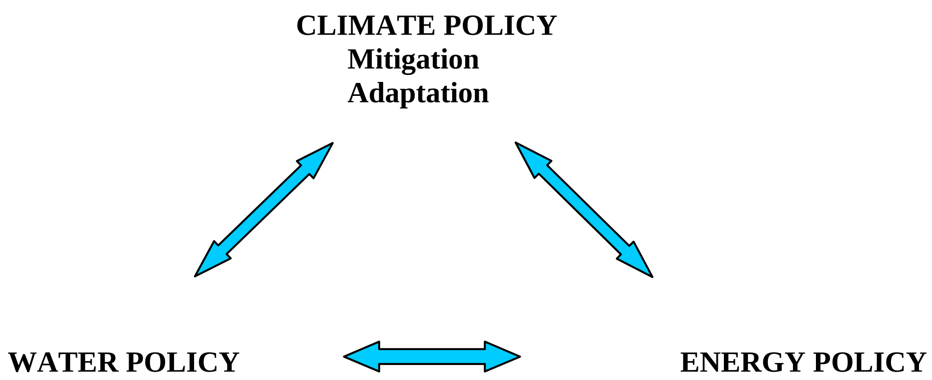
With population and economic growth there is increasing pressure on water resources and an increasing demand for energy.

Energy and water are inextricably linked: Energy production requires water; and water production, processing, distribution, and end-use requires energy.

Climate and water systems are interconnected in complex ways and a change in one of these systems induces a change in the other. It is increasingly apparent that a significant part of the changes in climate experienced today are anthropogenic, associated with increases in population and economic growth.

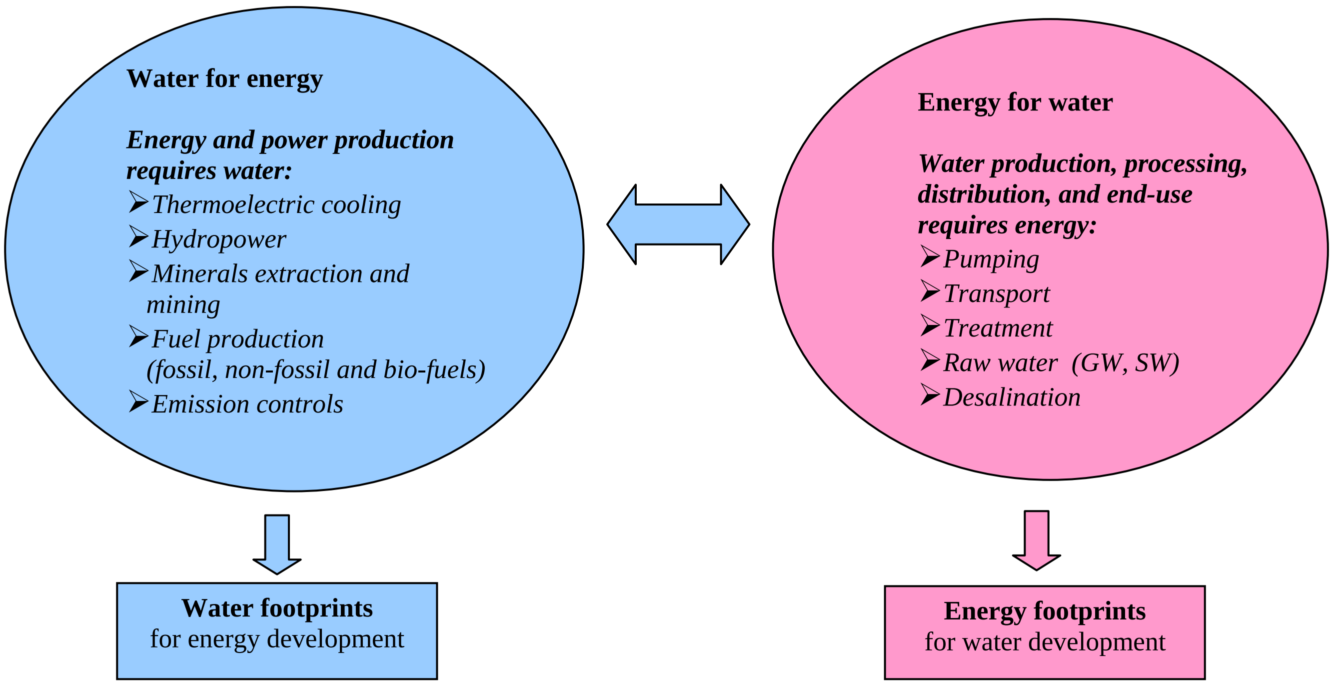
The interconnections between water, energy and climate are complex. Development exerts a strong pressure on limited resources of water and requires increasing energy supplies. Water use and energy production impact on climate and changes in climate cause shifts in water availability.

There is a need to ensure that the future use of water and energy production is closely considered together with the mitigation of and adaptation to climate change.



2 Towards a water and energy policy initiative

The idea for an energy-water-climate initiative was born at the International Conference, "Managing water towards the Millennium Development Goals", held in Copenhagen in April 2007. During the lunch, hosted by Danida, between UNEP's Executive Director, Mr. Achim Steiner and a small group of business leaders issues relating to energy, water and climate change were discussed, and the idea of a joint initiative between interested actors was raised. Subsequently, a "water and energy policy initiative", starting with a study and documentation phase, and resulting in an initiative towards the **UN Climate Change Conference, COP 15, in Copenhagen in 2009** is now being considered**.** The basic premise is that mitigation measures may have serious water resources implications, expressed in the form of *"water footprints"*, and vice versa that water development may leave serious *"energy footprints"*.



This present note proposes a process towards a *"Water & Energy Policy Initiative"* on better coordination between water and energy policy formulation to be raised at COP 15 in 2009. As such it should form the basis for a first meeting between the interested parties to decide how to go ahead.

3 Water footprints in the energy sector

The production of electrical power is associated with very large uses of water. Water footprints for energy production can be defined as "the amount of water *consumed* for fuel development and in the process of producing electricity". This consumption covers not only the water used directly in the energy plant for cooling and driving turbines, but also indirectly in the form of water used to develop and refine fuels as well as evaporation from water storage facilities such as dams.

It is important, however, to note the difference between *water withdrawn* and *water consumed*:

> **Definition**
>
> *Water withdrawn* is the gross amount of water removed from any source, either permanently or temporarily[1]. Some or all of the water withdrawn may be returned to the source after use but the gross amount removed or diverted is referred to as water withdrawn.
>
> *Water consumed* refers to the amount of water withdrawn which is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock, ejected directly into sea, or otherwise removed from freshwater resources.[2]

The fact that water is consumed, according to the above and widely accepted definition, by a given process does not necessarily mean that it cannot be used by users at a later stage – but most likely it will be by other users in a different location (maybe in another country) at a different time.

The table below illustrates the amount of water consumed to produce electricity by a selection of energy types using the U.S. as an example[3]. Similar tables could be developed for other countries.

"Water footprints for energy": Water consumed by energy type - based on the US Example:*

Energy Type	Approximate Total Water Consumed (m3/MWh)	Water Consumption for US Daily Energy Production (millions of m3)**	US Personal Daily Consumption Equivalents*** (people)
Solar****	0.001	0.011	44 thousand
Wind****	0.001	0.011	44 thousand
Gas	1	11	44 million
Coal	2	22	88 million
Nuclear	2.5	27.5	110 million
Oil/Petrol	4	44	176 million
Hydropower	68	748	3 billion
Bio-fuel (1st gen.)	178	1,958	7.8 billion

*Based on: Water consumed for production/extraction of raw materials; water consumed for refining fuel; water consumed at energy plant; and average totals by plant types.

[1] Definition of European Environment Agency: http://glossary.eea.europa.eu/EEAGlossary/W
[2] Ibid
[3] A similar table including water withdrawn would also be of interest in places vulnerable to water stress and scarcity.

** If the entire energy production of the US were based on one energy type only, this column illustrates what the consumptive use of water for that production would be (based on current US production of approximately 11 million MWh/day.
*** Corresponding to the average annual consumption of water from the indicated number of people and an average US consumption rate of 250ltrs/person/day). E.g. If the US immediately switched to 100% wind power the water consumed daily would be the equivalent to the daily use of 44,000 Americans.
**** Water consumption is primarily for maintenance in the form of cleaning. While the amount of water required is highly dependent on local conditions, in comparison to other energy types water consumption is minimal.

In situations where selection of energy type, plant location and water demands from other sectors (such as agriculture and domestic) require consideration, water footprints become an important policy issue. This is particularly relevant in situations where climate change threatens water availability.

In the U.S., where 39% of all freshwater withdrawals go to energy production, the energy-water-climate link has been the topic of much debate in recent years, including a *Congressional briefing in 2006: "Understanding the Energy-Water-Climate Nexus: Implications for Policy"*. A key point of note that the U.S. has in common with many other countries is that while the country as a whole has a net surplus of water, a number of regions have growing water availability issues that threaten social and economic development (see box below).

The US example:

"Climatic change and climatic variability can have a dramatic impact on water supplies, with the most obvious being drought. But even high precipitation provides no guarantee of adequate water if the inflow does not come at the right time".

(U.S Department of Energy (December 2006); Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy & Water p.31)

"The dependency of electricity supply and demand on water availability can impede societal and economic sustainability, adversely affect the future growth of demand for electricity…and impact electric grid topology planning."

(From Electricity Power Research Institute (EPRI) (2002); Water & Sustainability (Vol.3: U.S. Water Consumption for Power Production – The Next Half Century)

An analysis of the relationship between water, energy and climate in the U.S., or indeed in any other country or region, might well consider the following:

1. An overview of how much various water electricity producing technologies use for the same amount of electricity produced.
2. An overview of how much water in total the electricity sector will use by 2025/2030 in a business as usual scenario, and with alternative energy mixes by 2025/2030.
3. An overview of how seriously water stress and climate change will influence the water supply situation in a specific geographical area of analysis.
4. Conclusions and policy recommendations resulting from the above.

4 Energy footprints for water applications

Given the growing understanding that accelerated global warming is a result of increasing energy production from burning fossil fuels, apart from considering alternative energy types, there is broad recognition of the need to try to limit the amount of energy we use. One area with potential for considerable savings is related to the movement and processing and use of water, where its movement, processing and use is associated with very large amounts of energy, mainly for pumping. Another is the production of freshwater through energy intensive desalination. Consequently, energy footprints for water uses can be defined as "the amount of energy *consumed* during the conveyance, treatment and application of water".

Such a definition could be employed to include the amount of energy to be saved by employing different types of pumps and pumping arrangements, as well as alternative types of processing/treatment and applications. It would be of most obvious relevance in situations where energy conservation related to water applications is of significant importance for a given country. This could be as a result of social, economic and environmental concerns. The table below provides some illustrative examples of possible areas of interest, categorized by application and main energy footprint area.

"Energy footprints for water": Illustrative examples

Water Applications	Main Energy Footprint Area
Water supply	
Groundwater source	Conveyance
Surface water source	Conveyance
Water treatment	Treatment
Distribution systems	Conveyance
Dams and reservoirs	Conveyance
Sewerage	
Waste water treatment	Treatment
Sewerage	Treatment
Agricultural water use	
Irrigation	Application/Conveyance
Drainage	Conveyance
Industrial water use	
Industrial processes	Application
Cooling	Application/ Conveyance/Treatment
Energy production	
Hydropower	Application/ Conveyance/Treatment
Thermal power	Application/ Conveyance/Treatment

The similar table for "water footprints for energy" shown above (the US example) has been developed recently. The table for "energy footprints for water" is expected to be developed in a similar manner shortly, initially for countries with readily available data (such as the US), but also for other countries. In so doing the distinction between use of *primary and secondary energy sources* (as e.g. considering the losses in energy transformation from primary forms to electricity) will be important.

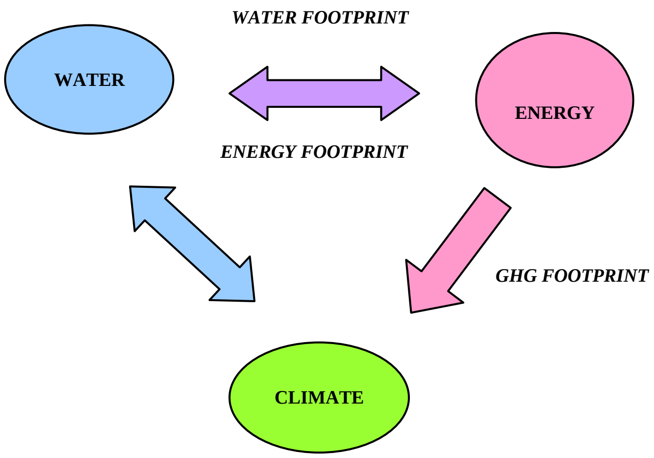
An analysis of the scope and potential for reducing energy footprints in water applications might consider the following:

1. An overview of how much energy various water conveyance/treatment/application arrangements require
2. The identification of water applications of relevance in specific geographical areas of interest
3. A consideration of current energy use for the identified water applications both today and by 2025/2030 in a business as usual scenario, and with alternative scenarios by 2025/2030.
4. Conclusions and policy recommendations resulting from the above.

5 Energy, water and climate: The added challenge

The energy-water-climate link makes it imperative to not only consider the water footprints in energy production, and the energy footprints for water development, but also ultimately the *greenhouse gas footprints* flowing from those.

Energy production results in greenhouse gas footprints that in turn affect both our climate and water



Energy-related emissions (including energy used in transportation) account for over two thirds of anthropogenic GHG emissions and contribute to well over 80% of worldwide emissions of CO2 - the main GHG, as a direct result of fossil fuel combustion. Energy also accounts for around one third of the global emissions of methane (the second largest source of GHGs), in fugitive emissions, mainly from natural gas production, transportation and coal production (World Energy Council 2006). With increased energy demands for various purposes GHG emissions will increase; conversely, *prudent water management holds the potential to reduce energy footprints, and hence the GHG footprints of development.*

The link from water to GHG footprints is indirect: water development leaves energy footprint which in turn result in GHG footprints, i.e. *water footprint* -> *energy footprint* -> *GHG footprint*.

This link should be kept in mind, but it is not suggested that studies on GHG footprints per se should be part of this initiative. Many other initiatives with focus on mitigation address the energy-to-GHG footprint question.

6 Towards coordinated energy and water policy development

The strong interdependency between energy, water and climate change makes it *imperative that policy formulation be coordinated*, particularly with respect to mitigation of and adaptation to climate change effects. Traditionally energy and water policies are developed within each their sector with little coordination and there is a need to coordinate. Importantly change from fossil fuel with large emissions, and considerable water use towards renewable sources with minimal emissions and water use, should be pursued.

In the United States *"an energy-water roadmap"* process was conducted in 2006, identifying a number of major national needs and issues to be addressed, and proposed actions to do so. As illustrated in the box above, the US is characterized by very significant water-related energy concerns, but similar exercises are required for other countries, and at the global level such exercises should lead to policy recommendations to inspire countries in both North and South.

The US example

Overall recommendations

- ***Decision makers should better integrate energy issues into water policy***
- ***Water conservation and efficiency should be given a higher priority by both water and energy planners***
- ***The greenhouse gas implications of both water and energy policy may be significant, with opportunties for fast, cost-effective reductions***

Federal recommendations

- ***Perform energy intensity studies of water systems***
- ***Manufacturers should report energy information on heating, recirculation, pressurization, and other Functions separately***
- ***Environmental assessments for water supply should address energy and associated air quality effects***
- ***Implement water conservation planning***
- ***Phase out irrigation, energy and crop subsidies that lead to waste of water and energy***
- ***Pursue smart labeling of water efficient appliances that also save energy***
- ***Examine the climate implications of federal water policies***

The ultimate task is to act responsibly in the face of the growing demand for water and energy, and the associated global environmental problems of climate change and diminishing freshwater resources.

The *UN Climate Change Conference, COP 15, in Copenhagen in 2009*, provides the high level platform required to give impetus to the integration of water and energy policy formulation on the broad scale needed to maximize mitigation and adaptation impacts on anthropogenic climate change and sets a timeline for developing such policy formulation recommendations.

7 Linking water and energy policy formulation: The proposed process

A phased approach, combining – in parallel - general studies and analyses, specific country studies, and an international policy development process towards the UN Climate Change Conference (COP 15) in Copenhagen in 2009 is proposed.

Analytical phase: general studies and analyses based on available information

Establish the baseline and define the challenges (establishing the facts and using these for assessing current policy formulation), including:

- Investigating and detailing the linkages, and documenting the figures, between water and energy (energy required for different types of water use – energy footprints), water required for energy production (water footprints)
- Analyzing the benefits and cost of water and energy development options
- Policy review at different levels of policy formulation: national cases from industrial countries, including the US and Europe, emerging economies and developing countries, and cases from technical groups involved in climate change from energy perspective and climate change from water perspective
- Compilation of lessons learnt and good practices in water and energy development: cases of minimizing water and energy footprints, and cases of good practices in policy analysis and formulation
- A first round of consultations: seeking feed back on the baseline and suggestions from relevant UN organizations.

This process has already started. DHI Water Policy has conducted some initial general studies on water footprints for energy production (including the table above), and expects to be able to make a similar first general analysis for energy footprint for water soon, initially working with interested Danish industries in the energy and water sectors. In addition contacts have been established with a series of interested partners: the European Water Partners (EWP), the Global Water Partnership (GWP), the Danish UNEP Collaborating Centres (Risø and DHI), the World Water Council (WWC) and the Cooperative Program on Water and Climate.

Pilot phase in selected countries

Conduct analyses and pilot recommendations in selected countries, e.g. including Danish development cooperation countries, countries in transition (BRIK) and industrialized countries. Initial contacts have been made to a number of countries who have expressed interest, including Brazil, Nepal, Singapore and a number of European countries through GWP-Mediterranean and EWP.

As suggested above, work in these countries would focus on *water footprints for energy*, including:

- An overview of how much various water electricity producing technologies use for the same amount of electricity produced
- An overview of how much water in total the electricity sector will use by 2025/2030 in a business as usual scenario, and with alternative energy mixes by 2025/2030
- An overview of how seriously water stress and climate change will influence the water supply situation in a specific geographical area of analysis
- National policy dialogue through consultations and national seminar
- Conclusions and policy recommendations resulting from the above.

and *energy footprints for water*, including:

- An overview of how much energy various water conveyance/treatment/application arrangements require
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- A consideration current energy use for the identified water applications both today and by 2025/2030 in a business as usual scenario, and with alternative scenarios by 2025/2030
- National policy dialogue through consultations and national seminar
- Conclusions and policy recommendations resulting from the above.

Synthesis and policy formulation phase

Develop a preliminary synthesis of the analytical and pilot phase, including,

- A preliminary se of recommendations for integrated water and energy policy formulation
- A second round of consultations: consolidating preliminary conclusions and policy recommendations.

International workshops

Present, modify and validate the outcome of the analytical, pilot and synthesis phases to international audiences (North and South) through regional/international workshops, in Denmark and/or elsewhere, leading to the preparation of recommendations, initially to the World water Forum in Istanbul in March 2009, and subsequently to be proposed at the UN Climate Change Conference, COP 15, in Copenhagen in 2009.

Preparations of the Copenhagen Climate Change Conference

Discussions (“negotiations”) of the proposed recommendations with key countries (North including EU and US, and South) and international organizations (UN) in preparations for the conference.

DHI, January 2008