BLUEPRINT FOR A CIRCULAR WATER SMART SOCIETY

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Tangible solutions for the practical implementation of circular water

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CIRCULAR WATER

We do not inherit the earth from our ancestors.

We borrow it from our children.

The vision of water uses within the urban environment

This blueprint provides an overview of the causes of the current water crisis and how the use of safe circular water sources in the urban environment is a quick-to-implement and smart solution to reduce tap water use and wastewater emissions by 25% to 45%.

Circular water can be applied without requiring residents to make concessions in their standard of living. On the contrary, even during long periods of drought and water scarcity, normal pre-water-scarcity living standards can be maintained while saving water and energy.

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The Cause

A global water crisis due to a bankrupt linear water system

Many parts of the world face a water crisis as natural water sources are depleted. This endangers the supply of tap water to hundreds of millions of people in many regions. Wastewater and pesticides also pollute nature and compromise natural water quality. Our society faces the challenging task of decisively addressing this water crisis. The traditional solution is to draw more and more water from nature, but natural resources are depleting. Alternative water sources such as desalination and extracting water from the air can contribute to the solution. However, these techniques are not sustainable because they use a lot of energy, and desalination is damaging to our natural habitat.

The cause of water scarcity

Water scarcity has three causes:

1. **Population growth;**
2. **Climate change;**
3. **Slow decision-making by governments and regulators in the past.**

Numerous scientific studies predicted population growth and climate change decades ago. Despite the warnings, the countries now facing severe water scarcity largely failed to take adequate measures to adapt water systems to the predicted water scarcity. The cause often lies in political or administrative unwillingness or incompetence or the financial interests of dominant organizations. This is in direct contrast to the interests of the public and public health.

The current administrators now face the great task of taking accelerated measures to solve the water crisis and serve the public in the short term. Swift, appropriate, and creative action is needed to protect society from the effects of water scarcity. This Blueprint for a Circular, Water-Smart Society aims to provide a concise overview of circular water solutions that can be safely deployed in the short term to reduce tap water use.

There are hundreds of millions of homes and apartments worldwide. If all these residents start drastically reducing their tap water consumption by using circular water for non-potable applications, it will greatly reduce tap water consumption.

Example demonstrating that measures can be taken quickly

Even a water-rich country like the Netherlands, known for its innovative solutions to global water problems, has faced water scarcity recently. Summer droughts have compromised the availability of natural water for tap water production. The Dutch water utilities jointly called on the Dutch government to reduce the use of tap water for non-potable applications and encourage the use of alternative circular water for those applications. In response, at the end of 2022, the Dutch government communicated a goal to reduce the tap water consumption of its more than 18 million Dutch citizens by 20% over the next 13 years, from 125 liters (27.5 gallons) to 100 liters (22 gallons) per person per day. The government's objective is to be achieved by utilizing alternative circular water sources such as rainwater, recycled greywater, and circular showers for non-potable applications, as well as alternative technologies such as vacuum toilets. Flanders, a northern state of Belgium, was already facing water scarcity 20 years ago. In 2004, the building code implemented a mandate for the collection and circular reuse of rainwater in homes for non-potable uses.

The above shows that political will and good governance can allow adequate measures to be taken quickly and implemented in cooperation with all stakeholders to make society more resilient and less dependent on changing weather patterns.

Governments worldwide face enormous challenges, but the urgency demands choices, and the water transition is possibly even more relevant than the energy transition.

In this blueprint, the expert group discusses the following aspects that governments and decision-makers can use to manage the water crisis:

1 Water-smart building

We must build homes and buildings that are climate-adaptive. In the area of water, for example, this means that we need to build water recycle ready homes and buildings to be able to collect and reuse water. The water management system must become more democratic; as it serves all citizens. If people do not realize the value (and scarcity) of water, they are not going to appreciate it.
We need to cherish water, understand that water is valuable and it is important to (re)define water that is fit for its purpose.

2 Circular systems for water-smart building

We need to incorporate circular systems in water-smart building, focusing on deploying water-saving techniques. These include rainwater harvesting, greywater recycling, circular showers, and low-water/waterless toilets. Additionally, the greening required to protect cities from heat stress necessitates the availability of circular water sources for the irrigation of green roofs and walls.

3 The need to amend building codes

Legislation and regulations should be accelerated to ensure that they do not act as obstacles but rather as enablers for the application of alternative circular water solutions. This approach is crucial for reducing tap water consumption while maintaining living comfort.

4 Safeguard quality and health aspects

We must safeguard the quality and health aspects of all circular water sources by adhering to existing standards for their safe use. Numerous international studies focusing on risk assessments related to the public health and safety aspects of using alternative circular water for non-potable applications show that risks are negligible when treated and disinfected circular water is utilized for toilet flushing, washing machines, and garden irrigation. In the USA and many other countries, the NSF/ANSI-350 standard is prevalent, whereas in Europe, standards such as EN 16941-1, EN 16941-2, and EN 1717 are applied. The use of smart, digital, IoT-connected solutions enables decentralization of water quality testing down to the point-of-use level.

5 Facilitating financial incentives

Financial incentives, such as tax exemptions or subsidies for water-smart building, rebates on levies, connection fees, or lower utility charges, can accelerate the adoption of circular solutions that save tap water.

1 Water-smart building

We must build homes and buildings that are climate-adaptive. In the area of water, for example, this means that everyone must be able to collect and reuse water.

DEFINITONS

Tap water is water intended for consumptive purposes such as drinking and food preparation.

Circular water is water for applications that do not require drinking water quality, such as flushing toilets, washing clothes, and irrigating gardens, green roofs and green walls. Site-specific circular water systems are systems and techniques applied within the confines of buildings and gardens, whether individual homes or apartment buildings, office buildings, sports facilities, hotels, etc. On-site circular water systems have the great advantage of avoiding cross-connections at the district level, and cross-connection control can be checked before its verified for operation. On-site circular alternative water solutions allow the safeguarding of safety and public health through existing field and/or lab tested and certified techniques. The use of state-of-the-art digital IoT-connected technologies provides 24/7 security monitoring and user data provision.

Hygienic water refers to purified and disinfected water sourced from alternative, circular water systems, intended for safe use in applications such as showers, whirlpools, and swimming pools. For example, using treated and disinfected rainwater for showering, combined with a greywater recycling system, offers the opportunity to use this rainwater from the shower a second time. This can achieve a tap water reduction of up to 80%. While hygienic water is not suitable for consumption, it is safe for human health.

A **Rainwater system** is the technology for non-potable water systems where rainwater is collected, filtered and used for non-potable applications such as flushing toilets, washing clothes, and irrigation. Many countries have standards that allow the safe use of rainwater, such as the EN 16941-1 standard in Europe. It is advisable that standards include a mandatory inspection procedure to check circular water networks for cross-connections before commissioning. The European EN 16941-1 standard includes a verification procedure to check individual systems for cross-connections.

A **Greywater recycling system** is the technology for non-potable water systems where greywater from showers, baths, sinks, washing machines and condensation water from heat pumps, air conditioners and clothes dryers is collected, treated and disinfected, after which it can be reused in the home or building for non-potable applications such as flushing toilets, washing clothes, and irrigation. Many countries already have excellent standards in place to safeguard public health when using treated and disinfected recycled water. The international NSF/ANSI-350 standard is used in the USA and other countries. EN 16941-2 is the European standard for greywater recycling systems. We recommend residual disinfection for larger collective distribution networks to ensure adequate disinfection throughout the distribution network. The recommendation is to maintain an inspection procedure to check circular water networks for cross-connections before commissioning. The European EN 16941-2 standard includes a verification procedure to check individual systems for cross-connections.

A **Circular shower** is a shower in which water from the shower

channel or drain is filtered, disinfected, and reused during the shower session. This enables a spa shower experience using relatively little tap water.

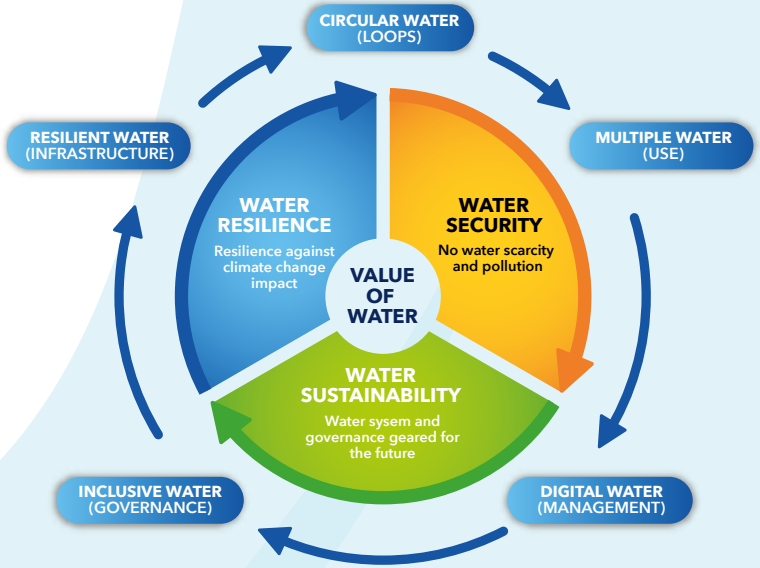
Vacuum toilets are toilets that use little or no water for flushing. Vacuum toilet systems are ideal for installation during the new construction of larger buildings.

Digital water management is the method by which circular water use and UV-C disinfection can be checked through sensors. This can be an important safeguard for public health and safety in circular water systems combined with smartphone apps. The apps provide consumers with 24/7 monitoring and real-time information on water quality, usage, conservation, optimization, and leak detection. These information flows will strengthen consumer engagement and greatly increase awareness of the value of water, both to the consumer personally and to society. There are also opportunities for the use of dynamic tap water rates to allow the value of water to be expressed in variable rates at any time of day, based on peak load and scarcity. The energy market – with its digital information flows - provides a good example of how digital metering, could also be applied for water.

Water-Smart Society is a concept by Water Europe in Brussels. Initiated by the European Commission in 2004, Water Europe has evolved into a multi-stakeholder platform that represents members from across the European Union water value chain and aims to create a 'Water-Smart Society'.

A Water-Smart Society is one in which the value of water is recognized and realized to ensure water security, sustainability, and resilience; all available water sources are managed so that water scarcity and pollution are avoided; water and resource loops are largely closed to foster a circular economy and optimal resource efficiency; the water system is resilient against the impact of climate and demographic change; and all relevant stakeholders are engaged in guaranteeing sustainable water governance.

Water Europe has developed the Water-Smart Society model to illustrate the main objectives and the various elements involved in the aforementioned paradigm shift and their interrelationships. The model consists of one core value, three core objectives that must be achieved to realize the core value, and five specific innovation concepts that are critical to achieving the objectives. The model shows how the innovation concepts and core goals are interrelated, generating a 'flywheel' that drives the process toward the Water-Smart Society.



Circular water is one of the five innovation concepts. This blueprint document aims to further explain the concept of circular water with practical information that can foster the implementation of circular water systems.

2 Circular systems for water-smart building

Increasing and structural water scarcity is taking a toll on water availability and demonstrates that we will need to make major changes to our water system to secure the world's water supply for the coming decades.

Water-saving circular systems should become the norm for new construction and home renovations.

The Global Expert Group Circular Water highlights that the water technology sector is already present in many countries to provide proven, market-ready solutions to optimally deploy rainwater systems, greywater recycling systems, and equipment such as circular showers and vacuum toilets.

Homes and buildings built 'recycle-ready' can be equipped with water-saving circular technologies during construction or even years after completion. The house or building is technically prepared to be able to use circular water.

Vacuum toilet systems and circular showers are also proven applications for water-saving construction.

The savings potential is significant. Using circular water as an alternative source for toilets, washing machines, and gardens, the total potable water consumption can be reduced by up to 45%. And water recycling systems can reduce wastewater emissions by up to 45%.
If hygienic water is used for showering, tap water consumption could be reduced by up to 85%.

Water-smart building can be achieved at a relatively low cost

By designing and building recycle-ready homes and buildings using:

- The installation of a separate water supply system for the toilets, washing machine and garden;
- The installation of a separate greywater drainage system from shower/bath/washing machine/condensation water for decentralized collection, treatment and reuse.

3 The need to adjust building codes

Current legislation and regulations should be adapted more to ensure that rules are not an obstacle but provide opportunities for the application of alternative circular water solutions to reduce tap water consumption while maintaining living comfort.

Adjust building codes to include a national requirement for water-saving construction by installing recycle ready plumbing for water-saving circular systems.

4 Safeguarding the quality and health aspects of all alternative water sources

The Global Expert Group Circular Water endorses the importance of uniform standardization of quality requirements for the various types of water.

Existing standards provide an excellent basis for ensuring the necessary safe circular water quality. The NSF/ANSI-350 standard is used in the USA and many other countries. The EN 16941-1, EN 16941-2, and EN 1717 standards are used in Europe. Safety can be further ensured by applying smart digital IoT-connected monitoring solutions.

It is very important to have the right fit-for-purpose water quality standards so that, on the one hand, water safety and public health are assured, and on the other hand, water quality requirements are not too high. Having too stringent water requirements will inevitably result in significantly higher cost water treatment equipment, which are not necessary for non-potable use. Purchasing costs that are too high will prevent the introduction and application of circular water technologies.

Numerous international research studies have focused on risk assessments regarding the public health and safety aspects of using alternative circular water for non-potable applications. This is a brief summary of the conclusions from three important scientific studies:

1. "Toilet Use in Relation to Exposure to Microorganisms in Aerosols" (2003)

by C.A.A. Butijn, J.P. Groot-Marcus, W.A.M. Hijnen, M.C. van Putten, P.M.J. Terpstra. Summary: Toilet flushes with drinking (tap) water were compared to those using raw greywater with a higher dosage of microorganisms. The experiments aimed to quantify how microorganisms are aerosolized from different toilet types and assess the effects of physical contact with lab-simulated greywater compared to tap water. The conclusion was that greywater poses no significant additional health risks compared to tap water.

2. "Microbiological Safety of Household Water" (1999)

by G.J. Medema, A. Brouwer, and M. de Graaf.
Summary: This study involved artificially contaminating household (circular) water with high levels of specific microorganisms for research.

- Using circular water for toilet flushing didn't significantly increase E.coli and MS2 phages concentrations in the air.
- Drying clothes in tumble dryers didn't significantly raise the concentration of microorganisms in the air around the dryer or in the condensate collection tray.
- Spraying circular water through a garden hose, particularly with a pressure washer, significantly increased the concentration of all tested microorganisms in the air near the spray.

The study concluded that because contamination levels in real-world untreated household water are expected to be more than 1,000 times lower than those in the study, no measurable increase in airborne microorganisms is expected from toilet flushing, tumble dryers, skin contact with wet laundry, or using a garden hose with a spray head.

The exception is the pressure washer. The study recommends reducing risk with the pressure washer and using tap water for this application.

3. "Microbiological and Hygienic Usage Aspects of the use of Rainwater as Process Water for Toilet Flushing, Garden Irrigation, and Laundry Washing" (1996)

by R. Holländer, M. Bullermann, C. GroC, H. Hartung, K. König, F.-K. Lücken, E. Nolde.
Summary: From 102 rainwater storage reservoirs used for various household purposes, around 1600 water samples were microbiologically analyzed. With proper precautions like strict separation of drinking and rainwater pipe networks and appropriate labeling, rainwater use poses no hygienic risk for household applications.

The studies mentioned above were conducted with untreated, non-disinfected rainwater or greywater and demonstrate that the exposure risks for the type of use will not lead to unacceptable health risks. If the circular water is additionally treated and disinfected in accordance with EN 16941-1/2 and NSF/ANSI-350, which we strongly recommend, the risk is further substantially reduced."

The environmental aspects of alternative circular water sources

Alternative circular water sources offer significant environmental benefits, including aiding in the recovery of groundwater levels and restoring the natural water balance. The environmental impact of products, quantified as Eco-costs, shows that circular water incurs lower Eco-costs due to its reduced ecological footprint, compared to tap water. The concept of Eco-costs, developed using databases from Delft University of Technology, is detailed at www.ecocostsvalue.com. This approach highlights the environmental and economic benefits of circular water over traditional methods.

5 Facilitating financial incentives

The Global Expert Group Circular Water advocates that the government should develop schemes that provide financial incentives for citizens and developers to co-invest in the inevitable transformation of the water chain. Incentives could include tax exemptions and subsidies for water-smart building, discounts on utility fees, or lower utility charges. The positive effects of the financial incentives deployed in the energy transition have shown that these incentives are effective at setting the flywheel in motion.

Blueprint for a Circular Water Smart Society

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Conclusion: Water scarcity requires urgent adequate action

To shape the inevitable future vision of the water transition, we recommend governments to:

1. Discourage and eventually ban the use of tap water for non-potable purposes in the shortest possible time, starting with new construction and renovation;
2. Encourage and eventually mandate the use of alternative circular water sources in the broadest sense;
3. Ensure the livability of cities by deploying smart, efficient and safe alternative circular water sources for watering gardens, green roofs and green walls, and to prohibit the use of tap water for these applications;
4. Urgently adjust regulations and building codes;
5. Accelerate the implementation of existing standards for safe circular water use or expand existing standards with sections on safe circular water use. If standards for safe circular water use are not yet available, governments could speed up the introduction of standards and cooperate with existing standards organizations such as NSF or European organizations;
6. Safeguard public health and make circular water available at a lower cost than tap water by applying fit-for-purpose circular water quality criteria;
7. Encourage public-private collaboration among water sector stakeholders to enable them to play a leading role in the transformation to a Water-Smart Society.

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