The contribution of water technology to job creation and development of enterprises

by Karl-Ulrich Rudolph[1]

"Green technologies can contribute to green growth because they have the potential to create new business opportunities, markets and jobs. They can boost water and energy use efficiency and contribute to achieving the Millennium Development Goals and building the green economy. Innovative water technologies can increase the amount of water available for drinking, agriculture, and manufacturing and can allow us to use water more efficiently. This can be done by technologies in areas such as water resources assessments, reduction of water losses, waste water treatment, efficiency of water utilities, bio technologies, etc.

Technology development – if combined with public awareness – can also contribute to decreasing water footprints through increased conservation, reuse and recycling, and greater efficiency in most water using sectors, particularly agriculture. This can enhance overall poverty reduction and socio-economic development.

Research and development (R&D) and innovation are central to the green economy since they can reduce the costs of existing environmentally sustainable technologies and deliver the new technologies that are needed to advance efforts to cut emissions, reduce waste and increase resource efficiency. In both developed and developing economies, innovation plays a critical role in generating employment; enhancing productivity and growth; increasing energy, carbon, water and material efficiency; improving performance of goods and services and creating new markets and jobs through knowledge creation and diffusion."

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Technological challenges for green growth in the water sector

The challenges to implement advanced and more efficient water technologies and management have been highlighted in the SICK WATER REPORT of UNEP and UN-HABITAT (2010), especially for urban areas:

"*Already, half of the world's population lives in cities, most of which have inadequate infrastructure and resources to address wastewater management in an efficient and sustainable*

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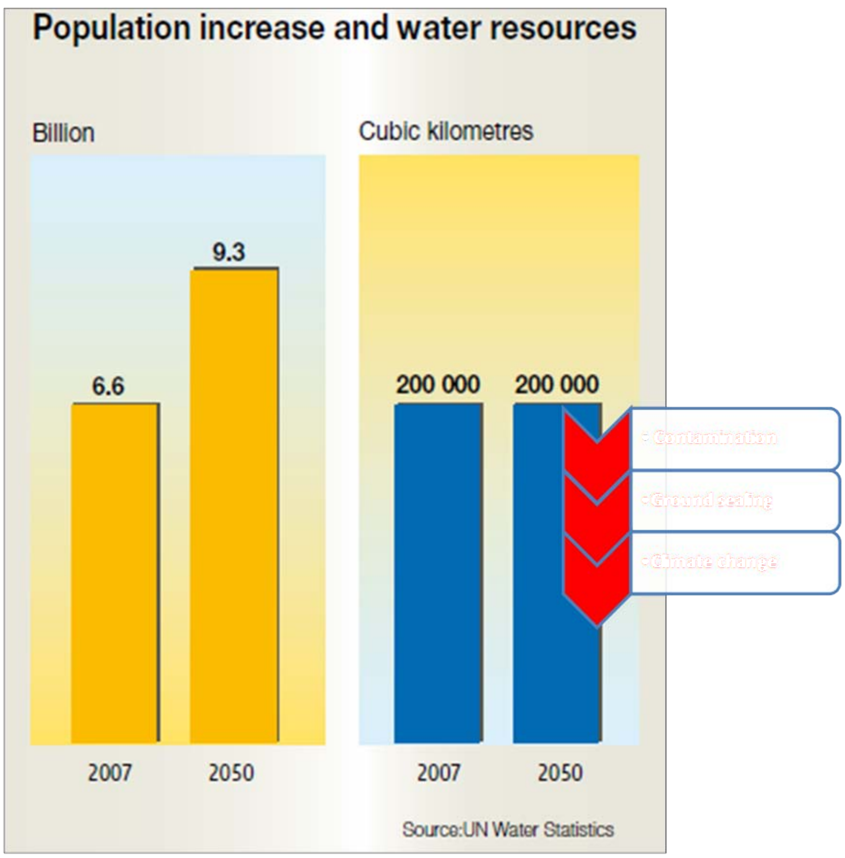
way. Twenty-one of the world's 33 megacities are on the coast where fragile ecosystems are at risk. Without urgent action to better manage wastewater the situation is likely to get worse: By 2015, the coastal population is expected to reach approximately 1.6 billion people or over one fifth of the global total with close to five billion people becoming urban dwellers by 2030. By 2050, the global population will exceed nine billion."

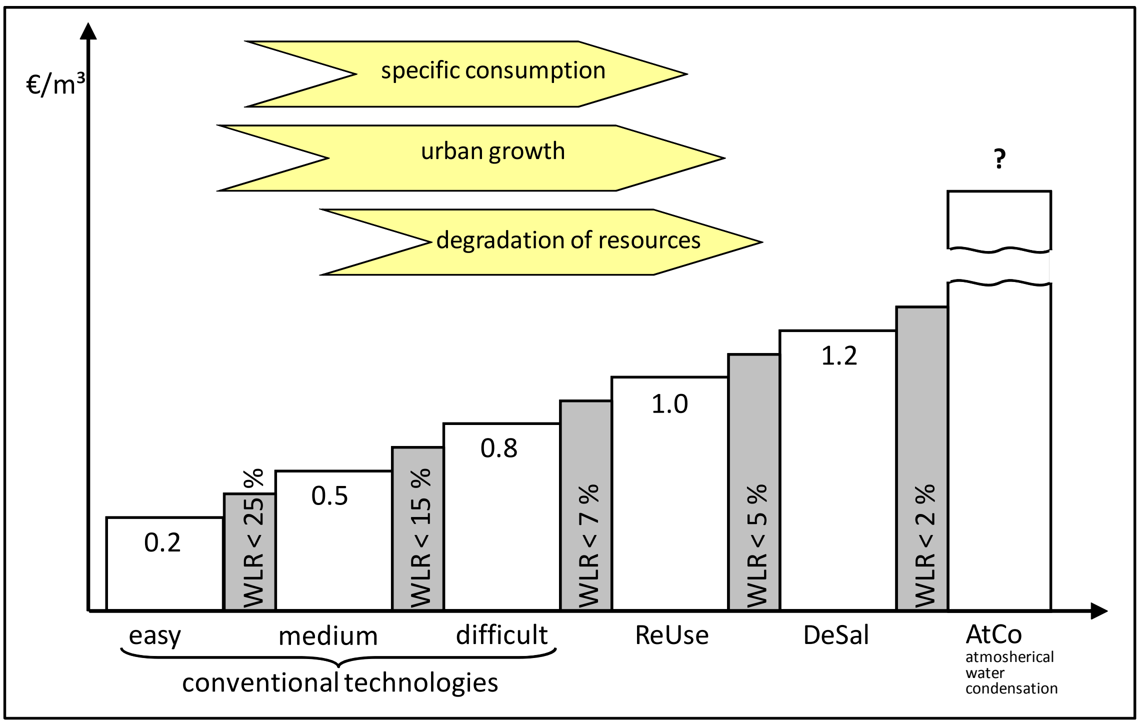
The combination of population growth, rising water consumption, improvements in public health and welfare, rapid urbanisation (causing problems like contamination of raw water resources, widely spread land sealing with prevention of natural groundwater recharge), and the impacts of global climate change, will undoubtedly lead to more pressure on politicians and industry to resolve water problems (see figure below).



Water supply is a regional issue and shortages depend on location and time (seasons). This stands in contrast to energy supply, where problems (e.g. greenhouse gas emissions) are not related or limited to particular regions.

Water demanding agriculture, industry and settlements should (preferably) be located wherever cheaper water resources are available – from the view of water management. However, there are often other and more dominant factors driving spatial planning, meaning that it is impossible to prevent water intensive activities in arid areas or in urban areas which are short of water.

The need for improved technologies to expand water supply production and enhance water efficiency (the latter can be understood as driver of the green growth) is visualised in the following figure "Hierarchy of Water Production Costs".



The higher the costs of water production are, the more water saving measures, water loss reduction (WLR), and sophisticated water recycling technologies become profitable. WLR, selected for the figure above, is one important method within a broad toolkit to enhance water efficiency.

In locations where water production is easy and cheap (e.g. in towns with clean mountain water which needs no pumping to reach consumers), it may well be acceptable to tolerate water losses of 25 %. As soon as water production has to pump deep groundwater or purify contaminated raw water, requiring significant technical effort, water loss should be reduced and the economic optimum might range between 15 % and 7 %. In water scarce locations, conventional water production will need to be accomplished with more expensive technologies, like water reuse (wastewater re-cycling resp. down-cycling) and brackish-water or seawater-desalination. Under such circumstances, water loss rates above 5 % would not be feasible, economically. In cases with very high water production costs (like for supply-water condensed from the air, atmospheric water supply), the water losses should be as low as around 2 % (about the very best benchmark currently achieved in water distribution networks in Germany, where the national WLR 2010 is reported to be 6.8 %).

Considering the effort and status of WLR in many countries worldwide, one could say that the real value of water and water utility is not reflected appropriately in day-to-day water operations, and that there seems to exist a great potential for profitable WLR measures in many places.

Besides solutions contributing to water efficiency (i.e. efficiency in water consumption, such as water saving technologies and water demand management, water loss reduction, water reuse, utilisation of unused water resources such as rainwater harvesting, etc.), there are technological challenges contributing to non-greentech growth. Examples include seawater desalination technology which requires considerable energy consumption, as well as oil-, coal- or gas-powered, or high-energy consuming water reuse technologies (e.g. multi-stage membrane technologies with reverse osmosis). However, even for these technologies, a trend towards greentech is happening (e.g. solar-powered desalination).

Another issue is improved welfare leading to water consumption in the "health and wellness sector" associated with a wide range of technologies from necessary medical applications to luxury applications, such as private pools and spas in arid and water scarce settlements. This field of water consumption bears a "green image", but is often accompanied with extensive water use and cannot be regarded as "green growth", at least not in water scarce locations and seasons.

Overall, the technical challenge in the water sector is advancing a multi-coloured growth, with strong elements of green-growth. Depending on market prices and the political costs of raw water resources and environmental pollution through wastewater discharge (which is very much a matter of governance and law enforcement), the powers of the market (which are stronger than political talking, in the long run) will focus either on GREEN or UNGREEN growth.

The role of the water sector regarding green growth is ambiguous, due to the fact that the sector is incorporating both strong drivers and strong barriers for green growth business development.

Value-wise, the water sector is less important (in nearly all countries, worldwide) than the power sector, the IT-/communication sector and (in industrialised, fully developed countries) strong industrial branches such as automotive. Furthermore, within the water sector, water supply is definitely stronger, value-wise, than wastewater and sanitation. This may contradict the importance that water supply and sanitation certainly has for the survival of deep land economies. And, it may be a strong contradiction to official statements from scientists, NGOs and politicians. Nevertheless, it is a fact that much more is paid for power, IT and cell phones in many countries, as well as in many slum settlements, than for water and sanitation.

Technology-wise, there has been huge progress in the development of new, adapted technologies in the water sector. Many of these are "collateral gains" from higher-valued sectors, like membrane technologies (first applied in industry and marine technology), IT/automation (most hardware and software originally developed and applied in higher-valued fields of business asset management etc.) or high-tech bio-technologies (many coming from organic chemistry or the pharmaceutical industry).

Barriers for technology in the green economy

"*Technological innovations may have unprecedented good or harmful impacts in the future and accountability for the harmful impacts is often lacking. Much depends on the framework in which it is developed and disseminated. More could be done to assess social, environmental or other impacts more thoroughly and holistically before they are embraced, disseminated and promoted on a large-scale.*

The technological development cycle does not exist in a vacuum. It is influenced by government priorities, market interests, social trends and risk thresholds, and power dynamics. As a result, policies and market mechanisms do not necessarily direct technological innovation to areas or people who need it the most or to advance sustainability.

If technological development is not regulated, the current uneven technological capabilities may aggravate existing inequalities between the developed and developing world and perpetuate polarities of have and have not's.

Structural or policy obstacles to technology transfer and dissemination due to intellectual property barriers, lack of investment in research and extension, lack of funding, may lead to regional disparities in access, potentially aggravating the current income gaps. Such gaps in access already exist, with small pockets of private sector interests holding the majority of public-interest patents and intellectual property rights.

Cultural obstacles to technological uptake, such as the resistance to the recycling of sewage water for drinking, can delay the adoption of technology. WWDR4

Technology is often seen as a proxy for progress and has sometimes raised unrealistic expectations as a cure-all for what ails society. More consideration could be given to broader implications of its development and dissemination – or lack thereof in some sectors. (SG Panel)

Inadequate governance and decision-making systems may create market distortions towards inefficient technologies, for example through inappropriate subsidies or a lack of long-term vision. (WWDR4)

The focus of investments is too often exclusively on those areas that will make returns at shorter term (i.e. specific renewable technologies that some governments favour more than others with specific subsidies). (UNECE)

The current economic and financial crisis lowers the financial potential of many countries to implement innovative water technologies. (UNW-DPC)

(UNW-DPC)

To understand the barriers to green growth in the water sector, it is necessary to highlight the specifics of the water sector, especially those in the DDM (donor-driven markets; in contrary to the CDM, customer-driven markets).

	Water sector specifics	Greentech as a "state-guaranteed market"
1.	The water sector (in the utmost of all countries) is state-guaranteed (especially wastewater, sanitation, which cannot survive without enforcement of environmental standards).	According to environmental standards set and enforced by the state (e. g. wastewater treatment plants for natural water body protection), greentech can be profitable or not.
2.	The water sector (in utmost all countries) is state-regulated (the state defines which standards, which rules, which organisational structures, which technologies are admitted to that market).	Wastewater treatment is seldom serving the final beneficiary (this would be the water consumer, not the municipal utility or so, asking for private technology providers, operational services etc.).
3.	The water sector is dominated by public entities (only 5 to 10 % of water services are provided by private industry, nearly 98 % of water resources worldwide are owned, governed by	Water greentech is working mostly for public customers (municipalities, water associations, municipal companies).

	the public).	
4.	Due to the "natural monopoly" of network-bound infrastructural services (supply or disposal), there is no, little or limited competition.	Greentech providers have to obey public procurement procedures (in developing countries strongly influenced through donor banks).
5.	Water tariffs, wastewater charges are no "real" prices, due to the lack of competition under the economic balance of supply and demand.	Greentech provider is mostly a contractor in a service market fed through state-set "prices" (water and wastewater fees, solid waste charges, carbon credits, subsidies for regenerative energies, etc.)
6.	The need for better water services is not the same as the demand for better water services.	Wherever the public water utility does not fulfil the demand, customers who can afford to do so, seek other "inofficial" services.
7.	There is a great difference between customer-driven markets (CDM) and donor-dominated markets (DDM) (the latter existing especially in developing countries).	Greentech in DDM is pioneering, but in CDM it is usually more efficient and financially sustainable.

Furthermore, greentech is seldom a "stand-alone-business":

- Sometimes, environmental protection is the main purpose of a business (e.g. a sewage sludge incineration plant)
- More often, environmental protection is one of several purposes of an investment (e.g. for a solid-waste-fed combined power plant)
- Very often, environmental protection is just side-purpose of an investment (e.g. for energy- and valuables-recuperation from wastewater).

The approaches

The importance of success stories

Taking into account the needs in the day-to-day operations of water utilities (which must provide reliable and safe, continuous water services and must try to avoid risks) and taking into account political decision-makers governing the water sector and local utilities (who want to be reelected and tend to avoid to introduce promising technologies and solutions unless all related political risks are eliminated), it is obvious what the water sector needs.

Green growth must be explained, yes, but of greater value than general explanations and arguments are success stories from locations, situations, site-conditions, and cultures that seem comparable or transferable to the case under discussion.

Considering exceptions

There may be some important exceptions, such as: (1) biological water process technologies, such as the activated sludge process, forest removal, algae production or no-dig-pipe rehabilitation with robot-driven underground machines; and (2) the anaerobic process technology for biogas generation from organic waste. These technologies have been developed predominantly in and for the water and sanitation sector, with a spill-over of inventions and technical progress to other sectors of industries.

Learning from other sectors

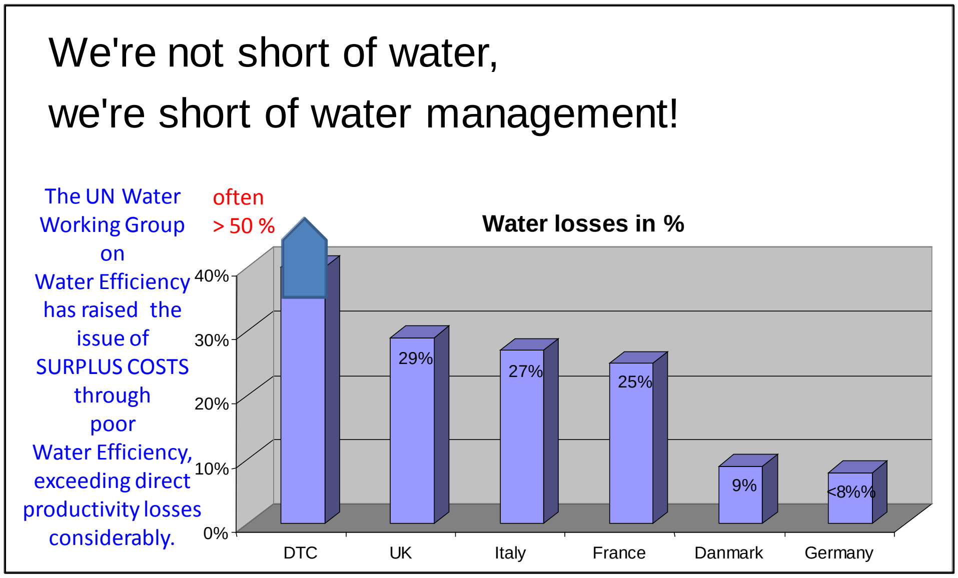
Water technology researchers, project developers and project implementers may be advised, in general, to have a closer look at other sectors of industry that are more technologically developed than the water sector, such as: (1) network construction and management for precious chemical gases; and (2) the technological set-up of the supply change in the automotive industry, such as monitoring and control systems in industry.

Technology choice

In the past, as long as water was not scarce, it has been reasonable to apply low-tech plus low-cost technologies in the water sector, even when neglecting certain negative side effects like secondary contamination (such as emissions of volatile organic compounds from water plants) and energy consumption (such as for robust pumps or aerators with limited efficiency, but easy maintenance and reliability, and cost-efficient in times when power was cheap).

Nowadays, as the transition to greentech is needed and becomes increasingly economically viable, there is a lot to do in the water sector.

The following figure highlights the gap between the current situation and the situation which should be realised in future, illustrating with the example of water loss.



There are huge deficits, especially in the developing and emerging countries. This also means there are huge opportunities to develop green business when moving from low to high water efficiency.

International cooperation and local collaboration on research and development (e. g. through networks or clusters) contributes to developing, absorbing, adapting, nurturing and diffusing innovation and green technologies.

One example, well known in the water and sanitation sector, is the progress in the use of small scale biogas plant technologies for rural farm estates, delivering gas for cooking and heating. This could not have happened without research collaboration in process and tank construction technologies, including international as well as local players, and strongly supported through multi-lateral donors for implementation.

The least developed countries' early stage of industrialisation offers avenues for leapfrogging and adopting technologies which offer greater energy and resource efficiency. They can adopt new and state-of-the-art technologies.

One very important example is the advances made in analysis technology for metering water toxicity on-line to locate harmful substances like pesticides, hormones, heavy metals and all kinds of non-degradable xenobiotics. Even though clearly high-tech and expensive, the analyser can bring enormous savings (a) for factory owners to detect and eliminate spill-overs of precious chemicals (e.g. in factories producing or mixing chemicals for agriculture) and (b) for environmental monitoring, to eradicate hazardous pollution near-to-source.

> *The experience with information and communication technologies is revealing of the capacity of poor countries and poor communities to achieve a jump in the technological development process"*

One good example, although under political controversy, is the development and implementation of computer based remote controlled pre-paid systems technologies, allowing water utilities to serve poor income zones, without having to provide water without revenues from tariff payment, and without powers to prevent excessive waste of water. Pre-payment systems allow the limiting of free water service to e.g. 6 kl per connection and month.

Lessons learnt from the case studies

Two general mechanisms can be observed, which might be valuable elements for building a strategy for green business development:

1. **Political governance and donor finance have been able to open up opportunities to unlock greentech development potentials**, for example launching pilot projects for water loss reduction under a public-private partnership scheme, generating savings for the benefit of the utility which exceed the expenses (even though, due to low water tariffs, the utility has not yet reached the level of financial sustainability).

2. **Greentech developments have generated technologies which have proven strong enough to overcome down barriers and governance-deficits well-known in the water sector.** One deficit is the huge gap between environmental law and the environmental situation, as can be found in many developing and transition countries due to poor law enforcement. One example of technology which has been able to overcome this challenge is the online monitoring of wastewater effluents, with real-time data transmission preventing manipulation in sampling and analysis data, thereby increasing transparency in countries with poor law enforcement. Another example is decentralised technologies for water treatment and wastewater reuse, allowing for small-scale investment and development outside of fixed network structures, setting a strong benchmark in water and economic efficiency by producing "virtual competition" to non-efficient utilities. (The author has seen hotels operating their own small water supply after the public utility had failed to provide services, with membrane plant, greywater reuse and stormwater harvesting, and at a level of managerial and technical efficiency the politicians managing the utility could never achieve).

As a general, overall conclusion, it seems justified to say:

1) In this world, there is no lack of water resources; there is a lack of water management. Once water efficiency levels are equal to good technical practice, most regions suffering water scarcity will find themselves sufficiently served.

2) Subsidised water tariffs suppress green growth. From the author's view, it would be wise to subsidise the poor, not the water tariffs.

3) Green business needs business structures. There is a need to transition from charity to investment, including PSP options, to unlock potential and meet the demand for greentech-based water sector development.

All of the above statements may have to be differentiated and modified for implementation on a case by case basis, depending on political, cultural, regional priorities and conditions.