UN WATER

Partnerships for improving water and energy access, efficiency and sustainability

Prepared by UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC) with United Nations University (UNU) and United Nations Industrial Development Organization (UNIDO)

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1. Introduction

Securing equitable access, efficiency and sustainability of water and energy may require focusing on an examination of how partnerships can help in developing appropriate responses and manage trade-offs, identify synergies, and maximize co-benefits for water and for energy.

Securing access is central

Securing access to both water and energy is a social challenge regardless of the stage of economic development, the location or the resources available. Water and energy are both drivers and constraints on human development and for this reason the challenges posed by both always deserve a privileged place at the top of the policy agenda. This is particularly true for the poorest level of society, where fulfilling the Millennium Development goals is still pending and the lack of adequate access to water and sanitation and energy sources to cover basic needs is still the main barrier to overcoming poverty and exclusion.

Access to W&E

W&E can be limiting factors for sustainable economic growth, which is the ultimate hope for widespread poverty reduction. Uncertain water supply is also becoming a major business risk for some energy sector managers. Securing access to modern energy services represents a major challenge.

W&E Efficiency

A particular emphasis has to be placed on increasing the water use efficiency in energy production –essentially producing more kWh per drop of water and vice versa. Many efficiency improvements in utilities, such as the repair of leaks, require regular attention to ensure a steady supply of new water and energy savings.

W&E Sustainability

Recognizing that ecosystems provide a variety of services to the water–energy nexus can help the management of trade-offs and ensure that short-term gains do not undermine services that are critical for resilience and long-term environmental sustainability.

Economic growth and demography - the main drivers

The nature of the challenge may change with the level of economic development but is far from eliminated once a society finds its way out of poverty. Growing economies and populations are drivers of water and energy scarcity. The transition towards a developed society requires secure

1 This report is the summary of presentations and debates during the UN-Water Annual Zaragoza Conference 2014. This conference was preparatory of World Water Day 2014, focused on the nexus of water and energy. This conference was preparatory of World Water Day 2014, focusing on the nexus of water and energy. It was co-organised with the United Nations University (UNU), the United Nations Industrial Development Organization (UNIDO) and in partnership with UNESCO, UNECE, WB, UNEP, WWAP, UNESCAP, Aquafed, WfWP, WCCE, ICLEI, and the Government of Spain, the Ebro River Basin Authority and the Municipality of Zaragoza.

and adequate access to water and energy both for the people and for practically all the goods and services in which water and energy intervene as essential production inputs. In fact economic growth and demography will remain as the main drivers of water and energy demands in the near future.

Maintaining advances requires decoupling growth from use of resources

Recognizing the scarcity of water and energy imply that maintaining the advances already obtained requires curbing natural resources scarcity trends and preserving the ability of all water and energy related ecosystems to continue providing the valuable environmental services on which humans and our entire production system depends on. At some point any individual region, country and even the planet as a whole will need to recognize that any feasible improvement depends on the ability to decouple further economic advance from the additional pressures over natural freshwater and energy sources and the reduction of wastewater effluents and energy related emissions into the environment.

A sustainable future is possible

A sustainable future is possible within the range of the resources available. The inventory and the evaluation of best water and energy technologies available shows that there is room for improvement in human development aspirations that are compatible with reversing natural degradation trends and with the building up of a more adaptable and more resilient society. However, the relative optimism of this conclusion cannot shade the magnitude of the challenge of transforming the promise into a reality.

Recognizing how the world's water and energy systems are inextricably linked

One essential condition to take advantage of these opportunities consists of recognizing how the world's water and energy systems are inextricably linked. Significant amounts of water are needed in almost all energy processes (from generating hydropower, cooling and other purposes in thermal power plants, to extracting and processing fuels). Conventional energy generation requires the mobilization and utilization of considerable water resources, particularly for cooling for nuclear and thermal energy, and reservoir storage and driving turbines for hydroelectricity. Power generation is particularly sensitive to water availability and several power plants have been forced to shut down due to lack of cooling water or high water temperatures (see chapter 3 below).

Energy needs Water

- 90% of power generation worldwide is water-intensive.
- There is an increasing risk of conflict between power generation, other water users and environmental considerations.
- Energy production accounts for roughly 15% of all water withdrawals, or roughly 75% of all industrial water withdrawals.
- Thermal power generation accounts for roughly 80% of global electricity production and is responsible for roughly one half of all water withdrawals in The United States and in several European countries.
- Hydroelectricity, which can also require abundant water supplies, accounts for about 15% of global electricity production.

Source: *http://www.unwater.org/topics/water-and-energy/en/*

Conversely, the water sector needs energy – mainly in the form of electricity – to extract, treat and transport water. The degradation of water sources implies increasing amounts of energy to pump the same amount of water from deeper aquifers or farther sources. Any alternative to reallocate water to its more productive uses might require energy for transport and to adapt water quality to its new uses and places.

Water needs energy

- About 8% of the global energy generation is used for pumping, treating and transporting water.
- Water, being dense, requires much energy to move it. Water transport and distribution are energy intensive processes. Reallocating water through uses and places might increase the value per drop but increase the use of energy.
- Drinking water for municipal systems typically requires extensive treatment and once it becomes wastewater it requires treating again before it can be discharged to the environment.

Source: *http://www.unwater.org/topics/water-and-energy/en/*

Water needs energy, energy needs water and human development needs both. One of the main risks in the search for a sustainable development path comes from ignoring the basic fact that there is no other option to handling the water and energy challenges in an integrated manner. These risks are already present in some of the most relevant alternatives to face water and energy challenges.

Water stress might put additional pressure over to energy. Going further and deeper to obtain water as water becomes scarce requires more energy for transport and pumping. The non-conventional sources that may compensate for the lack of freshwater may require energy intensive transformation processes such as desalination of sea and brackish water or regeneration of wastewater.

Growing demand for limited water supplies puts increasing pressure on water intensive energy producers to seek alternative approaches, especially in areas where energy is competing with other major water users (agriculture, manufacturing, drinking water and sanitation services for cities) and where water uses may be restricted to maintain healthy ecosystems.

Access to energy might worsen the water crisis. Uncertainties related to the growth and evolution of global energy production (e.g., via growth in unconventional sources of gas and oil, or biofuels) and the price of energy can create significant risks to water resources and other users. The increasing momentum in the production of biofuels has created a growing demand on water resources. Even a modest 5% share of biofuels in road transport demand (as predicted by the International Energy Agency for 2030) could increase the water demand for irrigation by as much as 20% (WWDR, 2012).

Avoid responses that fix one problem at the expense of worsening the other

The multiple interdependencies between water and energy mean that any response needs to tackle the two sectors in an integrated way. Ignorance of these basic facts may lead to responses that try to adopt alternatives that fix one problem at the expense of worsening the other and that might fail in the end (see box below).

Coordinated responses can take advantage of the synergies between water and energy

Instead of ignoring the interdependencies, coordinated responses can take advantage of the synergies between water and energy. Saving energy means saving water and vice versa. Enhancing the efficiency in the way that water is used translates into lower pressures over freshwater sources but also into a reduced demand of energy for water treatment, pumping and transport and then into even less water required to produce energy. Moving towards less water intensive energy sources and less energy intensive water sources, saving water and energy in any production and consumption process, reallocating water and energy to their more valuable uses are all alternatives that take advantage of these synergies in opening the option of producing more with less.

The risk of a non-coordinated water and energy response

- Desalinated water involves the use of at least 75.2 TWh/year, which is about 0.4% of global electricity consumption.
- Modern biofuels represent only 0.8% of global final energy consumption, but their contribution to energy supply is expected to grow rapidly. If bioenergy feedstock is produced on irrigated lands, then the potential impact of biofuels on water resources is also of major concern.
- Unconventional oil (e.g., oil/tar sands) and gas production (e.g., 'fracking') are generally more water intensive than conventional oil and gas production.

Source: *http://www.unwater.org/topics/water-and-energy/en/*

Partnerships for nexus solutions

Nexus solutions can and have been implemented by building partnerships to allow acting together and **supporting finding and implementing effective actions.** Building partnerships consists of making agreements to reap the benefits of cooperation in the water and energy sector. Not only are the challenges involved in the Water and Energy Nexus beyond the scope of any individual public authority, business or stakeholder but actions can be coordinated in such a way that the whole is greater than the sum of its parts.

Partnerships **might involve different actors** from the energy and water community including businesses, different levels of government, civil society, academia and all those with a stake in finding the way towards a sustainable social response to the water and energy challenges. While recognizing the diversity of perceptions, interests and roles all partnerships are in agreement to cooperate in reaching a mutual benefit.

Mutual benefits are essential to make partnerships work for sustainable development. For instance, a credible policy to increase water security in the long term can reduce the risk of investments in the energy sector and the simultaneous increase in both water and energy security can result in important competitive advantages for the entire national economy. A long term water and energy strategy with clear targets on the water and energy portfolio, a prospective role for renewable energy and non-conventional water sources, might speed up the diffusion of the best available technologies and foster innovation. These are only some of the synergies that partnerships can create in order to ensure a sustainable development.

But partnerships **require an enabling environment.** Institutions and technologies still favor the mutual ignorance of water and energy issues both in business and policy making. Water risks are not adequately considered in the assessment of energy projects and plans and energy issues still play a marginal role if any in water projects appraisal and river basin management plans.

Partnerships might have **multiple functions.** They may serve to integrate policies and broaden the scope and enhance the effectiveness of both water and energy planning but also to coordinate different sectoral policies, such as land planning, rural development, nature conservancy, manufacturing, etc., all within a sustainable use of water and energy.

Effective partnerships are social constructions that **advance through mutual commitment and trust** and when successful might make important contributions to both water and energy governance. They favor transparency, inclusive and legitimate decisions and help to provide better regulations and enabling institutional frameworks, among other advantages.

Partnerships are also knowledge alliances. They allow Identifying opportunities to improve water and energy access, efficiency and sustainability as well as finding the way to implement win-win solutions that are more sustainable. They allow learning from the water and energy communities; they enhance the ability of anticipating risks and learning from failure as well as improving the chances of success. On a broader scale partnerships allow building a shared vision of the challenges involved in the joint management of water and energy and pave the way to enhancing the acceptability of the tough decisions that need to be taken in the short term to come back to a sustainable trend in the medium and the long term.

2. The UN and the Water–Energy Nexus

2.1 The Nexus in the International Agenda

Since the Bonn Nexus Conference (The Water, Energy and Food Security Nexus: Solutions for the Green Economy, 16-18 November 2011) the United Nations has triggered the dialogue to promote finding sustainable development pathways by increasing the policy coherence between the areas of water and energy.

The UN system – working closely with its international partners and donors – is collectively bringing its attention to the water-energy nexus. Particular attention is being paid to identifying best practices that can make a water- and energy-efficient ‘Green Industry’ a reality: several methodologies are at play in which industrial productivity can be increased while reducing water and energy use.

The United Nations Conference on Sustainable Development, held in Rio de Janeiro, in June 2012, marked an important milestone. The UN brought together governments, international institutions and major groups to agree on a range of smart measures that can reduce poverty while promoting decent jobs, clean energy and a more sustainable and fair use of resources. Under this basis securing water and energy is now seen as a key priority within the new and emerging agenda for the Sustainable Development Goals and the post-2015 development dialogue.

2.2 What is the UN doing?

To pursue these objectives the UN has organised the following actions:

Decade of Sustainable Energy for All (2014-2024)

Through Resolution 67/215, the United Nations General Assembly declared the decade 2014-2024 as the Decade of Sustainable Energy for All. The Decade underscores the importance of energy issues for sustainable development and for the elaboration of the post-2015 development agenda. It highlights the importance of improving energy efficiency, increasing the share of renewable energy and cleaner and energy-efficient technologies. Enhancing the efficiency of the energy models would reduce the stress on water.

Sustainable Energy for All initiative

The Sustainable Energy for All initiative is a multi-stakeholder partnership between governments, the private sector, and civil society. Launched by the UN Secretary-General in 2011, it has three interlinked objectives to be achieved by 2030: (1) Ensure universal access to modern energy services; (2) Double the global rate of improvement in energy efficiency; (3) Double the share of renewable energy in the global energy mix.

International Decade for Action 'Water for Life' 2005-2015

The UN International Decade for Action 'Water for Life' 2005-2015 aims to promote efforts to fulfil international commitments made on water and water-related issues by 2015. Focus is on furthering cooperation at all levels, so that the water-related goals of the Millennium Declaration, the Johannesburg Plan of Implementation of the World Summit for Sustainable Development, and Agenda 21 can be achieved. The challenge of the Decade is to focus attention on action-oriented activities and policies that ensure the long-term sustainable management of water resources, in terms of both quantity and quality, and include measures to improve sanitation.

World Water Day

World Water Day (WWD) is held annually on 22 March as a means of focusing attention on the importance of freshwater and advocating for the sustainable management of freshwater resources. Each year, World Water Day highlights a specific aspect of freshwater. In 2014 the focus is on water and energy issues. The United Nations University (UNU) and the United Nations Industrial Development Organization (UNIDO) are leading official celebrations.

UN-Energy

Established in 2004, UN-Energy was initiated as a mechanism to promote coherence and inter-agency collaboration in the field of energy and to develop increased collective engagement between the United Nations and other key external stakeholders. UN-Energy's work is organized around three thematic clusters: (1) Energy access; (2) Renewable energy; and (3) Energy efficiency.

United Nations Industrial Development Organization (UNIDO)

UNIDO's primary objective is the promotion and acceleration of integrated and sustainable industrial development in developing countries, using sustainable practices primarily focused on water and energy security, and countries with economies in transition and the promotion of international industrial cooperation towards sustainable development.

United Nations Environment Programme (UNEP)

UNEP coordinates United Nations environmental activities, assisting developing countries in implementing environmentally sound policies and practices. The Water-Energy Nexus, its interdependencies and best practices related to energy and water security have been highlighted in its wide range of publications. UNEP has played a significant role in developing international water, energy and other international conventions, promoting environmental science and information and illustrating the way those can be implemented in conjunction with policy, working on the development and implementation of policy with national governments and regional institutions in conjunction with Non-Governmental Organizations (NGOs).

World Bank's Thirsty Energy initiative

To support countries' efforts to address challenges in energy and water management proactively, the World Bank has embarked on a global initiative: thirsty energy. Thirsty Energy aims to help governments prepare for an uncertain future, and break disciplinary silos that prevent cross-sectoral planning. With the energy sector as an entry point, thirsty energy quantifies trade-offs and identifies synergies between water and energy resource management. Thirsty energy demonstrates the importance of combined energy and water management approaches through demand-based work in several countries, thus providing examples of how evidence-based operational tools in resource management can enhance sustainable development. This created knowledge will be shared more broadly with other countries facing similar challenges. Thirsty Energy tailors approaches depending on the available resources, modelling experience, and institutional and political realities of a country. In order to ensure client owner¬ship and successful integrated planning, thirsty energy focuses on building the capacity of relevant stakeholders and leveraging existing efforts and knowledge. The energy-water challenge is too large for any organization to tackle alone.

2.3 What have we learnt?

These are the main results of this process so far:

- An improved understanding of the development scenarios and of the driving factors behind water and energy demand.
- Improved knowledge on best practices, experience, know-how and tools on the nexus and sharing of these among stakeholders with competing priorities.
- Improved understanding on how these challenges are interlinked to each other and a better recognition of the trade-offs, and opportunities for win-win courses of action.
- A better knowledge of the existing opportunities and the multiple gains that can result from reversing unsustainable trends.
- Improved dialogue on policy to support consensus building among the wide range of stakeholders involved in improving policy coherence across sectors.
- Best practice innovations and solutions are being disseminated.

2.4 2014 Road map on the water-energy nexus

The World Water Day (WWD), held in Tokyo, Japan, on 20-21 March 2014, coordinated by the United Nations University and the United Nations Industrial Development Organization (UNIDO), has addressed the nexus of water and energy in the context of sustainable development. The WWD aimed to raise awareness across a broad range of business domains and government sectors to solve water and energy challenges in a cohesive way. In preparation the Zaragoza Conference addressed the challenges, relationships and joint solutions that arise from ensuring access, efficiency and sustainability in the provision of water and energy. On the occasion of the WWD, the UN-Water 'Water for Life' Best Practices Award was presented and the World Water Development Report 2014 on Water and Energy launched.

The International Water Management Institute (IWMI)-Tata Water Policy Programme (ITP) in India and the NEWater programme' in Singapore have been the 2014 Award winners. ITP successfully filled the gap between research and policy action to improve groundwater use in India through energy infrastructure and policy improvements. NEWater wide uses water reclamation,while this is not a new concept, what is significant is the successful wide-scale implementation and public engagement plan of NEWater along with its participatory practices and public education programmes, which have allowed delivery of an exponentially successful service.

The World Water Development Report (WWDR) provides answers to key questions such as: what are the implications of the water-energy nexus for SDGs? How can we make better policies for integrated management and governance? How can we make a business case for water-energy nexus? How do we create enabling environments – public/private, pricing, improving joint access – urban vs. rural? Finally, how do we guarantee the long-term sustainability of water and energy systems?

The 2014 Roadmap

- 20-22 January. **Abu Dhabi:** World Future Energy Summit, Joint Closing Session with IWS The Water-Energy Nexus (Thirsty Energy).
- 06-08 February. **New Delhi, India**: 14th Delhi Sustainable Development Summit, "Attaining Energy, Water and Food Security for All", New Delhi/India.
- 03-07 March. **Chapell Hill, USA**: "Nexus 2014: Water, Food, Climate and Energy Conference", Chapel Hill/USA.
- 20-21 March. **Tokyo and Kumamoto City, Japa**n: World Water Day.
- 07-09 May. **Québec City, Canada**: International Forum on Integrated Water Management "Tools For Action!"
- 19-20 May. **Bonn, Germany**: International Conference "Sustainability in the Water-Energy-Food Nexus".
- 21-23 May. **Mexico:** Nexus Conference, IWA Water, Energy and Climate Conference 2014.
- 31 August-5 September. **Stockholm, Sweden**: World Water Week Energy and Water.
- 29-31 October. **Lyon, France**: Water and Energy Interactions International Symposium.
- 1-13 November. **Beijing, China**: International Conference, "Solutions For The Nexus".

3. Water and Energy Scenarios and Challenges

3.1 Water and Energy today and projections

Meeting the challenge of building a sustainable water and energy future requires building a fact based scenario able to understand the likely evolution of the main drivers behind water and energy demands as well as the capacity to cover these demands with the resources available. Prospective scenarios are essential tools to understand present and future challenges, they help setting up priorities for public policy and also provide the basic information to set short and long term objectives and assessing the relative success or failure of the initiatives undertaken to cope with them. Water and energy scenarios are crucial to construct a common vision of the problems ahead so as to endow public and private stakeholders with the foresight required to come up with ambitious policy responses that are required to increase the access, enhance the efficiency and converge to a sustainable water and energy future.

This chapter reviews the extensive work carried out in recent years by the World Water Assessment Programme, the World Bank, the OECD, the International Energy Agency and the international organizations that, based upon what we actually know, have taken part in offering the best possible representation of our common future.

Water and energy access today

Water and energy are two integral components of human development. A sufficient and reliable provision of water and energy for life and for all the economic activities on which both resources intervene is an essential production input and a basic enabling condition to overcome poverty, for the transition towards higher levels of economic and social progress.

The lack of availability and access to basic water and energy services impedes individuals and communities from achieving greater levels of well-being and benefiting from opportunities for social and economic development. This is particularly true for the most poor and vulnerable segments of the population, such as women and children. Investing in water and energy services will lead to increased levels of human health, reduced levels of poverty and indigence, and increased opportunities for education and employment, resulting in overall national economic development.

In many poor countries, biomass accounts for 90% of household energy consumption. Hence, ecosystem services not only sustain energy supply in low-income countries, but they are also critically affected by the predominant choice of energy carrier and aggregate consumption levels. Water security and ecosystems have a reciprocal relationship necessary for the enhancement of both and thereby conserving energy.

Securing access to modern energy services represents a major challenge in pursuing sustainable development. Water and energy have crucial impacts on poverty alleviation – directly, because a number of the Millennium Development Goals depend on major improvements in access to water, sanitation, power and energy sources; and indirectly, as lack of access to water and energy can be a limiting constraint to sustainable economic growth, which is the ultimate hope for widespread poverty reduction.

The Millenium Development Goals: Outstanding Success...

- Between 1990 and 2010, more than two billion people gained access to improved drinking water sources.
- The proportion of people using an improved water source rose from 76 per cent in 1990 to 89 per cent in 2010.
- The share of urban slum residents in the developing world declined from 39 per cent in 2000 to 33 per cent in 2012. More than 200 million of these people gained access to improved water sources, improved sanitation facilities, or durable or less crowded housing.

Source: MDG and Beyond *http://www.un.org/milleniumgoals/environ.shtml*

...and new or remaining challenges

- In 2011, 768 million people remained without access to an improved source of drinking water.
- Over 40 per cent of all people without improved drinking water live in sub-Saharan Africa.
- 2.5 billion people have unreliable or no access to electricity and around 40% of the world population still relies on wood, coal, charcoal or animal waste to cook their food (EIA, 2012).
- 2.8 billion live in areas of high water stress (WWAP, 2012).

Future scenarios: water and energy demands

Under the OECD (2012) baseline scenario by 2050 the world economy will grow to four times its current size. This is expected to result in a less than proportional increase in water demand but will still require 55% more water. Households' water demand is expected to grow by 130% due to the combined effect of higher population with better living standards. The higher increases in water demands are expected to come from manufacturing (+400%) and from thermal power plants (+140%).

These projections are in line with those developed for the energy demand and consumption that by 2035 are expected to be 35% higher than in 2010 and will result in a more than proportional 85% increase in the water consumption (EA, 2012).

Competing and interlinked water and energy demands will put additional pressure on finite water resources. As renewable water resources are limited, without changes in the resources available, the amounts of water and energy required or the efficiency with which they are used, this might only result either in higher conflicts between users or in further degradation and increased water scarcity.

Allocation for natural water flows in rivers and lakes will also be competing with these demands. The forecasted changes will lead to increased competition for a limited supply of water use might also proceed beyond critical sustainable thresholds at the expense of increased water scarcity, degraded water sources, resource exhaustion and impoverished water quality. Currently, there is little scope for increased use of irrigation water use in most regions and by 2025, the proportion of people living in water stressed areas is expected to increase from 2/5 to 2/3 (WRI)

With the total annual sustainable freshwater supply remaining static at 4,200 billion cubic meters (m3), the annual deficit for 2030 is forecasted to be 2,765 billion m3, or 40% of unconstrained demand, assuming that present trends continue. India and the People's Republic of China (PRC) are forecasted to have a combined shortfall of 1,000 billion m3 reflecting shortfalls of 50% and 25%, respectively (2030 WRG).

Developing countries face bigger challenges

- **Africa**'s electricity generation will be 7 times as high as today by 2050.
- **Asia**'s primary energy production will almost double, and electricity generation will more than triple by 2050.
- In **Latin America**, the amount of electricity generated is expected to increase fivefold in the next 40 years and the amount of water needed will triple. WEO (2010).

Regional differences are important to put the water and energy nexus into a development policy perspective. While access to water and energy is a more pressing priority in the developing world, the developed world is more focused on water and energy sustainability. But both must be concerned with water and energy efficiency.

3.2 Water and Energy: New and bigger challenges ahead

Population growth, economic development

Future challenges depend on current responses. If we do not act now future challenges will be more complex.

Social and economic transformations affect the effort required to meet the development goals in many different ways. Population trends might put more pressure on urban areas and might make it harder to provide access to water and sanitation in urban areas where the population living in slums by 2035 is expected to grow by 40%. The significant advances in rural electrification and access to water and sanitation come with an increase in the costs of covering scattered populations in remote areas.

The Increased Financial Burden of Water and Energy Access

- According to the International Energy Agency (IEA) an extra $49 billion per year will need to be invested to achieve universal energy access by 2030.
- Investment for water infrastructure is even higher: it has been estimated that $103 billion per year is required to finance water, sanitation and wastewater treatment by 2015.

http://www.worldenergyoutlook.org/publications/weo-2013/

Water and energy are also linked by their joint importance for food security. Overcoming poverty in a world where more than 568 million people remain undernourished (2/3 in Asia) might require increasing food production in a sector that already accounts for 70% of water withdrawals. The combined effect of growing populations with changes in lifestyle and diet will result in an estimated increase of 130% on the demand of water for irrigation (OECD).

Reconciling these increases with the resources available represents an outstanding challenge for different reasons. Half of the world's food is grown on groundwater, much of which is unsustainable. As mentioned above the use of water for irrigation must face increased competition with other growing uses such as electricity generation, household consumption and manufacturing. The demands for biofuels for transport might also lead to increased competition with food within the irrigation sector.

Encompassing water and energy policy with human development requires coping with the challenges of securing enough water for energy development and enough energy for water development and this interlinked problem will increase with population, economic growth and climate change.

The Economic Losses from scarce and unreliable water and energy supplies

- Lack of sanitation access can cost countries up to 6% of GDP.
- Unreliable water supply and farm-to-market access can deprive farmers of 2/3rd of their potential income.
- Energy security is threatened by water challenges; 3% of Kenya's GDP from lost hydro production over 1998-2000
- Losses of biodiversity and ecosystem services with increasingly visible economic cost (e.g., China losing 5% GDP to pollution)

Source: The World Bank

A more water constrained world

In many areas of the world the development of the most common forms of energy (electricity from coal/thermal and hydropower) is limited by the availability of water. This is now a well-known reality in important water stressed regions in both poor and transition economies. But the lack of future resources did not prevent the building up of electricity generation facilities that can only currently work below their designed capacity.

Water security for energy security in different regions

- **Expansion plans for coal power plants in China** might not be feasible due to water scarcity issues. 40% of the country's thermal capacity is located in Northern China whereas only 20% of the country renewable freshwater supply is.
- **More than 50% of power plants in India and Southeast Asia** are in areas that will likely face water shortages
- **Nearly 93% of Middle East's onshore oil reserves** are exposed to medium to extremely high water risk
- **Europe's coal and nuclear power generating capacity will decrease by 6% to 19%** between 2031-2060 due to increased water temperature or lack of cooling water.

Source: *http://www.un.org/waterforlifedecade/water_and_energy_2014/index.shtml*

A more water-constrained future will impact reliability and costs in the energy sector. In fact water scarcity is mostly the unanticipated consequence of many endeavours in areas such as agricultural, manufacturing, electricity or land development that are appraised and accepted by using the same critical assumption: that the water available in the future will basically be the same as today. Examples of this water energy coordination failure, both in the developed and under developed world (see box below), serve to make visible the value of preserving water security. Making water security part of energy planning and project appraisal will avoid the water blind energy strategies pursued in the past.

Resilience to extreme events and climate change

Besides scarcity, defined by the unbalance between the water resources used and available on a normal basis, the increase in water use reduces the resilience of energy infrastructures and the overall economy to extreme events such as drought risks. The reduction in river flows and water tables also means there are less alternative sources that can play the role of buffer stocks to cover temporary shortages of water leading to higher damages and foregone benefits of the energy sector and the entire economy.

These risks may be exacerbated by weather uncertainty and climate change. For instance, the dependence of water and thermal technologies accompanied by an unreliable supply of water might increase the impact of heat waves over energy security. Heat waves reduce energy supply by evaporating more water and reducing its cooling potential but at the same time increases electricity demand for air conditioning.

In the same sense prolonged dry seasons and drought increase the demand of water for irrigation and thus the demand of energy for pumping, transport and applying the water to crops but reduces the supply of water for energy, with important consequences over hydropower generation. All these problems as illustrated in the box below might have important effects over the market and the entire economy.

The Energy Industry already faces water related risks

- The Energy Industry already faces water related risks
- In the **U.S.**, several power plants have had to shut down or reduce power generation due to low water flows or high water temperatures.
- In 2003 in **France** an extended heat wave forced EdF to curtail nuclear power output equivalent to the loss of 4-5 reactors, costing an estimated €300 million to import electricity.
- In 2012 a delayed monsoon in **India** raised electricity demand (for pumping groundwater for irrigation) and reduced hydro generation, contributing to blackouts lasting two days and affecting over 600 million people.
- The 2011 drought in **China** limited hydro generation along the Yangtze river, contributing to higher coal demand (and prices) and forcing some provinces to implement strict energy efficiency measures and electricity rationing.
- Exposure to recurring and prolonged droughts are threatening hydropower capacity in many countries, such as Sri Lanka, China and Brazil.

Source OECD (2012).

Water and energy are linked in many ways with climate change. Changes in the water cycle are one of the main ways in which the impacts of climate change will be felt – this includes increasing variability, increasing extremes (droughts, floods) and higher ambient temperatures (including warmer water temperatures). All this, as mentioned above, can only increase the exposure of energy supplies to water related risks.

On the other hand water and energy are also critical for meeting climate goals. This requires the design and effective implementation of policies to build up robust water and energy systems able to adapt to uncertain temperatures and be resilient to weather extremes. Different strategies can be designed to contribute to climate change adaptation.

Enhancing the energy efficiency of all the water related activities (including water withdrawals, treatment, transport, distribution, use and disposal) and the water efficiency of the energy industry (from fuel production to electricity generation and heat dissipation) are obvious means to reduce the mutual exposure of the two sectors. The higher the efficiency of the energy conversion the lower the residual heat and then the demand for water for cooling. Restoring rivers and reversing the degradation trends of aquifers and other water related ecosystems is also a means to enhance adaptability to climate change by improving the ability to cope with water extremes by, for example, making buffer stocks to smooth water supplies in dry periods or by containing flood peaks by improved natural water retention capacities in restored floodplains and soils. Water and energy also play an important role in climate mitigation. Carbon capture and storage requires water and energy. Renewable water sources might have a bigger potential to contribute to both water savings and climate change mitigation (such as wind, solar and geothermal energy), or might compete for limited water resources (such as irrigated crops for the production of biofuels). Non-conventional water resources with the potential to substitute freshwater might add to the demand for water and have negative consequences over climate change mitigation (such as energy intensive water desalination of sea or brackish sources).

4. The Water and Energy Nexus: Opportunities & Choices

The analysis of experiences by UNIDO, UNEP, Aquafed, ICLEI, UNU, the WWAP and WB ahead shows that there are different opportunities and choices to improve access, efficiency and sustainability of water and energy. We need to understand the trade-offs and synergies for different partners involved in finding an integrated response to water and energy challenges.

Although complex choices are involved and a closer coordination of targets and policies is required, a sustainable water and energy future is feasible within the current technological possibilities.

4.1 Feasible but Complex Choices

Existing technology

A sustainable future is possible. Many different opportunities do exist in coping with water and energy challenges. As a first approximation these opportunities can be found within the wide range of technologies available in the water and energy industry that have the potential to reduce the requirement of both resources and open the option to enhance human welfare. Such opportunities do exist when it is feasible to use less energy to produce the same water services and or less water to deliver the same energy. When this happens there is the option to reconcile the different objectives of sustainable development, opening a window of opportunity to reduce the impact of current production over the environment or to make possible further advances in the economy without additional environmental damage.

The prospective analysis, as the "New Policies" scenario developed by the International Energy Agency (OECD/IEA, 2012), for the period 2010-2035, makes evident that advances in energy supply can be decoupled from water use. Some examples include, the substitution of subcritical power plants [2] particularly the coal fired ones in the developed world, the progressive use of more efficient power generation plants[2], the on-going shift towards more water efficient cooling systems and the expansion of renewable sources. The combined effect of these trends in the baseline scenario might result in a reduction of 23% in the water withdrawn by unit of electricity produced between 2010 and 2035 and a "New Policies" scenario could be developed to extend this reduction to 33% (OECD/IEA, 2012).

Positive changes in the energy industry are already on track but still not in the scale required for a sustainable water and energy future. A more water efficient energy industry does not necessarily mean a more sustainable economy. As the "New Policies" scenario demonstrates, the reductions in water requirements per unit of energy will be compensated by the rapid increase in the scale of the energy sector. When the two effects are taken into account, the more efficient but bigger economy, might increase the energy produced by 80% with a less than proportional but still adequate increase in the water withdrawn of 20% (OECD/IEA, 2012).

No silver bullet, nor one size fits all solutions

Although technological opportunities are available worldwide the ability to take advantage of them and their purpose might differ substantially among regions and countries. With lower pressure to

2 Subcritical power plants work with relatively low steam pressures and attain energy efficiencies (rates of transformation of heat into electricity) between 33% and 37%. More modern supercritical and ultra-supercritical power plants are able to operate at higher steam pressures and to attain higher energy conversion rates.

increase energy supplies for domestic use advancing economies have the option to decouple water and energy use from economic growth, and continue on-going actions to reduce the amount of water used in the energy sector (which can be feasibly attained only with the substitution of obsolete coal-fired plants and more efficient cooling systems). On the other hand, in spite of further advances in water efficiency, transition economies will still expand the use of nuclear and fossil fuel technologies with once-through cooling systems in order to cope with rapidly increasing energy demands. This explains why, besides further advances in renewable energy, as much as 70% of the additional electricity demand will be covered with traditional energy sources (for instance, the water withdrawals for nuclear generation is expected to grow by a third in the period 2010-2035).

A sustainable future is then possible but there are not silver bullets or one size fits all solutions. Besides the technical opportunity to produce more with less, both in the water and energy sector, many other trade-offs need to be considered:

- Although some alternatives allow for simultaneous savings in water and energy many other might require balancing trade-offs between the two resources.
- More efficient water and energy systems are in general more complex to operate and imply additional financial costs.
- Savings in the production stage are not necessarily the equivalent to lower pressures over nature and some technical alternatives might imply positive and negative changes in the use of water and energy along the whole product cycle with ambiguous effects over the environment.

The following sections explore both the opportunities available and the above trade-offs that need to be considered to make them work in the decision making process for the benefit of a sustainable water and energy future.

4.2 The Water-Energy Nexus: Opportunities

Technology mix

Success in managing the water and energy nexus for the purpose of sustainability depends heavily on technology choices. The overall effect of the energy industry over freshwater resources is a direct function of the mix of fuels used, the balance between renewable and non-renewable energy sources and the water efficiency of the whole energy cycle from the production of the raw materials, to the final use of the energy produced.

Discussions around the technical opportunities available tend to focus on those critical areas where crossed impacts between water and energy are more important and where room for improvement is higher. These areas include

- the mix of water and energy sources, the electricity generation process, where most of the water used in the energy sector is required,
- the water efficiency of the energy transformation process,
- the energy efficiency of the production of water services,
- and the efficiency with which water and energy are used in the different sectors of the economy.

In all these areas there are important opportunities available to produce more and better quality with less. Besides current alternatives, research and innovation is a key element to widen the options available for a sustainable water and energy future.

The opportunities

1. The first set of opportunities consists in shifting towards **less water intensive energy systems.**

The energy industry has a wide array of technological options available. As scarcity increased, research and innovation as well as existing incentives have served to expand the number of sources that can be mobilized for the production of energy services. Existing incentives have served to add new and relatively more abundant energy sources that might replace the traditional and exhaustible ones as they are depleted or become scarcer as compared with existing demands.

There are important differences in the water required for primary energy production depending on the resource used. The water withdrawn and consumed may vary in terms of magnitude from some hundreds of cubic meters per ton of equivalent oil (for conventional gas), to thousands (for coal and conventional refined oil), and even to millions (for soya, corn and sugarcane based biofuels).

2. Another important window of opportunity consists in **choosing from different production processes for energy** within a given resource base. Even with renewable sources there is a wide set of technical options available to convert it into energy. For instance, solar power, depending on its type, can use little water (solar photovoltaic) or more than five times more water per unit energy (concentrated solar power) than a gas-fired thermal power plant or two times more than a coal-fired plant. Wind power uses a negligible amount of water.

3. **Location decisions** might also play a key role in the building up of a water sustainable energy future. For some technologies water requirements can depend heavily on local conditions. This is the case of geothermal energy, although having been reported to use and consume less water than other electricity generating technologies, under ideal conditions, may even require more water per unit of energy than natural gas or coal based systems (IEA, 2012).

4. In a similar sense , although variable in function of local conditions and the state of water sources, the energy requirements of obtaining water from different sources might differ from minimum to high amounts of energy from surface water to recycled waste water or desalinated sea and brackish water. The more effective the energy generation process the less the residual heat and the need of water for cooling purposes.

5. The production of **water services can also be more or less energy intensive.** For example waste water treatment can use little energy, when the self-depuration capacities of well-preserved soils or streams are used, or be energy intensive, when advanced membrane technologies are used, with a wide range of more conventional technologies in between. In the same sense managing flood risks can be done by using green infrastructures or restoring the river flood plains or building dams to retain flood peaks, with different impacts over energy demand and the environment.

Closer inspection of the Power transformation processes

A closer inspection of available technologies makes clear that water sustainable energy future is feasible. Particular attention must be given to the power transformation process in the water intensive alternatives that play the leading role providing electricity (as much as 80% of current supply) as well as still using the bulk of 15% of the world water withdrawn that is used by the energy sector.

Water saving opportunities in these thermal power plants are closely linked with the efficiency of the energy transformation process. Most water withdrawals are used for cooling (between 85 and 95% of the overall water withdrawn), that is to say the residual heat generated along with the electricity produced. Enhancing the efficiency of the electricity generation process means a simultaneous gain in the energy produced and reduction in the water required. In fact the main explanation of the water used is the heat rate (heat per unit of electricity), and this rate is in general lower for combined cycles of gas turbine (CCGT) than for other fossil fuel based technologies.

Besides reducing the residual heat, and increasing both the energy and the water available, another important opportunity consists of choosing the appropriate technology to reduce the water for cooling. Significant savings can be obtained by shifting from once through cooling, that return the water to its source, to cooling pond systems that reuse the water, and further gains can be obtained with using cooling towers to optimize the cooling process. For a given power technology, for instance the above mentioned Combined Cycle Gas Turbine, The water withdrawn can be reduced from a hundred cubic meters per Megawatt, with traditional once through cooling, to only ten litres with a dry cooling system.

Managing the transition

The development of alternative resources as well as the implementation of water efficient power generation technologies is a suitable option for developed countries that are not only better prepared to foster a rapid diffusion of innovations but have mostly exhausted their possibilities to develop freshwater resources to increase the supply of both water and energy. On the other hand the transition towards a water and energy efficient future will coincide with a relative growth in water and energy demands and with the real possibility of decoupling economic growth from increased water and energy demand and supply. The scale of the challenge is larger in transition developing countries where 90% of the expected increase in energy demand in 2010-2035 is expected. Though called to make a contribution, at least in the transitional period, the extensive use of pioneering technologies or the development of renewable energy sources is not expected to play the determinant role in the medium term. Nevertheless opportunities do exist in a conscious development of traditional energy sources. For instance, more than 75% of the hydropower opportunities in South America, Asia and Africa are still untapped in the transition.

Untapped potential

Further opportunities do exist to co-produce energy and water services and to exploit synergies. Some alternatives, such as low-flow fixtures, water and energy efficient, solar water heating will save water and energy at its final use so that benefits can be obtained by including all the water and energy saved along the entire production cycle.

Still many updated opportunities in fast growing water and energy demand countries

Hydropower Underdeveloped Potential

Africa	92%
Asia	80%
Australia / Oceania	80%
Latin America	74%

Source: OECD

In summary

Policies and integrated plans that encourage energy and water conservation can reduce future energy and water requirements. Besides changes in the mix of water and energy sources, it is important to consider the selection of water and energy technologies, the optimal location of water and energy investments and the extended use of water and energy efficient equipment and devices. Integrated approaches can take advantage of the following non-comprehensive list of well documented opportunities:

- Technological solutions that offer combined energy and water services, optimized to operate all local scales particularly to the poorest segments of the society.
- Putting effluents into value for the energy sector. Energy recovery from wastewater by, for instance, generating energy from sludge produced at the plant, saving costs in electricity production and in waste water treatment at the same time with important co-benefits such as the reduction of the health risks of uncontrolled water disposal and the option to produce organic fertilizers to replace the use of water and energy intensive ones produced by the agrochemical industry.
- Converting residuals from the energy into inputs for the water industry. Heat recycling from power plants by, for instance, integrating residual heat as an input in the water treatment process so that the volume of water required for cooling is decreased avoiding costs in the energy production reducing the need of water infrastructures and reducing waste water disposal costs.
- Recycling wastewater from a nearby wastewater treatment plant is a means to saving energy production costs, reduce water delivery costs and enhance water security of thermal power plants in water stressed areas.
- Integrated energy and desalination (treatment, recycling, etc.). Integrated water and energy production has several benefits.
- Cogeneration, the simultaneous production of power and useful heat, as a means to avoiding cooling costs as well as the costs implied in the separate production of electricity (by power plants) and heat (by energy intensive heating systems).
- Replacement of freshwater by alternative water sources for thermal power production. The quality of the water required for cooling nuclear and other thermal power generation plants allows wide use of alternative sources such as sea, brackish and waste water that might not compete with other uses that depend on freshwater supply.

4.3 Trade-offs and complex solutions

The inventory of well proven opportunities and potential synergies to manage the water and energy nexus must not hide the complexities of decision making and in particular the important trade-offs that need to be considered as well as the social challenges to overcome and the risks that must be avoided to pave the way towards a sustainable water and energy future. This section pays special attention to the trade-offs while the challenges and risks are developed in the following chapter.

So far all these opportunities have only been considered for their potential contribution to reducing the pressure over both water and energy sources by taking advantage of the multiple interdependencies and synergies between both resources. Trade-offs appear when different objectives enter into the picture and, in particular, when advances in one target imply a opportunity cost to the other.

More complex solutions

Some trade-offs might appear as unavoidable. For instance, an integrated system to produce energy and water is more complex to manage and operate. As water and energy become scarcer there is the need to take into account an increasing number of interactions and this is true at the local scale of a production plant, where different processes would need to be coordinated and at a policy level where water and energy need to be managed in a coordinated way so as to accommodate all the existing demands of both resources in all the areas of the economy within the capacity of existing water and energy resources.

Not easily adaptable/flexible

Complex energy mixes represent both an opportunity and a management challenge. Renewable and water efficient energy sources, such as wind and power, are also intermittent and then non-easily adaptable to the size of variable water demand but, on the opposite extreme, high scale non-renewable and water intensive thermal power sources are better and less costly to operate, producing a constant flow of energy that isn't adaptable to changes in water demand throughout the day. Flexible sources of energy, such as hydropower and to a lesser extent small scale combined gas plants, play an important role as they allow matching water supply and consumption as well as the smooth operation of the adaptation to the uncertain supply of non-renewable sources.

Additional financial costs

Water efficient technologies come with additional financial costs and often with reduced production levels. This is the main reason that, in spite of their advantages in terms of resource efficiency, they don't come with the incentives that might make them attractive from a pure business perspective.

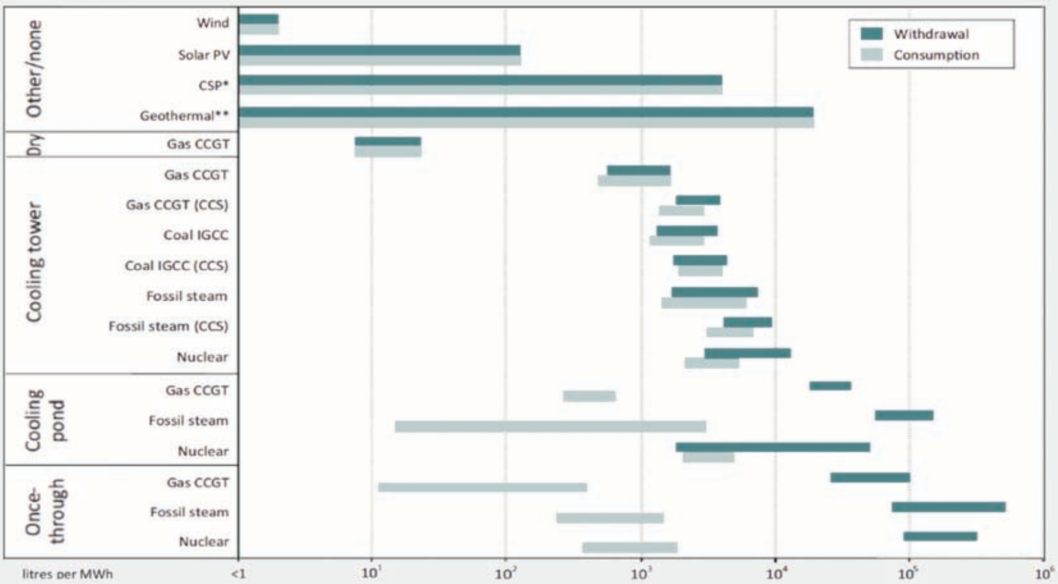
Requirements for additional infrastructure

The reuse of water for cooling requires additional infrastructure, such as ponds and cooling towers and additional costs to control corrosion and other associated management complexities. Water efficient irrigation systems require additional energy, operation and maintenance costs.

Reduced efficiency

Trade-offs between resource efficiency and productivity are also to be considered. Water efficient cooling systems reduce the efficiency of the energy transformation system in the same way that the use of gravity instead of pumping to apply water to crops increases the water required and reduces yields per drop.

Water use and water consumption don't go together: Lower water use in electricity production is not the equivalent of less water depletion.



Source: Water use for electricity generation by cooling technology (IEA, 2012)

Trade-offs along the product cycle

Many alternatives imply complex trade-offs between the use of water and energy at different stages along the product cycle. For instance hydraulic fracturing is an effective and competitive means to increasing the relative weight of the more water efficient gas combined cycle technology in the overall electricity portfolio. However, fracking requires large amounts of water and also generates waste water that needs to be treated. Depending on local conditions, the water gains thus obtained in electricity generation might come at the expense of increased water use in the extraction of fuel.

On a broader scale, decisions made for energy production can have significant, multifaceted, and broad-reaching impacts on each other with a mix of both positive and negative repercussions.

Trade-offs according to different objectives

Trade-offs between coping with alternative sustainability challenges may also be relevant in many areas. Bio-fuels for transport might be an effective means to sequester GHGs, but irrigated biofuels may add to water scarcity and water demand conflicts by competing for water and land with food production. Geothermal energy, for instance, produces minimal or near-zero greenhouse gas (GHG) emissions, but its impact over water resources can be significant. Under its current stage of development it is not yet a cost- competitive technology though its availability is infinite in human time scales.

Assessing tradeoffs, environmental and social impacts and exploring the use of multipurpose dams is necessary for sustainable development.

- Dry cooling systems require no water for their operation, but decrease efficiency of the plant, Increasing capital and operational costs, increasing GHG emissions per kwh.
- Trade-offs between water withdrawn and water use are particularly relevant in the discussions about water and energy efficiency. Traditional once through cooling systems imply the diversion of important amounts of water, with detrimental effects over water ecosystems, but most of the water withdrawn returns to the system and is available for additional uses downstream. Cooling towers don't require taking the same amount from water sources downstream but consume more water and then reduce the water available downstream. The shift from once through to cooling towers in the nuclear and the fossil steam technologies might be a classical example of a water saving change that reduces water withdrawals per unit of energy produced but increases the water consumed (and depleted) (See IEA/OECD, 2012).
- Trade-offs between water withdrawn and water depleted explain why in the baseline and the "new policies" scenarios the intensity of global withdrawals and consumption for energy production – that is, water withdrawals and consumption per unit of energy produced – head in opposite directions during the Outlook period (OECD)
- Similar trade-offs between water diversions and water depletion might appear when the efficiency of water distribution, an application system, is enhanced, for instance, when agricultural systems shift from gravity to drip irrigation. This may lead to lower returns, due to high evapotranspiration rates and might have negative effects on water availability downstream. The relevance of these complex trade-offs between water withdrawn, used and depleted depends on many different factors such as water abundance and scarcity and location.

5. Making the Case for Partnerships

The previous chapters presented the discussions and results of the Conference regarding two important issues: the challenges involved in the water and energy nexus (Chapter 3) and the opportunities available to meet these challenges (Chapter 4).

These two chapters paved the way to the central question of how to make it happen. It is actually in this context that the importance of partnerships can be fully appreciated. The shift towards a sustainable water and energy future is not spontaneous. The transition towards a green water and energy future must be the result of a deliberate social effort. It means building the social and institutional pre-conditions required to take advantage of the existing opportunities and also implies making difficult choices, building new assessment frameworks, developing new institutions and technologies and all the changes required to readdress the way water and energy have been managed in the past.

This chapter collates the responses from the Conference participants to the following central question: Why might partnerships offer better social responses to the water and energy nexus? The basic hypothesis resulting from the discussions held in Zaragoza is that partnerships are innovative institutional arrangements that are better suited than traditional institutional setups to take advantage of the existing opportunities and provide superior responses to the water energy nexus challenges.

5.1 Why Partnerships?

The logic behind the critical need to build effective partnerships can be deduced from the multiple interlinks and the need for integrated solutions in the Water and Energy nexus. Coping with the challenges posed by water and energy in the long term is possible within the range of the resources available as well as the existing knowledge and best technologies available. But this would not happen as a result of the spontaneous action or individual decisions made by any water and energy firm or user in isolation, without considering the actions taken by all the others.

Beyond competition and individual decisions

While useful to foster innovation and the efficiency in the use of water and energy, competition and individual decisions on their own have a very limited capacity to solve some of the collective challenges involved in the search of a sustainable future for water and energy. In fact, the uncoordinated decisions of a competitive market might be one of the driving factors of water and energy scarcity.

The energy-water challenges are too great for any agency or organization to tackle on their own. These challenges are out of the scope of any public or private organization.

In the market economy the perception of individual firms is limited and this might lead to wrong decisions in the short term and to unsustainable decisions in the middle and long term. Firms are increasingly aware of the importance of taking into account the prices and the effective availability of water and energy in the future as a critical element to assess the costs and the benefits of new project investments. But, due to information gaps and the complex nature of long term investment decisions, decisions continue to be taken with limited information.

Considering scarcities today and in the future

Many water and energy development projects are for example appraised and approved by assuming that future water resources will be similar to present and past water resources and that energy prices will not substantially change in the near or distant future. Assessing the costs and the benefits of new investment projects in the water and energy industry require consideration of the future availability of both resources as well as the very short term.

When, for example, water and energy scarcities are underestimated, business decisions tend to ignore the risks ahead. As usual, when future scarcities are overestimated, the market economy can lead to an excessive investment in many water dependent activities, such as irrigation, hydropower and urban development. This might lead to an overall demand of water that would not be possible to satisfy, at least not all the time, with the limited resources available. The only way to avoid excessive investment in water development is by coordinating the investments into a sustainable level of water use.

Once water became a priority it allowed focusing on the critical questions in the power generation process, the ones with higher potential to save water resources, and focus on both the efficiency of the energy transformation process, in order to reduce the residual risk, and in the cooling processes, by the search for more water effective alternatives. Since the development of dry cooling technologies, almost water free thermal power plants became feasible and competitive within some still restrictive but increasing market conditions. In the same sense, important advances have been registered in the quest for alternative sources, such as waste, brackish and sea water, and the recirculation and recycling of water.

All these technologies seem to have broken up in the energy industry and have paved the way for a robust water independent energy future. However, technological transitions in these areas proceed smoothly and, except in the more advanced countries, even in the more optimistic scenario traditional technologies will provide the bulk of the new energy flows required during the next decades. Partnerships may also serve to promote aligning the existing incentives so as to speed up the diffusion of water efficient technologies in the industry and anticipate the replacement of the traditional plans already in operation.

A brief balance of the innovative advances registered so far in power generation is the outstanding potential that is now available to handle the implications for water in terms of the growing demand for energy at a global scale. The water efficiency gap between traditional and water efficient power generation technologies is wide enough to make room for a water free energy sector and thus to relax the challenge of building a water sustainable future. If sustainable development is an option that fits within the resources and technologies available, the discussion about making it happen shifts from technology to governance.

Investments may halt

But in the same way that market incentives can lead to investment bubbles, they can also produce the opposite effect. This can happen when water becomes scarce. If firms perceive that future water supplies are uncertain this would affect their willingness to invest in new energy development projects and, as this perception is shared by any individual firm, this might lead investments in energy to a sudden halt with the derived problems to the rest of the economy in the medium term.

Businesses need governments

Despite the remarkable advantages of markets and competition to trigger innovations and promote useful investments and resource efficiency, making business and markets work for the benefits of sustainable development requires a certain level of coordination. As a minimum necessary requirement this coordination must guarantee that all the energy and water used in the economy fits in the range of the obtainable supplies of these resources, produced and used in a way that doesn't compromise the continuous provision of the two valuable resources.

The government is needed to create the right environment and ensure regulation and compliance as well as providing incentives. The main conclusion is that managing all the interdependencies involved in the Nexus requires a sort of coordination that cannot be guaranteed only by the market environment.

While individual businesses are in general willing to internalize water concerns in their decisions on long term investments and risk management, this is not necessarily true for the production of fuels. This issue becomes critical with emerging fuels that might be intensive in the use of water resources such as natural gas obtained by fracking and biofuels. In the first case the protection of water property rights becomes a critical condition to avoid the further depletion of already water stressed areas and to control the incentives to take advantage of irrigation systems. Technology options allow for freshwater independent fracking methods and rain-fed growing of biofuels but this will only become the selected option if, firstly, water use rights are properly controlled, and, secondly, the incentives in place favour the water efficient alternatives.

Governments need businesses

But successful public actions are inconceivable without the active involvement of businesses and other private partners. By pursuing collective interest governments and public agencies are in a better position than business and households to understand water and energy challenges from a wider environmental, social and economic perspective. However, for various reasons they are not able to cope with these challenges on their own.

Governments have at their disposal the means to develop and maintain a level playing field but the important decisions on how, by how much and for whom to produce the water and energy services mostly belong to individuals rather than governments. The government can do its best to promote innovation and to speed the diffusion of the best technology available, but in the end these processes are triggered by decisions made by individual firms. Governments may raise awareness, standardize norms and develop incentives to promote an efficient and sustainable use of water and energy, but the final outcome will be the effect of a plethora of individual decisions taken by many individuals that use water and energy for consumption or for producing goods and services. For all these reasons successful governments need business and technology partners as well as the active involvement of firms and households.

Reducing enforcement and implementation costs

Legitimacy and social acceptability is an essential ingredient to water and energy policies. It reduces enforcement and other implementation costs and makes the empowerment of business and households easier. Cooperation is important to agree on a shared vision of the challenges ahead and to design policies that will ensure continuous advances in the objectives of water and energy efficiency, accessibility and sustainability.

Foster interdisciplinary knowledge development and exchange

As far as integrated responses are required, partnerships might serve to foster interdisciplinary collaboration between the energy and water sectors and to provide the playground for the knowledge exchange necessary to develop and implement integrated management responses (see box below).

The energy sector faces several water–related risks that can only be tackled within a better integrated water and energy policy framework

- Increased water temperatures can prevent power plants from cooling properly, causing them to shut down or decrease production, incurring financial and economic losses.
- Decreased water availability can affect thermal power plants, hydropower, and fuel extraction processes due to their large water requirements.
- Regulatory uncertainty including restricted operational water permits, rising discharge compliance costs and withdrawal limits.
- Sea level rise could impact coastal energy infrastructure and power plant operations.
- Water quality can impact energy operations if it is not regulated and managed adequately.

Partnerships can help

Partnerships are a means to many different ends. Among other valuable intermediate objectives they might allow for:

- Integrating policies, broadening the scope and enhancing the effectiveness of both water and energy planning.
- Improved water and energy governance by helping to provide better regulations and enabling institutional frameworks.
- Developing transparent assessment criteria to evaluate the outcomes of both water and energy policies in terms of sustainability rather than by the particular objectives of each area.
- Broadening the water and energy policy assessment so as to make them consistent with the need to protect and preserve the water and energy related ecosystems and the variety of services provided by them which are critical for resilience and long-term environmental sustainability.
- Learning from each other's successes and failures within the water and energy communities.
- Identifying opportunities to improve water and energy access, efficiency and sustainability.
- Identifying and implementing mutually beneficial solutions that are more sustainable.

5.2 Challenges for partnerships

In spite of the important gains that can be reaped from a better integrated water and energy response, building enabling and effective partnerships is a challenge on its own.

Overcoming Institutional lock-ins and path dependence

Existing institutions and legal frameworks are established to implement specific actions/solutions. 'Institutional lock-in' may be preventing the necessary change to move towards integration. This can be the result of many factors including tradition, vested interest, poor regulations and many others that can trap businesses and societies into well established, and difficult to change decision frameworks.

The Water-Energy Nexus: the special role of business

The world's water and energy systems are linked in many ways; both sectors are not only mutually connected by the water needs of the energy production and the energy requirements of the water industry.

Both areas are also linked by their cross vulnerability. A small, unreliable supply of energy limits the amount of water resources that can be mobilized to serve human needs or the production of goods and services; on the other hand, water related risks are already an important concern in the production of energy in many parts of the world. Tradition and institutional inertia might still favour handling these two problems separately, but as recent experiences show business concerns might be a powerful force to break institutional silos, open fresh communication channels and push the need to provide an integrated response up in the political system.

The World Bank: *http://goo.gl/5Rp1nx*

Although the link between water and energy is evident, these domains have historically been regulated and managed separately. The mutual ignorance is still embedded in the way water and energy decisions are taken at different levels from the top government to individual businesses and, instead of contributing to match demands and supplies in the future they might aggravate water and energy scarcity.

Current energy planning is often made in a myopic way without considering changes in water availability and quality. In a baseline scenario characterized by trends towards increased water and energy scarcity this is the equivalent to ignoring competing uses and the impacts associated with climate change, among many other determinant factors of future water and energy supplies.

The Energy Sustainability Challenge (ESC): A BP Initiative

The ESC is a BP-funded consortium of experts from leading universities that studies the complex relationships between natural resources and the supply and use of energy. This multi-disciplinary programme investigates the effects of scarcity in natural resources, such as land, water and minerals, on energy supply and consumption. It also examines how technology can improve energy production in a resource-constrained world. *http://goo.gl/fL1MvN*

More information: *http://www.bp.com/en/global/corporate/sustainability.html*

The lack of foresight that characterizes separate water and energy planning tends to be reproduced and reinforced by local authorities and businesses who appraise long term investment projects by using practical but essentially wrong ceteris paribus assumptions. It is not uncommon to find power generation projects that take for granted future water supplies or, alternatively, water development projects that assume future unlimited access to energy at prices similar to those of the present.

Building partnerships might be an integral part of the institutional transformations required to break existing institutional lock-ins. In other words, a comprehensive response to the water and energy challenges implies overcoming the current institutional set-up where both policies have been traditionally taken.

Overcoming technological lock-ins

The energy options and the water options being considered need to be adapted to changing conditions of water scarcity and energy options. However, investment decisions being made today or in the past years may be locking us into water intensive energy options and vice versa.

In fact past responses to cope with water and energy demands that have traditionally consisted of using non renewable energy sources and the building up of infrastructures, which were able to take advantage of the economies of scale and provide the supplies of water and energy required by a growing economy, may be limiting what we can do and what we cannot do now and in many years to come, as these investments need to be amortized. With limited water resources some energy sources may not be viable but we may be continuing to invest in them (e.g. coal).

A transition needs to be made from non-renewable to renewable options, from increasing supply to a wise management of the resources available and from infrastructure development to a more balanced mix of solutions.

It is important to overcome the technological lock-ins because once the opportunities available to develop water infrastructures have been developed and conventional energy resources have been depleted, the only alternatives to reconcile water demand and supply with the objectives of a sustainable economy consists of managing water and energy demand, enhancing the efficiency with which both resources produce, use and develop new renewable and non-conventional sources. The lessons from the past become obsolete or unfeasible and innovation ceases to be optional.

Reshaping the role of financial and economic incentives.

The way water and energy are financed is an important part of current and future institutional set ups. Traditionally the bulk of water and energy infrastructures have been provided by the public sector and the costs have only partially transferred to the multiple beneficiaries. Abundant and cheap water and energy, when available, have always been considered a priority for economic development. Water planning for example has traditionally been given a subsidiary role behind other apparently more relevant objectives for instance from agricultural, industrial or land development.

Although water and energy prices and other incentives have been part of the policy debate, the ability of prices to reflect the financial, environmental and economic cost has rarely ranked high in government priorities. Low water and energy prices can preclude many investment decisions from water and energy. Though water users may pay market competitive prices for energy supplies, energy producers have little or no incentive to conserve water due to low prices. In other cases, energy development, in particular in rural areas where access to freshwater is not adequately controlled, might have been one important factor behind water over-exploitation. One of the most important challenges in responding to the water and energy challenge consists of changing current water and energy incentives such as realigning those individual decisions to the collective targets of sustainability.

New innovative options require mobilizing huge amounts of capital that are out of the scope of any single business and the long periods of time for which most water and energy infrastructures make them unfeasible in the absence of water and energy security. The size of future investment required for both domains cannot be filled solely from public finance. Investment strategies may require convincing private investors and venture capitalists that the water-energy sector is a viable proposition for return on investment.

The setting up of long term water and energy policy objectives

The importance of preserving the future options needs to be given at least the same importance as the satisfaction of current demands. Water and energy strategies need to be simultaneously rewired for the long term. Though important in the short term current deficits and unsatisfied demands of water and energy cannot shade or relegate long term priorities and in particular the objective to rely in a sustainable mix of both water and energy resources as a condition for building a sustainable future. The traditional options to put more and more water and energy into use are as exhaustible as the water and energy sources themselves.

Dealing with asymmetries: building fair and reciprocal alliances.

Differences between the water and energy businesses and communities need to be recognized in order to understand the importance of building up an open dialogue, enabling trustful relations and enabling mutually beneficial agreements.

The energy sector is a well-integrated market with global dimensions and competitive prices. With the global energy market estimated at 6 trillion US dollars annually, the energy sector is synonymous with 'big business'. In clear contrast water is a constellation of small markets only relevant at local or regional scale, whose prices are rarely defined by competition rather than set by the administration. The energy sector is well funded, highly organized, and greatly attracts more political attention than water in most countries.

The reciprocal interest in building close collaboration links also depends on the outstanding differences between the two sectors. For example, energy is essential for the production of water services (such as water treatment, pumping, delivery and waste water treatment and disposal). Water is needed to produce hydropower, to transfer water (from steam), as a pollution remover (for heat dissipation), as a means to store energy, as enhancer of fuel mining (in fracking), etc. This way water availability and water becomes a critical location criterion for an energy development project, while energy is not in general a factor that might constrain the location of water development. These differences might shape the mutual interest.

Prices in the more competitive energy markets might fluctuate and reflect better current energy scarcities and might act as a better incentive for energy efficiency than water prices do for water efficiency. In the same way the innovations and development as well as the diffusion of new technologies seem to proceed at a higher speed in the energy sector than the water sector.

5.3 Policy and Governance: what can governments do to create an enabling environment for partnerships and improve cooperation?

Making visible the risks of uncoordinated action

Enabling partnerships require deliberate actions to show the risks involved in pursuing uncoordinated water and energy strategy, on one side, and the benefits of coordinated actions on the other.

Coordination through partnerships is an instrument to restore the coherence between water and energy policies so as to avoid unsustainable trends. Incoherent policies might find themselves with severe scarcity of one resource or the other–or both. Options to increase water security are often energy-intensive. They include vastly increased energy requirements of water supply augmentation strategies–such as long haul transfers and desalination. In addition, water efficiency improvements are in some cases made at the expense of energy efficiency. For example, efforts to reduce water consumption at power plants are accompanied by the tradeoff of increased costs and lower power efficiency, also resulting in higher GHG emissions.

Capacity Development in Sustainable Water Management: CAP-Net

- Cap-Net, a UNEP initiative is an international network for capacity building in sustainable water management. It is made up of a partnership of autonomous international, regional and national institutions and networks committed to capacity building in the water sector.
- Networks have proven to be effective at promoting the understanding of integrated water resources management and play a key role in supporting the development of IWRM and the achievement of the MDG's.

More information: *http://www.cap-net.org/content/introduction-cap-net/*

By showing the importance of water to meet future energy demands and the importance of energy to meet future water demands and for meeting climate goals, governments raise awareness but also make the gains of further collaboration visible to all its potential partners.

Encouraging firms and stakeholders to take a long term view and recognize vested interests

Partnerships need a better definition of public and private roles. Public authorities must be more focused on the ends. The government role can be better defined by its focus on long term objectives of sustainable development, such as the building up of water and energy security, resilience and adaptability, the curbing of degradation processes, the control of water sources and the definition and enforcement of property rights, among others.

Governments maybe focused in finding and promoting the partnerships with the best potential to contribute to long term water and energy goals. Partnerships represent a unique opportunity to recognize the vested interest of the parts involved, such as the interest of the energy industry in a better guaranteed supply of water in the future, but also to empower all business and other stakeholders with the common objectives of sustainable development.

Greenpeace initiatives to push the Water Energy Nexus up in the political agenda promote social dialogue, share information and transparency

In **India**, the national debate on water scarcity for large scale expansions of coal has not really caught the attention of policy makers until Greenpeace commissioned a study in 2011. The study conducted by IIT Delhi analysed the present and future water demands over the rivers Wardha and Wainganga in Vidarbha, including the 1700 Million cubic metres of water per year required for the coal based thermal power plants proposed in the region. This has helped focus the debate on the long term policy options as well as on the on the efficiency of water use by all sectors. *http://goo.gl/JGVw2H*

The in depth research into the energy-water nexus promoted by Greenpeace in **South Africa**, served to articulate the discussion around water and energy choices. It has served to increase concerns about the likely impact of new coal-fired power stations on a future water crisis. Information is being collected to document both health damages and the impact of coal over the availability and quality of water in coastal areas. Studies have conceited the interest of potential investors and served to assess the business risks involved. *http://goo.gl/dMH0SC*

More information: *http://www.greenpeace.org/*

Partnerships are then an important element to improve water and energy governance. On one side individual business, local authorities and other stakeholders are forced to show that they are not pursuing their vested interests at the expense of the general one, and that all partners involved are pursuing a common interest, on the other.

The Water for Energy Framework (W4EF) Initiative: An Action Group within the EU EIP-Water

Under the umbrella of the European Innovation Partnership for Water, Electricité de France (EDF) leads the Action Group W4EF. This group is an alliance between various international stakeholders to help develop a comprehensive evaluation framework (W4EF) which can provide common and coherent definitions and indicators to assess the energy production's impact on water. The Action Group will implement the methodology in a coherent way and ensure large dissemination across the European energy industry, potentially on an even larger scale. *http://goo.gl/RGGr7U*

More information: *http://www.eip-water.eu/working-groups/action-groups*

In this way, through linking diverse individual interests, partnerships allow for building broad alliances around long term vision and objectives. Governments, firms and stakeholders must be encouraged to take a longer-term view, to invest in water conservation, and investments in new energy sources assuming higher costs in the short term in exchange for long-term benefits. Public awareness creation, public participation and education is essential to foster collective actions as well as to make individual decisions on the use of water as an energy compatible resource with sustainable supplies.

Promoting better governance: transparency, trust and accountability

The transitional process might contribute towards better governance through improved transparency, as a requirement of mutual trust, and accountability. Partnerships might become active social agents that could control and avoid poor governance, corruption and short sighted decisions that result in missing opportunities. A first step in improving governance consists of development outcome oriented and performance indicators promoted both by local and international institutions.

Improving regulatory bodies

Among the conditions that enable the formation of effective partnerships a special mention is reserved for the need of improved regulatory bodies. Besides its importance to control firms' behavior, regulation must be flexible to make room for innovation, cost effectiveness and other contributions from water and energy firms. A strong regulatory body would be capable of tapping the leaks and discovering room for improvement in the water and energy management systems through benchmarking and setting standards. Improvements in participation of interested parties on water and energy in the development of policy and laws related to energy and water use so that they are more flexible and adaptable to be able to respond to and/or mitigate extreme events and environmental impacts.

Regulations can trigger important advances in water and energy efficiency

- Labeling obligations on water efficient appliances might simultaneously increase water and energy efficiency, as in **Singapore**.
- Compulsory building regulations might lead to energy and water efficient constructions. For example: mandatory solar hot water systems on new buildings in **Israel**.
- Incentives to put residuals into value might save water and energy. For example, the use of waste heat from thermoelectric power plants for desalinating seawater to produce reliable drinking water in the **Middle East**.
- Strict waste disposal controls might lead to further environmental improvements. This is done with the recycling of effluent from bio-refineries to reduce negative impacts on freshwater ecosystems in **Brazil**.

Establishing incentives

An important priority for water governance is the implementation of enabling incentives for partnerships to be established and maintained. Appropriate pricing structures can provide sufficient revenues for continued operation and maintenance but, at the same time, prices must not be an impediment to make water and energy affordable.

What incentives?

Fossil fuel consumption subsidies totalled US$523 billion in 2011 (an increase of almost 30% over the total for 2010). Financial support for renewable energy, by comparison, amounted to only $88 billion in 2011, and increased by another 24% in 2012.

Besides its role as financial instruments economic instruments are incentives that can be designed to promote the sustainable use of water. These instruments include taxes, pollution charges, subsidies, and markets for buying and selling a service, a resource or the rights to use the service or resource.

Subsidies on water and energy can be an important driver of energy inefficiency and unsustainable water use. Pricing and subsidies need to be reoriented from promoting consumption to enhance sustainable water and energy use (See box below).

Water and energy incentives must also be coordinated so as to avoid negative cross effects: for example, massive access to electricity in rural areas at a subsidized price might exacerbate groundwater pumping.

Improving institutional coordination

OECD work on water governance (2011) shed light on many **obstacles to effective coordination between water and energy policies**, such as the lack of institutional incentives and platforms to manage trade-offs, interference of lobbies, absence of strategic planning and sequencing decisions, and intensive competition between the different ministries and public agencies.

Institutional coordination

- In **Brazil**, in order to limit the impact of water extraction for energy production on freshwater ecosystems, the legal framework requires a previous authorization from the National Water Agency for concessions to exploit hydropower potential.
- In **England** and **Wales**, 89% of the energy used in abstracting, treating, distributing, using and returning water to the environment is used on hot water in the home. The Environment Agency is now working with the Energy Saving Trust to develop policy in this area to target hot water use as a way of mitigating climate change.
- In **Spain**, the National Water Council includes representation of the energy sector by the head of the Directorate General for Energy Policy and Mines, Ministry of Industry, Tourism and Commerce as well as a representative from the Spanish Association of Electrical Industry.
- In **Australia**, researchers at the Australian National University and the University of Technology Sydney have formed the Climate-Energy-Water Links project to build upon existing water resource planning by adding the energy dimension to the policies.

6. Building Partnerships – partnerships in practice

There is now a wide variety of water and energy partnerships worldwide. They vary in size, number and type of partner as well as in the scope of their objective and realms of cooperation. They include partnerships for policy development and planning as well as for the development of major infrastructures such as industry partnerships for efficiency improvement, local partnerships between water and energy utilities and between local authorities and other actors and also partnerships for policy research and innovation.

This experience has been analysed by the World Bank, UNIDO, UNEP, Aquafed, ICLEI, UNU and WWAP *(http://www.un.org/waterforlifedecade/water_and_energy_2014/index.shtml)* and is presented below.

6.1 The Business Case for Partnerships to promote integrated planning and policies

Changes in the business strategy to be less exposed to water risks

In the energy industry, evidence of exposure to real rather than hypothetical water related risks, has fostered an important change in the business strategy regarding water resources. In the last two decades many electricity generation firms and their representatives shifted gradually from the traditional way of trying to secure water for their infrastructures, and eventually competing with other users when these resources were not abundant enough, towards a more active involvement in promoting integrated responses and, at the same time, developing strategies to become less dependent on water and thus more resilient and adaptable to water related risks.

Two way dialogue to build a stable regulatory framework

Innovative corporate strategies within energy tend to substitute the classical demand for water security by a two way dialogue with other sectors and governments to build a stable regulatory framework, to tackle long term water and energy policy interactions and create an enabling environment for innovation.

Fostering interdisciplinary collaboration

Businesses that consider fostering interdisciplinary collaboration between energy and water sectors can provide the knowledge exchange necessary to develop and implement integrated solutions. Within this context private public collaboration becomes a priority for major key stakeholders, in these two sectors, to build country capacity by identifying water constraints and planning energy and water resources comprehensively.

The World Bank's Thirsty Energy Initiative

Under the new scenario, the World Bank has embarked on a global initiative: thirsty energy, which quantifies trade-offs and identifies synergies between water and energy resource management and aims to help governments prepare for an uncertain future, and break disciplinary silos that prevent cross-sectoral planning. It focuses on increasing awareness of the urgent issues among relevant stakeholders in both water and energy sectors.

http://www.worldbank.org/en/topic/sustainabledevelopment/brief/water-energy-nexus

Main results

The new collaborative arena has already allowed the building of **a better understanding of mutual dependencies and synergies** between water and energy as most of the case studies considered in this report demonstrate. They have also helped to **raise awareness and highlight the implications of different energy development scenarios** over freshwater related ecosystems and, probably more importantly, have pushed the interest in enhancing water sustainability as an integral element to shape long term public policy and business strategies in the energy industry.

The new scenario also created **the conditions for joint research and innovation efforts** around the decoupling of energy development from water use. This has become a business priority coupled with increased support from national research and development policies. One interesting example consists of the emergence of water concerns as critical criteria for technology choices within the electricity generation sector.

Energy businesses have integrated water concerns in decisions on technology and location. Besides internal firm decisions and technology choices governance is still important in the transition to a low carbon economy and a water efficient energy system.

Enhancing the role of Water in the Energy Portfolio

Hydropower is a flexible energy source. Different from nuclear plants, that are better operated with a constant flow of energy, and from weather dependent renewable sources, such as solar and wind power plants, water power supply cannot be predicted in advance, hydropower offers a means to store energy that can be delivered .

Combination of different power sources offers the possibility to take advantage of this distinctive characteristic of hydropower. In La Muela (Spain) two interconnected reservoirs which fall more than 500 meters offer the possibility to use the off-peak excess supply from the thermal plants to pump back the water into the upper reservoir. On the island of Hierro (Spain) a similar scheme has been develop to store the excess energy produced by wind mills In both cases hydropower serves as a buffer stock to adapt water demand and supply and to put into value some energy that would have otherwise been lost.

More information: h*ttp://goo.gl/icliGC* and *http://goo.gl/pbSZ67¡*

Public private dialogue is a long term task which allows building a common understanding that enables the building up of coherent water and energy policies, based on long term challenges and verifiable outcomes, the creation of common and transparent information sources, the control of long term risks, and streaming these objectives into research and innovation policies.

Pilot Assessment of the Water-Food-Energy-Ecosystems Nexus in the Alazani/Ganick Basin

UNECE, in cooperation with partners, notably the Royal Institute of Technology (KTH, Stockholm) and the Food Agriculture Organization (FAO), has been developing a highly participatory nexus assessment methodology for transboundary basins with an important capacity building dimension. This is being applied with relevant sector ministries and other stakeholders from Azerbaijan and Georgia with a view to applying an intersectoral approach to resource management, taking into account the interrelations between water, land use (agriculture in particular), the energy sector and ecosystems in the Alazani/Ganikh River Basin. A better understanding of the complex interlinkages between these resources and joint identification of ways to strengthen synergies and policy coherence in the management of these different resources is necessary to reduce tensions between sectoral objectives, in particular in transboundary settings. A set of basins in the pan-European region, Africa and Asia will be assessed by mid-2015 under the UNECE Water Convention using the same methodology in revised form.

http://goo.gl/5Lo4cb

The Nexus Dialogue on Water Infrastructures Solutions

Following the commitment made in the Bonn 2011 Nexus Conference, the IUCN is leading the partnership with the International Water Association (IWA) and the US State Department. The dialogue is designed to bring together key actors from each of the water, food and energy sectors to build partnerships needed to take practical, collaborative steps in creating and implementing water infrastructure solutions that will accelerate action on optimisation of the nexus. Hence, the dialogue process likely has more significance as a platform for building partnerships than it does in terms of the partnership which has come together to organise the dialogue.

www.waternexussolutions.org

6.2 Industry Partnerships to Ensure Water and Energy Efficiency and Sustainability

Water and energy are two essential inputs in the production of almost every one of the manufactured goods that characterize a modern economy.

"Industry is essential to economic development. Rapid industrialization has been and continues to be the main driver for income and job creation and therefore accelerating development and poverty reduction in developing and transition countries is essential" (UNIDO, 2011). Economic development requires an enabling business environment to promote investments and industrial development as well as the simultaneous expansion of critical inputs such as water and energy, which are essential for manufacturing.

Reaping the benefits os a long lasting government Business Dialogue in the USA

- Collaboration in the USA has enabled the investment of more than 600m US$ to develop cooling technologies.
- Fracking companies are reported to be trying to minimize water consumption.
- Firms in semiarid zones in the US have increased preparedness for a water future based on non-conventional water sources (Brackish, waste and sea water).
- Water is now one of the main objective functions in energy research. More than 30 laboratories involved in energy research have gradually moved from single criteria (cost minimization) to multiple (sustainability).
- Irrigated biofuels have been pushed back in Indiana and Oregon.
- Prices in water stressed areas have pushed power plants towards dry cooling and have made water a driver of innovation by pushing fracking to alternative resources.

Source: Michael Highttower. Sandia National Laboratories. *www.sandia.gov*

Aligning business interest to sustainable development requires effective partnerships to promote the kinds of industrial development that being compatible with market incentives are also a mechanism to protect society and the environment from the risks driven by economic growth.

Save the source-effectively partnering with the private sector

In 2012, the United Nations Industrial Development Organization (UNIDO) entered into a partnership with the Carlsberg Group and its subsidiary Baltika Breweries to undertake a project which aims to address the water and energy nexus in breweries as a water and energy intensive industry. The partnership aims to reduce natural resource consumption, pollution and greenhouse gas emissions (GHG), while also improving the agro-ecosystems and water systems in the Russian Federation. Under this partnership a U$ 30 million private sector investment and incremental funding of U$ 6.3 million by the Global Environment Facility (GEF) are mobilized.

Some of the main activities to be undertaken by the partnerships include; developing a life-cycle assessment methodology to measure environmental footprint of breweries and suppliers from cradle to grave and developing regional, Transfer of Environmentally Sound Technologies to breweries and agro-industrial suppliers for water and energy footprint reduction, demonstration of application of innovative waste to energy approaches, technical assistance for the development of national and international policies and policy instruments for the mainstreaming of resource efficient cleaner production principles.

Results will be disseminated through national breweries associations and well as international industry platforms (Beverage Industries Environmental Roundtable) for countrywide and global replication and up-scaling. *http://goo.gl/QeWMkp*

According to the above mentioned experiences, partnerships can become an important institutional framework to promote and effectively implement the Green economy agenda. They can deliver this promise by gathering industry sectors and firms so that they contribute more effectively to integrated and sustainable manufacturing and to develop sector strategies for the realization of Green growth in the industry sector.

The UNIDO Green Industry Initiative for Sustainable Industrial Development

Green Industry transforms manufacturing and allied industry sectors so that they contribute more effectively to sustainable industrial development. Green Industry is thereby the sector-strategy for the realization of Green Economy and Green Growth in the industry sector.

Green Industry is operationalized by scaling-up and mainstreaming proven methods and practices for reducing pollution and resource consumption in all sectors ('greening of existing industries') and expanding the supply of affordable, appropriate and reliable environmental goods and services ('creating new green industries').

This has proven to be good for business, environment and climate as well as for communities, for consumers, and for development at large in thousands of enterprises in developing and transition countries.

At its best, Green Industry unleashes the business and innovation potential arising from a process of continuous improvement in natural resource use efficiency, minimizing waste and reducing emissions.

Source: *http://www.greenindustryplatform.org*

As in the UNIDO Green Industry Initiative, rather than converting the environment into an additional constraint to business development, partnerships can convert the protection of the environment into a number of business opportunities, to save water, energy and many other natural resources and to produce more and better with less. In the same sense cooperation through partnerships can deliver important benefits by turning the traditional reactive and defensive attitudes to environmental concerns in the business sector into proactive and innovative actions once the opportunities of the Green economy are realised and transformed into new and more sustainable business opportunities.

Partnerships to Transfer Environmentally Sound Technology (TEST)

The GEF/Danube-TEST project implemented by UNIDO during 2001-2004 in five countries of the Danube river basin (Bulgaria, Croatia, Hungary, Romania and Slovakia), resulted in four companies achieving ISO14001 certification by the end of the project, and three more since. More than 230 cleaner production solutions have been implemented in the 17 participating companies, complemented by US$1.7 million of investment in new technologies. These changes have brought estimated savings of US$1.3 million per annum for the companies, reinforcing their competitiveness. Total reduction of waste water releases into the Danube river are estimated to be 4.6 million cubic meters per annum, with most sectors reporting a 30 per cent reduction in water use after the introduction of cleaner production methods, and up to 90 per cent reduction after investment in new technologies. The integrated TEST methodology has become one of the key technical assistance products offered by UNIDO to effectively and efficiently address the water and energy nexus. TEST methodology has been successfully applied in the Africa, Asia, Latin America and in the Mediterranean. *http://goo.gl/6zKQhs*

Industry partnerships can help in designing sector strategies to promote decoupling of production growth from the increasing use of natural resources, water and energy included, as a prerequisite to make economic progress sustainable.

The Hydropower Sustainability Assessment Forum: A global partnership

In 2007 the World Wide Fund for Nature (WWF), The Nature Conservancy (TNC) and the International Hydropower Association (IHA) agreed to endorse the IHA Sustainability Assessment Protocol (2006). Since then, the Forum members jointly reviewed and recommended enhancements, and have developed tools to assess social, environmental and economic performance of hydropower projects and operating facilities.

After a period of consultation and trialing a final Protocol was produced and was adopted by IHA in November 2010. This is an example of the industry perception of the business opportunities taking steps towards making the production of electricity sustainable.

http://www.hydrosustainability.org/

The inclusive business development strategies embedded in Green Industry partnerships address the root cause of poverty – lack of opportunities for sustainable livelihoods – rather than simply addressing its symptoms. This means increasing the economic returns to the productive factors that the poor possess (e.g. raising returns to unskilled labour), as well as improving access to skills and technologies so as to stimulate entrepreneurship and increase productivity. This includes promoting the development of rural non-agricultural activities, like production in micro, small and medium-sized enterprises.

6.3 Local authorities and Water and Energy Partnerships

Cities and sub-national partnerships

Cities and sub-national jurisdictions are privileged spaces for coordination of the multiple actors involved in the water and energy nexus. The water and energy challenges are the result of multiple individual decisions made by households, firms and individuals in the same city. Not only private decisions are uncoordinated: modern policy systems have also divided responsibilities between zones, departments, legal categories and other specialized silos that operate with increasing autonomy and decreasing communication with each other.

Zaragoza: Building a Smart Water and Energy City

Through private public partnerships the Zaragoza council has been able to involve public, social and private actors to promote water and energy efficiency and awareness and capacity building. More than 50 best practices have now been implemented converting Zaragoza into a demonstrated success in water saving: the average domestic water consumption is half the Spanish average and more than 30,000 citizens and 300 social entities signed public commitments on water efficiency. The key actors promoted a cluster on water efficiency. Zaragoza partners are now actively involved in the recently created International network on human right to water in Central America. *http://www.ecodes.org*

This is why, the dialogue and the common interests that are in the essence of partnerships brings to light the opportunities of recovering the lost connections between institutions and individuals in order to achieve social and economic objectives more effectively.

Addressing the Water-energy nexus in rural settings:

District and village authorities in Mweteni supported by Women for Water promote the empowerment and the capacity development of the community to provide basic services for a 10,000 people community in the Kilimanjaro. *http://www.womenforwater.org*

Renewable energy plants represent an important opportunity in small communities that due to its small or scattered population can't benefit from the scale economies of big water treatment plants and dense water distribution networks. The City Council of Villar de los Navarros (Spain) promoted the installation of photovoltaic solar panels capable of creating electricity to propel water into the distribution network with significant savings for the local community. Similar developments are being implemented in other small towns in Spain (such as in Ayerbe in Huesca) and some irrigation districts (Vall D'Uxo in Castellon). *http://goo.gl/yjjnrm*

Partnerships may be effective means to solve resource issues within the boundaries of the complex local systems where both public and private decisions are made but not necessarily coordinated with each other.

According to this experience, partnerships at a local level allow us to seei that technological solutions are only one side of the coin and that the water and energy nexus is only one of the many important linkages, along with poverty reduction, food, land planning, social inclusion and others, that can be more efficiently managed at a local level. Success in local partnerships depends critically on the ability to link the response to water and energy challenges to these varied local development priorities.

This experience shows that local partnerships are an important driver of better water governance. Advances in the building up of effective partnerships are simultaneous with increased social awareness, social inclusion, transparency and other good governance practices that are increasingly recognised as pre-conditions to make society tackle the challenge of making a sustainable water and energy future. This is of course a long term endeavour where longevity is increasingly more important than short term business and commitment to shared goals becomes more important than windfall profits.

Public Private Partnerships

The experiences of local private public partnerships provide convincing arguments on the benefits of cooperation. While developing the social dialogue required to empower authorities and social actors in the challenges ahead and the available solutions at hand, the involvement of private actors will bring to the table the means to convert these opportunities into a reality. These alliances are based upon a shared understanding of the sustainability challenges and the opportunities and barriers that need to be overcome at a local level. This common ground allows the appreciation of the many synergies and the advantages of cooperation. For example, the public commitment to reduce water scarcity and the priority given to water and energy efficiency are self-enforcing objectives that promote social objectives while controlling investment risks and ensuring business opportunities in the long term.

5P A community based energy and water development initiative in Cinte Mekar, Indonesia

5P, a Pro-poor Public Private Partnership. Mobilizing private sector involvement through PPPs in providing sustainable electricity supply to the poor by empowerment of the community and support its own social development plan including safe drinking water supply and small hydroelectric plants and rural development actions.

http://goo.gl/XLM24t

According to the experience in Mekar (above) and Veolia (below), private public partnerships, when built with the vision and the will required, can be a two way means to connecting business and policy into an effective cooperation to manage the water and energy nexus. Reportedly, on one side it might be a powerful instrument to convey to the policy discussion arena all the information utilities have on environmental constraints as well as the technical information required to build a sustainable water and energy path. On the other, social dialogue is an effective mechanism to transmit the social objectives and make private actors aware of the advantages of aligning their individual decisions with them not just for altruism but for taking advantage of the business opportunities opened up by cooperation.

Transforming Water Efficiency in cities and industries into a Firm Business Strategy

Veolia Environment supplies water to 150m people worldwide and treats waste and water or provides energy services for over 1,000 businesses in all sectors. The company's expertise, portfolio of technologies and audit methodologies allows it to identify and unlock local potentials for water and energy savings at territory and/or site scale. To best achieve such targets, it recommends partnerships between municipalities, water intensive industries and local communities, focusing on operating water treatment, water supply, heating/cooling networks at the optimal cost and continuity of service.

In addition to the efficiency driver, the partner is also faced with the three integrated facets of the sustainable development: social (creating jobs and supporting community), economic (reducing operating costs) and environmental: water quality and quantity, limiting CO2 emission, and saving energy and other key resources. The partnerships allow saving up to 50% of either water, or energy expenses and from 10 to 30% of emissions and costs savings.

www.veolia.com

Partnerships among water and energy utilities

Coordinated responses at a social level need to be matched by coordinated responses at a firm level: that is to say by downscaling the social challenge into practical actions taken by the water and energy utilities. In other words a water and energy sustainable future requires both water-efficient energy and energy-efficient water. Though this collaboration has not been common to date, this requires the building up of effective partnerships within water and energy utilities.

Smart Business for Water and Energy Access and Efficiency

The horizontal integration of water and energy provision into a single firm in Casablanca (Maroc) has enabled an effective coordination of policies and has served to facilitate stakeholders' involvement. Through a long term contract, LYDEC, a private firm, provides the services of water and electricity distribution, along with waste water collection and disposal and public lighting. Effective regulation and public participation has served to put the economies of scale and the advantages of an enlarged market to take advantage of the synergies between water and energy. This way, for instance, the gains obtained from power distribution are used to finance water and sanitation infrastructures providing access to the less favored. In the same progressive pricing allows the application of cross subsidies amongst users serving as a solidarity mechanism and to encourage water efficiency at the same time. *http://goo.gl/IJfQZw*

As far as both sectors realising the importance of saving water and energy in their business strategy, these interactions are mutually reinforced by the entire economy. Saving water means a lower demand for energy so that energy challenges are alleviated. Saving energy reduces the demand for water and makes coping with water scarcity in the future easier.

As explained by Jack Moss (2014 UN Water Zaragoza Conference *http://goo.gl/An0o7B*), in fact, linking water and energy utilities is favoured by the important similarities between the two sectors. From a business perspective, they are network public services, producing and selling undifferentiated products with important economies of scale, which are crucial to all households and virtually all businesses in the economy. From a collective perspective, they are both connected to the three dimensions of sustainable development: crucial to economic progress, social inclusion and poverty reduction and increasingly important in relation to the environment.

Madrid: Integrated Water and Energy Strategies for Reducing Drought Exposure

Canal de Isabel II, the Madrid public water Utility, has developed an important hydropower capacity that allows the production of most of the electricity required for the water provision and treatment in normal years. Moreover, the increasingly frequent and severe droughts increase the electricity required in the water cycle and reduce the hydropower supply creating an important energy deficit and increasing the water production costs. To adapt to an uncertain freshwater supply The Canal de Isabel II has developed alternative energy sources, ranging from micro-turbines to modern biogas plants, has used its bargaining power to negotiate better electricity prices in the market and, finally, has applied a comprehensive energy efficiency strategy. All this has served to reduce drought exposure and to adapt to the likely impact of climate change over water supplies. *http://goo.gl/OMvv1A*

However, experience has also shown that linking water and energy sectors requires bridging the important differences between the two sectors. They come from distinctive historical traditions and still talk different languages and use different concepts. While energy is mobile and market decisions are increasingly globalised, water is bulky, expensive to transport and reallocate relevant to local markets and mostly non-tradable in global ones. Both sectors are also different with respect to how they are regulated and governed.

The opportunities to take advantage of synergies between water and energy are increasingly important to pave the way towards integration of water and energy production processes. Experience has shown that these links have been independently recognized by both sectors. Water has become an important concern for energy utilities. In practical terms this has resulted in the development of water efficient technologies for cooling, in recognizing the importance of hydropower in the energy portfolio and in the need to use adapted fuel production to the local water constraints as a critical requirement, for example, to develop new renewable sources, such as biofuels, and non-renewable ones, such as fracking for natural gas.

In the same direction energy concerns play an increasing role in how water utilities cope with increasing water scarcity. Energy efficiency has led to reconsidering important trade-offs such as, slow vs intensive energy water treatment technologies and has become an important issue in the development of abundant but water intensive sources such as waste, brackish and seawater sources.

6.4 Partnerships for Policy Research and Innovation

Integrated policies and solutions are possible thanks to innovation. The option of continuing with traditional ways to mobilize the existing water and energy sources that have fuelled economic growth in the past is as exhaustible as the non-renewable water and energy sources that have played the main role in the past. Especially as freshwater becomes scarce and fossil fuels are depleted, innovation ceases to be optional and becomes a pre-condition for sustainability. Some key experiences show how coping with the challenge requires reshaping the research policy agenda and this in turn requires stronger alliances between public authorities and private business with the scientific community. An enabling partnership must be able to mainstream policy challenges and priorities into basic research and also to transform established and new scientific knowledge into practical innovations for the business industry.

Putting science, society and governments together to assess the extent of the threat to water resources in China

Greenpeace and the Institute of Geographical Sciences and Natural Resources under the Chinese Academy of Sciences worked together on a ground breaking study of the estimated water consumption of coal power stations. It is estimated that water demand to this energy strategy will reach at least 9.975 billion m3 in 2015 – equivalent to one sixth of the annual total water volume of the Yellow River during a normal year. The study also estimates that in 2015, the water demand for coal power in Inner Mongolia, Shaanxi, Shanxi and Ningxia will either severely challenge or exceed the respective areas' total industrial water supply capacity.

More information: The Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), Greenpeace East Asia. 2012. Thirsty Coal: A Water Crisis Exacerbated By China's Mega Coal Power Bases, China Environmental Science Press (in Chinese) *http://goo.gl/44E9Mo*

So far, as explained by Zafar Adeel (2014, UN Water Zaragoza Conference, http://goo.gl/bSrOzs), the awareness of the water-energy nexus issues in the policy domain has triggered an increasing response and attention in the scientific and research community. This is because the challenges of understanding and implementing the nexus policies are further complicated by gaps in the related scientific evidence. In particular, in spite of the advances, there is minimal evidence, or even an established methodology, for determining the trade-offs and synergistic benefits for combined water-energy planning at the national level, or for considering the obviously tremendous potential to conserve resources, sustain ecosystem services and to contribute to improvements in human well-being.

The Energy Sustainability Challenge - a science industry partnership

A BP-funded consortium of experts from 15 leading universities, including Massachusetts Institute of Technology, University of Texas, Tsinghua University and the University of China, examined the complex relationships between natural resources and the supply and use of energy. This multi-disciplinary research programme – the Energy Sustainability Challenge (ESC) – is investigating the effects of natural resource scarcities on patterns of energy supply and consumption in order to provide research data on the volumes of water withdrawn and consumed along different energy pathways and the energy use in water supply and treatment systems.

More information: BP (2013) *"Water in the Energy Industry"*

Researchers have traditionally focused on narrower sector-driven mandates, in part, because there has been limited incentive to initiate and pursue more integrated research across different research fields. Conversely, some existing research does relate to barriers that exist between the water and energy domains. As addressed by the BP "water and energy industry", while it is intuitively evident that an increased level of collaboration and coordination between the scientific and professional communities in improving information in the water and energy domains would produce favourable outcomes, we need to provide solid and evidence-based arguments for achieving investment in this.

European joint programming initiative "Water challenges for a changing world" (The Water JPI)

The European Joint Programming Initiative (JPI) is an assembly of **Public Research, Development and Innovation Funding** Organizations from 19 countries in Europe (Member States of the European Union plus Associated Countries), plus the European Commission, a non-voting partner. Specific challenges have been identified in the economic, ecological, societal and technological domains. Objectives involve issues such as user participation, attaining targets in the coordinated use of funds and progress in the integration of RDI agendas and activities.

The research questions are cast in five axes: maintaining ecosystem sustainability; developing safe water systems for the citizens; promoting competitiveness in the water industry; implementing a water-wise bio-based economy; closing the water cycle gap.

More information: *www.waterjpi.eu*

A first basic step in building a crossed research agenda consists of identifying and quantifying the important trade-offs between alternative energy and water development paths and in particular underlying the importance of tackling both issues together to build an effective response to increased scarcities and risks and to favour adaptation to climate change. As addressed by the EU Water JPI, the common ground required for collective action must be based upon science based understanding of the links between climate change, water security, social instability, economic bubbles and downturns, etc.

The European Innovation Partnership on Water (EIP Water): an initiative within the EU 2020 Innovation Union.

By facilitating support for the creation of innovative solutions to address European and global water challenges, the EIP on Water aims to remove barriers by advancing and leveraging existing solutions. It promotes and initiates collaborative processes for change and innovation in the water sector across the public and private sector, non-governmental organisations and the general public.

Multi-stakeholder Action Groups commit to work on priority area to develop tools to support water related innovation. These tools are open to any actor dealing with water and innovation. Tools include the Online Market Place and the annual EIP Water conference.

More information: *www.eip-water.eu*

Once these trade-offs are well defined, the synergies between water and energy can be clearly identified and the potential gains of integrated water and energy responses become evident. Scientific knowledge is then essential to understand the benefits of integrated responses at different scales ranging from the global to the local one and also from the individual business to the collective interest.

Innovative partnerships play an important role in helping society to understand the value and contribution of new technologies. Contrasted knowledge is important to shape social perceptions and help stakeholders to shape their perceptions and enable adoption, as appropriate, of new efficient technologies and infrastructure developments, such as desalination and other sensitive alternatives that need to be discussed in a constructive way in order to appreciate the actual promises and the threats involved.

TOTO: Transforming water efficiency into a driver of innovation and a business strategy

Japanese research group showed that the spread of water saving equipment could contribute to a 1% reduction of CO_2 emissions in Japan. As a result, water saving equipment spread is included as a part of the environmental policy of Japan. Then, CO_2 reduction potential by water saving in developing countries was evaluated. In developing countries, if a water infrastructure is constructed with consideration of a city water demand, bigger CO_2 reduction potential is expectable. Water saving is effective not only in reducing energy consumption for heating but also in reducing the peak load of electricity. *http://www.toto.co.jp/company/profile_en/*

7. Key Lessons on Partnerships

Partnerships between water and energy are essential to secure water and energy equitable access, efficiency and sustainability. Overall there are some key Lessons emerging from the experiences presented in this report:

1. Water and energy **challenges are consubstantial to economic progress.** The nature of the challenge varies with development: the developing world is concerned with water and energy access. The developed world is concerned with water and energy sustainability. Both are concerned with water and energy efficiency.

2. Water and energy access have **critically immediate impacts on poverty alleviation.** Access is also critical for economic development as the lack of water and energy can be a limiting constraint to sustainable progress, which is the ultimate hope for widespread poverty reduction.

3. Water and energy supplies are **strongly linked to each other.** Water is required to produce energy and energy is needed for the extraction, treatment and distribution of water as well as its collection and treatment after use. The development of the most common forms of energy (electricity from coal/thermal and hydropower) is limited by the availability of water.

4. Pursuing policy objectives independently often lead to **"water-blind"** energy policies and to **"energy -blind" water policies.**

5. **Future challenges will depend on current responses.** If we do not act now future challenges will be more complex.

6. The main risk in the search of a sustainable water and energy future consists in going further with solutions that intend to **cope with one challenge at the expense of worsening the other.**

7. **Opportunities do exist** to tackle both energy and water sustainability and challenges do exist with the resources available and within the range of existing technologies. Cross efficiency in the water and energy sectors is essential to produce more and better with less and to pave the road to a sustainable water and energy economy.

8. Sustainable solutions require a systematic approach of integrated solutions rather than addressing issues in isolation. Most of these opportunities take advantage of the synergies between water and energy. Among the **existing solutions,** the following have been successfully implemented:

- Sustainable Hydropower: a means to better integrate water and energy planning and management.
- Renewable energy technologies based on renewable sources instead of finite sources such as fossil fuels.
- Geothermal energy for power generation. It is abundant and climate independent, produces minimal or near-zero greenhouse gas (GHG) emissions, and might be implemented with minimal water consumption.
- Solar photovoltaic, wind and other sustainable sources for power generation.
- Technological solutions that offer combined energy and water services, particularly to the poorest segments of society.
- Heat recycling and other alternatives to use residual heat as part of the water treatment process, so that the volume of water required for cooling is decreased.
- Self-production of energy in order to reduce water treatment costs and then increase financial attractiveness.

- Alternative water sources for energy production. Low quality water for cooling nuclear and thermal power generation plants may save freshwater by opening a window of opportunity to put other sources into value and use.
- Securing wastewater from a nearby wastewater treatment plant could reduce future uncertainty and ensure a reliable, continuous water source for the power plant.
- Integrated energy and desalination (treatment, recycling, etc.).
- Cogeneration to recover heat.
- Reduction of health risks from putting wastewater into energy production.
- Reduce sludge disposal costs.
- Use organic material as a fertilizer.
- Production of Biogas for transport, heat and cooking or to electricity and replace fossil fuels and thus greenhouse gas emissions.

9. However, making sustainable water-energy decisions requires careful consideration of the **many trade-offs** involved in the water and energy nexus. These are some of the trade-offs identified during the conference:

- Alternative water sources for cooling might be more expensive.
- Alternative sources may come with additional management complications such as corrosion, need of special treatments, health risks, etc.
- The reduction in water use for cooling might result in an increase in water consumption.
- Integrated systems to produce energy and water are more complex to operate. Water and energy demands vary seasonally depending on many local circumstances.
- More efficient irrigation systems might result in lower water use but might increase water depletion and reduce the returns and then the infiltration and the run-off downstream.
- More sophisticated systems, such as dry cooling or drip irrigation might be more expensive and then less profitable in financial terms.
- The perception of what solutions are more advantageous depends on the existing institutional set up in place. The current political and economic incentive system still favours independent sectoral outcomes over cross-sectoral results.
- Inadequate water and energy pricing and environmentally harmful subsidies might reduce incentives to increase water and energy efficiency. Water efficiency gains would only be permanent provided these incentives are revised.

10. Decisions made for water use and management and for energy production can have significant, multifaceted, and broad-reaching impacts on each other – often with a **mix of both positive and negative repercussions.**

11. The following **recommendations may help society to take advantage of existing opportunities** and overcome with the existing barriers:

- Establishing appropriate pricing structures can provide sufficient revenues for continued operation and maintenance, and avoid waste and distortions.
- Economic instruments include taxes, pollution charges, subsidies, and markets for buying and selling a service, a resource or the rights to use the service or resource.
- Integrate water concerns in energy planning in particular when location of water intensive thermal power plants, including assessments on water resources, water facilities and other sectors that might compete for water supplies.

- Enhancing the efficiency in energy transformation processes as a means to saving water. The more effective the energy generation process the less the residual heat and the need of water for cooling purposes.
- Improve water and energy efficiency and conservation. Improving efficiency in the water domain saves energy for treatment and supply and therefore reduces the amount of water needed by the power sector.
- Focus on long-term objectives: policies and integrated plans that encourage energy and water conservation can reduce future energy and water requirements. Establishing appropriate pricing structures that can provide sufficient revenues for continued operation and maintenance, and avoid waste and distortions.

12. Partnerships are required to improve water and energy access, efficiency and sustainability, at different levels, and between private and public stakeholders, businesses, users and governments, social and private actor, science and policy, etc. These are the main reasons **why partnerships are required:**

- The energy-water challenges are too great for any agency or organization to tackle on their own.
- There is the need to work with an array of partners to design policies and for planning and investments that will ensure continuous improvement.
- Governments need technological and business partners.
- Businesses need Governments to ensure a stable regulatory framework and facilitate integrated information and long term planning. Fostering interdisciplinary collaboration between energy and water sectors is essential to providing the knowledge exchange necessary to develop and implement integrated management frameworks.

13. Partnerships need to be seen as a social means to many ends. In general terms, effective partnerships improve the social ability to respond to the water and energy challenges and take advantage of the synergies between water and energy. In particular, **partnerships might contribute** to the following relevant objectives:

- Integrating policies, broadening the scope and enhancing the effectiveness of both water and energy planning.
- Improving water and energy governance by helping to provide better regulations and enabling institutional frameworks.
- Learning from each other's success and failure among the water and energy communities.
- Identifying opportunities to improve water and energy access, efficiency and sustainability
- Implementing win-win solutions that are more sustainable.
- Promoting and stimulating coordination between the water and energy domains to reduce waste and inefficiency.
- Developing a common and better understanding between the two sectors of the connections and effects on each other will improve coordination in energy and water planning leading to optimized investments and reduced inefficiencies.
- Encouraging government to create enabling environments to foster greater coordination between the water and energy domains and support R&D in water-efficient energy and energy-efficient water service provision, for example, heat/energy recovery from warm water in buildings or biogas from sludge from water treatment facilities.
- Mainstream gender concerns into water and energy governance.

14. Success in reaching the multiple objectives partnerships depend on the correct identification and assessment of the challenges and barriers that need to be overcome for building effective water and energy partnerships. These are the most **important challenges and barriers partnerships might need to cope with:**

- Traditional water and energy investment and planning which are mostly based upon existing rather than on future resources.
- The mutual ignorance of each sector in the water and energy community.
- The reliance on engineered solutions while natural green infrastructures are underappreciated.
- The existing incentives that are still designed to deal with water and energy separately.
  - Energy producers have little or no incentive to conserve water due to very low prices whereas water users do pay for energy, even though the prices may be subsidized.
  - Water and energy prices are strongly affected by political decisions and subsidies that support major sectors such as agriculture and industry.
- Although the link between water and energy is evident, these domains have historically been regulated and managed separately.

15. These ambitious tasks can be attained by partnership if they allow to progress in the following directions:

- Change the traditional institutions that do not encourage innovation and integrated responses. Traditionally, the bulk of both water and energy infrastructure has been provided by the public sector and that might have favoured the perception that these problems must be tackled by public authorities without much involvement of private agents.
- Overcome institutional silos that still neglect integrated responses.
- Create investment opportunities and build long-term security for investment returns in the long-term. The size of future investment required for both domains cannot be supplied solely by public finance.
- Convince private investors and venture capitalists that the water-energy sector is a viable proposition for return on investment.
- Develop new investment instruments to enlist private finance may comprise public expenditure reviews to improve public spending and its monitoring, reducing investment inefficiencies, helping utilities to move towards cost recovery, public–private partnerships, and results-based financing.
- Develop mutual understanding and common ground for the identification of long-term viable strategies at a local level and align business interests with collective goals of poverty reduction, resource efficiency.
- Mainstream environmental objectives and priorities into the research agenda and develop effective research on innovation instruments to trigger advances in water and energy efficiency, climate change adaptation and disaster risk reductions, among other socially relevant objectives.
- Support for innovative technology to move it from laboratory to pilot testing to implementation.
- Transform current knowledge into a driver for innovation by connecting science to firms concerns both to improve business operations and social responsibility.
- Strengthen the science policy link to provide a better understanding of the interconnections between water and energy as well as to improve the information basis, the assessment models and the decisions support systems all in order to enhance the collective capacity to respond to the existing sustainability challenges.

16. Information and new integrated decision support systems are said to play an important role in improving policies and collective decision making capacities. These are some of the **information deficiencies and gaps to be filled:**

- There is still room for improvement in water accounting and energy accounting systems (before the ambition of an integrated accounting system becomes a viable target).
- The best integrated models available still have to overcome important drawbacks (in energy general equilibrium models, water is an emission rather than a carrier, models are sensitive to water prices but not to water shortages, limited ability to deal with uncertainty, dynamic effects, technology choices, etc...).
- Prospective scenarios are still based on BAU and ad-hoc assumptions on the drivers and the options available to reconcile future demands and supplies.
- The availability of data, clear concepts and information is key to determine which solution is most appropriate–e.g. water consumption vs withdrawal.

17. **Building effective partnerships is a marathon** rather than a sprint. Dialogue is a long term task, so don´t try to make too much too soon.

- Try to capitalize the attractiveness of the first easy steps.
- Be aware of the fact that successful dialogue is a gradual learning and self-reinforcing process (don't be too ambitious in the first steps).
- Bear in mind that partnerships progress through building a shared vision among different partners.
- But keep in mind the need to accept and recognize self-interest as a driver of action.
- Note that incentives for innovation depend on the ability of the private sector to push their priorities up in the political agenda.
- Don´t forget that stable regulatory frameworks drive innovation.
- Partnerships start with mutual knowledge and progress through mutual compromises. The benefits can be reaped from the beginning by allowing better water informed energy decisions and better energy informed water decisions and can be increased by linking decisions in order to reduce the water costs and uncertainties of energy decisions and vice versa.
- Successful partnerships are self-sustained. Once established they might enable the identification of mutually beneficial alternatives providing the incentives for further agreements able to reap the co-benefits of integrated water and energy actions.

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International Decade for Action ‘Water for Life’ 2005-2015

A Decade for Water, a Decade for Life

Contributing to the primary goal of the Water for Life Decade, Spain has agreed to provide resources to the United Nations to establish an Office to support the International Decade for Action (UNO-IDfA). Located in Zaragoza, Spain, and led by the United Nations Department of Economic and Social Affairs (UNDESA), the Office implements the UN-Water Decade Programme on Advocacy and Communication (The Office) aimed at sustaining global attention and political momentum in favour of the water and sanitation agenda at all levels during the Decade.

United Nations Office to support the International Decade for Action ‘Water for Life’ 2005-2015 (UNO-IDfA)

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