Circular Water Kit addressing water re-use and water saving in cities

Part of the NiCE D.2.4.1 Solution Box

24.02.2026

NICE GUIDES OVERVIEW

This document is a part of the NiCE Solution Box – a set of four guides offering practical and interconnected approach to advancing circular lifestyles and sustainable development in cities. Though each guide addresses a specific area, together they provide a complete toolbox for organizations, businesses, authorities, and citizens seeking to make urban spaces more resilient, resource-efficient, and community-oriented. All guides can be accessed on the NiCE Knowledge Platform: https://circularlifestyle.eu/resources.

Methodology Kit on stakeholders' engagement in circular lifestyles

This guide focuses on the human and organizational dimension of circular development. It provides step-by-step methods for NGOs, schools, and public authorities to initiate participatory processes, re-activate spaces, and encourage behavioral changes toward sustainability. It emphasizes scaling successful initiatives and sustaining impact over time. The kit combines theory with good practices from Central European cities (Bologna in Italy, Brzeg Dolny in Poland, Budapest in Hungary, Graz in Austria, Jihlava in Czechia, Košice in Slovakia, Ptuj in Slovenia, and Würzburg in Germany), offering versatile tools that can also be applied in other areas of sustainable urban development.

Guide: How to build, run and sustain a multifunctional resource centre

This guide focuses on transforming underused urban areas into dynamic hubs supporting circular practices. It provides a framework for planning, designing, and managing spaces that encourage the sharing, repair, and reuse of materials. Targeted mainly at NGOs and SMEs, this guide emphasizes the importance of stakeholder engagement, financial planning, and day-to-day operations. It also includes case studies from the NiCE Project that show how such centres can become economic and social anchors for city centres in Brzeg Dolny (Poland), Graz (Austria), Košice (Slovakia), and Ptuj (Slovenia).

How to link sustainable e-commerce with city centres. A guide for SMEs and municipalities to bring retail channels together for the benefit of all.

This guide responds to the growing influence of e-commerce on local economies. It offers SMEs actionable strategies to connect their online business activities with physical urban spaces, ensuring that city centres remain vibrant and economically relevant. This includes exploring localized delivery systems, creating synergies between digital and physical marketplaces, and encouraging sustainable practices that align with circular lifestyles. The guide also identifies opportunities for collaboration with logistics providers, technology developers, and community groups, positioning SMEs as key drivers of sustainable urban commerce.

Circular Water Kit addressing water re-use and water saving in cities

This guide highlights water as a critical resource in urban environments. It explains how local authorities and citizens can improve water efficiency, integrate reuse technologies, and enhance climate resilience. The guide’s focus is both educational and applicative: it raises awareness about the value of water and provides policymakers and planners with tools to implement circular water strategies. Real-world examples from Bologna (Italy) illustrate the benefits of collaboration between public authorities and communities, showing how saving and reusing water can strengthen sustainability efforts across cities.

Content

1 INTRODUCTION

1.1 Context: about the NiCE project

The NiCE (From Niche to Centre - City Centres as Places of Circular Lifestyles) project is a transnational initiative aimed at revitalizing urban centers by promoting circular and sustainable lifestyle and consumption. In response to challenges such as the COVID-19 pandemic and the rise of online commerce, which have led to the decline of traditional retail spaces, NiCE seeks to transform city centers into vibrant hubs of circular lifestyles.

Central to the project's vision is the promotion of sustainable consumption habits and the establishment of strategic frameworks to support circular lifestyles. Through innovative urban development approaches, NiCE encourages the repurposing of spaces for reuse, repair, and sustainable consumption initiatives. The project also emphasizes education and collaboration, offering inspiration and practical tools to municipalities, citizen associations, and policymakers to foster sustainable behaviors and practices.

NiCE operates across eight Central European countries: Austria, Czechia, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia, bringing together a diverse group of partners to share knowledge, implement pilot projects, and scale successful models. By doing so, it aims to position city centers as active hubs of sustainability and circular innovation, inspiring broader adoption of these practices throughout the region.

Building on these core objectives and recognizing the critical role of water resource management in creating circular and resilient urban centers, NiCE's efforts naturally extend to the development and promotion of the Circular Water Kit.

1.2 Purpose of the Circular Water Kit

The Circular Water Kit is designed to support the adoption of water reuse practices in urban environments, addressing the need to reduce water wastege and promote sustainable resource management. This guide[1] aims to raise awareness about the importance of circular water management in tackling urban challenges and enhancing climate resilience. It offers practical recommendations for implementing water-saving and reusing technologies and solutions.

In addition, the guide provides local authorities and urban planners with tools and knowledge to integrate circular water principles into their projects, fostering sustainable urban development. By including case studies and best practices, it highlights successful water reuse

[1] Throughout this document, the terms "Circular Water Kit" and "this guide" are used interchangeably to refer to the same resource, i.e. the present document.

strategies and demonstrates their positive impacts on cities. It serves as both an educational resource for the general public and a practical toolkit for decision-makers, bridging the gap between understanding and action.

1.3 Target groups of the guide

The Circular Water Kit is designed to address the needs of two primary target groups: public authorities and the general public.

Public authorities in Central Europe, including urban planners, policymakers, and environmental departments, will find this guide particularly valuable. It provides them with actionable insights and tools to develop and implement circular water strategies within their jurisdictions. By outlining practical solutions and offering policy recommendations, the guide supports decision-makers in tackling urban water challenges while advancing sustainability goals.

The general public living in cities of Central Europe is also a key audience for this guide. By raising awareness about water reuse and its benefits, the guide seeks to inspire individuals to adopt sustainable water practices in their daily lives. Through accessible explanations and real-world examples, it empowers citizens to contribute to circular water management efforts in their communities.

By addressing these two groups, the guide fosters collaboration between decision-makers and the public, ensuring that water reuse initiatives are both effective and widely supported.

2 UNDERSTANDING CIRCULAR WATER MANAGEMENT

2.1 Overview of water reuse principles in cities

Understanding the significance of circular water management, the 5Rs framework developed by the International Water Association (IWA) provides a comprehensive approach encompassing Reduce, Reuse, Recycle, Restore, and Recover. From a systems perspective, it is crucial to integrate these principles across the entire water value chain – from the source and supply to end users. According to the World Business Council for Sustainable Development (2017), this involves minimizing water losses and improving efficiency, reusing water where possible, recycling water and resources, restoring water to its original environment with appropriate quality, and recovering valuable resources (beyond water) from wastewater for beneficial use.

Ensuring adequate access to water is essential for a sustainable future, particularly as climate change is expected to exacerbate water scarcity in various regions across Europe. Water reuse has emerged as a key adaptation strategy, helping to alleviate pressure on freshwater resources while maintaining water security for human needs and ecosystem health. As highlighted in a recent study published by the Environmental and Energy Study Institute (EESI) by Jamiya Barnett (2024), water reuse can be categorized into potable and non-potable applications. Potable water reuse involves the advanced treatment of wastewater from residential and commercial sources, sometimes blending it with surface or groundwater supplies, to produce safe and reliable drinking water. In contrast, non-potable water reuse – also referred to as water reclamation – recycles treated wastewater for applications that do not require drinking water standards, such as irrigation, industrial processes, or toilet flushing.

Typical types of water reuse include the following approaches:

- **Rainwater harvesting** – as discussed by Wartalska et al. (2024) – is a widely recognized and promising method, involves the collection and reuse of rainwater. This practice not only contributes to water conservation but also helps prevent the overloading of sewage systems. Collected rainwater can be used for various non-potable purposes such as garden irrigation, car washing, and toilet flushing. With proper purification, it can also be made safe for drinking.
- **Greywater reuse** – explained by Barnett (2024) – refers to the repurposing of relatively clean wastewater from sinks, showers, and washing machines, typically for use within the same building or property. This method reduces freshwater demand and supports sustainable water management. (Barnett, 2024)
- **Wastewater treatment and reuse** – described by Barnett (2024) – can take two main forms. In one approach, treated wastewater is released into a natural basin or reservoir, where it undergoes additional natural filtration through soil and rock layers before re-entering the water supply. Alternatively, purified water reuse involves subjecting wastewater to advanced treatment technologies, allowing it to be reintroduced directly into the drinking water supply without the need for an environmental buffer.

Figure 1 highlights reclaimed water applications relevant for urban areas based on the report by the Joint Research Centre (JRC) titled "Water Reuse in Europe" (2014).

Urban uses

- Irrigation of public parks, sporting facilities, private gardens, roadsides;
- Street cleaning; Fire protection systems; Vehicle washing; Toilet flushing;
- Air conditioners; Dust control

Recreational uses

- Sport facilities irrigation
- Recreational impoundments with/without public access (e.g. fishing, boating, bathing)
- Aesthetic impoundments without public access
- Snowmaking

Environmental uses

- Aquifer recharge
- Wetlands
- Marshes
- Stream augmentation
- Wildlife habitat
- Silviculture

Potable uses

- Aquifer recharge for drinking water use
- Augmentation of surface drinking water supplies
- Treatment until drinking water quality

Figure 1 Reclaimed water applications relevant in cities. Own reproduction based on “Water Reuse in Europe” (2014).

Ghimire et al. (2014) and Stephan & Stephan (2017) both suggest a lifecycle approach to water in urban areas, which considers the entire journey of water – from its source, through distribution, use, treatment, reuse or disposal, and eventual return to the environment. This holistic perspective is essential for ensuring sustainable, efficient, and resilient water management in the face of growing urban populations, climate change, and resource scarcity.

2.2 Key challenges in urban water management

Water scarcity is a growing global concern, driven by climate change, population growth, and unsustainable water use. In urban areas, the situation is especially critical as rising populations and expanding industries place increasing pressure on already limited freshwater resources. Cities often rely on distant or over-exploited sources, leading to environmental degradation and reduced resilience to droughts. Without effective management, the gap between water demand and available supply will continue to widen, threatening public health, economic development, and ecosystem stability. (Ghimire et al., 2014; Stephan & Stephan, 2017, WBCSD, 2017)

Addressing this challenge is directly aligned with United Nations Sustainable Development Goal 6 (Clean Water and Sanitation), which calls for ensuring availability and sustainable management of water and sanitation for all. Achieving this goal in urban contexts requires integrated, forward-thinking solutions such as water reuse, efficiency improvements, and investments in resilient infrastructure. (UN, 2015)

Concering the infrastructure limitations in cities, we conclude that urban areas face significant challenges due to aging, fragmented, or insufficient water infrastructure. Outdated distribution systems often result in high water losses through leakage, while limited wastewater treatment capacity hinders safe reuse and environmental protection. Rapid urbanization can outpace infrastructure development. Achieving Sustainable Development Goal 11 (Sustainable Cities and Communities) and Goal 6 (Clean Water and Sanitation) requires targeted investment in modern, resilient, and inclusive infrastructure that supports circular water use, efficient service delivery, and long-term urban sustainability. (UN, 2015)

"Water Reuse in Europe" (2014) report identifies several key barriers to the broader adoption of water reuse practices. These include limited public and governmental support, as well as insufficient institutional capacity to design and implement effective recycling and reuse strategies. When developing local water reuse strategies, it is therefore essential to prioritize education, awareness-raising, and active citizen engagement. These elements play a critical role in fostering acceptance, building trust, and creating the social momentum necessary for the successful integration of water reuse into urban water management systems.

2.3 Benefits of circular water strategies for cities

The “Water Reuse in Europe” (2014) report highlights that water reuse contributes to several key European and global sustainability goals. It supports the objectives of a resource-efficient Europe *(COM(2011) 21)*, the development of highly resource-efficient cities and communities (as promoted by initiatives like Smart Cities – http://eu-smartcities.eu), and aligns with international efforts such as those led by the Water Environment Research Foundation (WERF) and the Global Water Research Coalition (GWRC).

As acknowledged by the Common Implementation Strategy for the Water Framework Directive (2000/60/EC), practices such as rainwater harvesting and greywater reuse enable cities to substantially reduce overall water consumption while minimizing the discharge of untreated or lightly treated wastewater into natural ecosystems. These measures not only conserve valuable freshwater resources and help mitigate environmental pollution, but also ease the burden on centralized wastewater treatment infrastructure. Water utility and sewer charges vary significantly across countries and municipalities, but reducing freshwater demand – particularly in public buildings – can lead to considerable cost savings for local governments and public institutions. In some cases, this may amount to thousands or even hundreds of thousands of Euros annually in reduced utility and energy costs. Furthermore, buildings implementing on-site water reuse systems can also lower their carbon footprint. By increasing water efficiency and diversifying supply sources, water reuse also enhances urban resilience to climate-induced stressors, such as droughts and growing water scarcity, reinforcing its role as a strategic adaptation measure.

2.4 Benefits of circular water strategies for city residents

As urban populations grow, two out of every three people are likely to be living in cities or other urban centres by 2050 according to the UN , and climate change intensifies water stress, cities must adopt innovative and resilient approaches to water management. Circular water strategies (as introduced in Figure 1), such as rainwater harvesting, greywater reuse, and decentralized treatment, represent a key solution for sustainable, inclusive, and adaptive urban water systems. These strategies align with the United Nations Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production).

Among the key benefits for urban residents, we can identify environmental, economic as well as social outcomes. Among environmental gains enhanced water security, pollution reduction and more liveable urban environments due to the spread of urban nature-based reuse options can be mentioned. Economic advantages cover cost savings, reduced infrastructure pressure due to decentralized systems as well as cretaion of green jobs supply. Social outcomes incpororates advanced resilience by enhancing emergency preparedness, improved urban quality of life as greener infrastructure contributes to cleaner, healthier, and more attractive neighbourhoods as well as community cohesion, since collaborative projects for water reuse have the potential to foster environmental awareness and active participation in local sustainability initiatives. (Common Implementation Strategy for the Water Framework Directive (2000/60/EC))

3 CASE STUDY FROM BOLOGNA

In 2017, the G7 Environment Summit was hosted by Bologna (Italy). During the event, the mayors of the Italian metropolitan cities, including Bologna, signed the Bologna Charter for the Environment. With this charter, the cities commit to a series of key environmental issues, including circular economy, water quality improvement, urban greenery, and biodiversity protection.

In line with this committment, in 2019 the metropolitan city of Bologna developed its Agenda for Sustainable Development, identifying eight key issues to address in the region. One of these is climate change, which in recent decades has led to a significant increase in extreme events and the alternation of long dry periods with periods of very heavy rainfall and floods. The issue of water, and particularly the sustainable management of water resources in urban settings, therefore plays a central role in climate change adaptation strategies from a circular economy perspective in the area.

In recent years, the city of Bologna has been involved in numerous projects on the topic of water and, in 2023, was chosen by ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, as the Italian pilot city for the NiCE project. The overall goal of the "Acqua in Circolo" (water in circulation) pilot activity was to promote water reuse and conservation, inspiring the local community to adopt more sustainable lifestyles and consumption in line with the principles of the circular economy.

3.1 Key measures implemented

The pilot applied the Living Lab methodology, open innovation ecosystems that promote collaboration and co-creation between citizens, institutions, businesses, academic communities, and non-governmental organizations.

The activity had two main areas of intervention, i.e. the Urban Living Lab (ULL) and the School Living Lab (SLL). Through the ULL, citizens and local stakeholders were involved in hands-on, participatory activities related to the topic of water and its use for urban farming. At the same time, the SLL targeted schools in the area, offering educational paths and workshops that stimulated awareness in young people on the importance of water saving and circular economy good practices.

For the ULL, in the fall of 2024 three meetings were organized by ENEA between citizens and experts in circular economy and circular water management. The aim of the first one was to discuss the topic of the circular economy applied to the urban context, with a particular focus on urban farming and water use. During the second one, citizens and experts jointly identified three solutions for a more circular and efficient use of water for urban farming (a rainwater tank with phytoremediation, a wicking bed, i.e. a raised bed with a water collection tank under the soil, and a hydroponic growing tower). In the final meeting, the three solutions were built and handed over to three citizen groups (co-housing residents, a community gardening association, and a group of researchers and students from the University of Bologna, respectively). In the following months, the three groups of citizens tested the solutions, monitored their water consumption, and assessed the water savings, also with the help of experts. In June 2025, the entire experience was shared at a public event that marked the formal conclusion of the NiCE pilot activities in Italy. However, the installations remain available to the local community and its citizens, and their continued use is already planned, for example for educational purposes in municipal gardens and for research at the University.

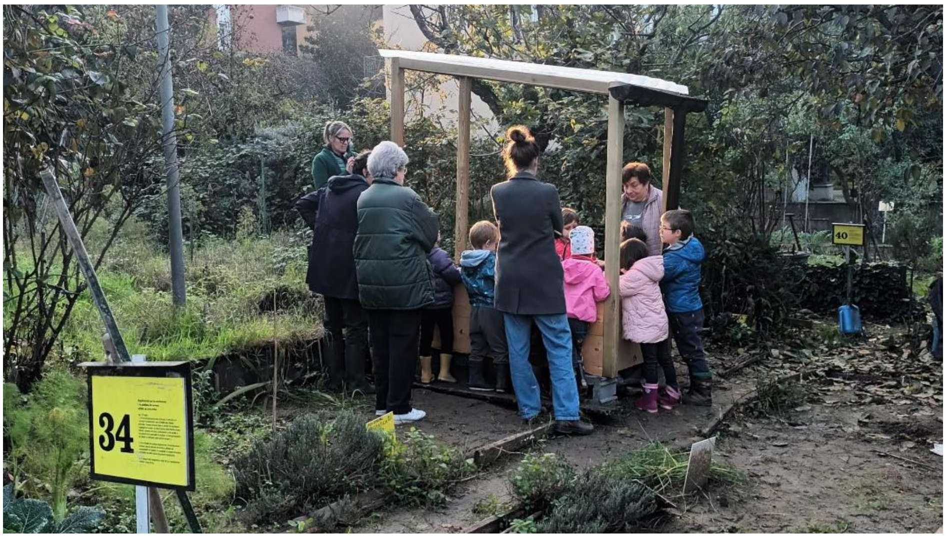

Figure 2 The wicking bed installed at the Porta Saragozza municipal gardens. Source: ENEA

For the SLL, four lessons were organized by ENEA in various elementary and middle schools in Bologna in February-March 2025. The lessons, based on active teaching approaches and the use of simple laboratory tools, aimed to introduce students to the water cycle and the principles of water saving at home. ENEA also shared its "Decalogue" for water saving with the students (later expanded to twenty tips) inspiring games, discussions, and creative activities. In some classes, middle school students monitored their families' water consumption, while others created themed comics, demonstrating lively and attentive engagement.

3.2 Results and lessons learned for replicability in other cities

Several factors contributed to the successful implementation of the “Acqua in circolo” pilot project in Bologna and the overcoming of obstacles that arose during its duration.

Of vital importance was publicizing the pilot and its activities through intensive communication efforts across various channels (email, flyers, and personal communications about events among residents of the city's neighbourhoods) to engage residents, teachers, and students. Support and regular discussions with a Stakeholder Board, composed of Bologna's institutions, associations, and citizen groups, allowed the activities to be optimized and disseminated to a broad and diverse audience. In addition to communicating with individuals, working with citizen groups, such as members of the municipal vegetable gardens association, enabled the involvement of numerous individuals in associations, undoubtedly contributing to the success of the initiatives. Finally, the presence of external technical collaborators, such as the start-up Aquaponic Design, which specializes in soil-less and low-water cultivation, provided ENEA researchers with indispensable support, particularly for the more practical and time-consuming activities carried out with citizens (e.g., construction of the three solutions and monitoring of activities in the ULL).

On the other hand, some aspects did not work well, and the researchers had to face and overcome some difficulties. For example, the rainwater tank, originally located in the co-housing courtyard, had to be moved during the pilot because of the need for unexpected renovations to the adjacent building. This was certainly a challenging obstacle, to be overcome in a very short timeframe, but thanks to the network built throughout the pilot, finding a new temporary location offered the opportunity to learn about and meet other associations working in the field of circularity, thus overcoming the initial difficulty. In general, the placement of the installations in areas outside of ENEA's control, or not directly under its control, posed challenges in terms of required authorizations and related permits, extending the implementation timeline. This aspect must be carefully considered by anyone wishing to replicate the “Acqua in Circolo” experience. Some issues related to seasonal variability in urban farming should also be addressed, if possible. In fact, for a pilot like “Acqua in Circolo” to be successful, it would be beneficial to have all four seasons available, not just for a limited period. The timing of the NiCE project did not perfectly accommodate this requirement, but it could be considered for possible future experiments.

All things considered, the NiCE pilot project in Bologna achieved interesting results in terms of participation, both among the residents of the ULL and among the students of the SLL. Especially in schools, students showed great interest in the topic of water saving and recycling, thanks in part to the careful preparatory work carried out by teachers and educators, together with ENEA researchers. The Bologna pilot project is certainly replicable for a number of reasons. First, the issue of water scarcity is common to many cities and nations, sparking interest among citizens and stakeholders. Furthermore, the solutions implemented in the Bologna pilot project are scalable, as the systems can be installed in large or small spaces, indoors or outdoors, and the activities can involve adults, youth, and children. They can also be implemented with DIY solutions and using waste materials, making them more sustainable, including economically, and accessible to all.

Considering all these aspects, those intending to replicate the Bologna pilot project should be proactive in reaching out to people and careful in choosing installation locations and checking the related regulations, restrictions, and permit requirements. Furthermore, they should provide adequate technical support and organize all activities, if based on urban cultivation, throughout all four seasons of the year, for optimal implementation of the pilot project.

4 PRACTICAL GUIDELINES FOR LOCAL AUTHORITIES AND CITY PLANNERS

4.1 Steps for integrating water saving & reuse into urban planning

4.1.1. Assessing Local Water Needs and Resources

The first step in integrating water saving and reuse into urban planning is to make a thorough assessment of local water demand, distribution infrastructure and available resources that refer to the supply of water. This foundational analysis ensures that strategies are tailored to the water consumption and specific hydrological, climatic, social, and infrastructural conditions of the area. Key steps include:

- **Mapping water demand and the patterns of consumption**: It means an analysis of current consumption across residential, public, commercial, and industrial sectors. The first step is to identify peak demand periods, major users and inefficiencies (if exist). It is crucial to know how water is currently used in different areas, such as homes, public institutions, businesses, and factories. The goal is to find out: how much water is used; when it is used the most (peak times); who the biggest users are; and whether there are any areas where water is being wasted or used inefficiently.
- **Evaluating existing water infrastructure**: Infrastructure refers to the physical systems and facilities used for the extraction, treatment, storage, distribution, reuse, and discharge of water. It covers both potable water and wastewater systems, as well as stormwater and sometimes flood control infrastructure. It is necessary to assess the condition and capacity of water supply, wastewater, and stormwater systems. For example, reservoirs and dams, drinking water and wastewater treatment plants, distribution systems (pipes, pumps, valves, pressure regulators), sewage networks, stormwater drainage systems, water towers and tanks, rainwater harvesting systems (cisterns, barrels, tanks) should be examined. The goal of the evaluation is to know: what condition they are in; how efficiently they operate; and whether they can support future water-saving and reuse efforts, or if upgrades are needed.
- **Quantifying local water sources**: Having focused on the demand and the distribution infrastructure, it is important to understand where the water comes from. This involves identifying and measuring all available sources, including traditional sources like rivers, lakes (surface water), underground aquifers (groundwater), and alternative sources such as rainwater, greywater (lightly used water from sinks, showers, etc.), and treated wastewater. The goal is to assess how much water each source can provide and how reliable they are.

- **Projecting future water needs**: This means estimating how much water will be needed in the future. To do this, population growth, economic trends and consumption patterns must be considered. Different development scenarios (like building more homes or expanding agriculture/industry) are used to predict future water demand, so that long-term planning can be more accurate and sustainable.
- **Identifying weaknesses and vulnerabilities**: The last step looks at the risks and problems that could affect the water system. It includes: climate change impacts, such as more frequent droughts, floods, or extreme weather; physical issues like old, leaking, or poorly maintained pipelines; gaps or weaknesses in policies, regulations, and management of water distribution. Understanding these vulnerabilities helps create a more resilient and adaptable water system for the future.

4.1.2. Developing a Comprehensive Water Saving & Reuse Strategy

Once the local context is explored, then based on the evaluation, city planners should work with stakeholders to develop a coherent strategy that promotes water efficiency and reuse across all sectors. Circular water solutions need many actors from a region to be involved. Key elements of the strategy can be:

- **Vision and strategic goals**: This initial part contains the establishment of a long-term, integrated vision for sustainable water management, aligned with environmental, social, and economic priorities. Clear, measurable objectives and the most relevant indicators should be determined, e.g., targeted reductions/savings in potable water consumption or greenhouse gas emissions; increased reuse or treatment rates; or improved system efficiency. The vision should guide all planning, investment, and regulatory actions over time, and should be available and clear to all the stakeholders. Precisely defined vision and objectives serve as a commitment of the main entities.
- **Local governance, and regulatory frameworks**: Regulation of the water supply system is largely managed at the national, state level rather than locally. As a result, municipalities and local stakeholders affect policymaking limitedly, but still have several important ways to promote efficient water use within their jurisdictions. For instance, municipalities can require water-efficient fixtures and appliances (like low-flow toilets, faucets, and irrigation systems) in new buildings and renovations through local building regulations and permit conditions. Local governments control zoning and land development plans, which can incorporate requirements for sustainable water management, e.g., mandatory rainwater harvesting systems, green infrastructure, or limits on water-intensive landscaping. Municipalities can run education campaigns

(even in schools) and offer local incentives or rebates to encourage residents and businesses to conserve water and install efficient technologies. Local authorities often manage wastewater and stormwater systems and can adopt regulations to promote greywater reuse or reduce water loss.

- **Integration of advanced technologies**: This phase should facilitate the deployment of scalable and proven technologies that enhance system efficiency and reuse. These could include dual plumbing systems, decentralized wastewater treatment units, smart metering and leak detection, and integrated rainwater harvesting. Modernization of the water supply system, encouraging innovation through pilot projects and supporting research and development can also be the parts of this section.
- **Public engagement, education, and behavioral change**: Technology alone is not enough. Without informed and conscious users, the situation could even get worse by using advanced technologies (see e.g. the rebound effect in literature). For the system to operate efficiently, intelligently, and in an environmentally sustainable manner, it must be supported by public education, active consumer engagement, and a shared sense of responsibility. Therefore, ongoing public awareness campaigns, educational programs, and participatory planning processes are essential to build broad community support. Water-saving behaviors can be encouraged through accessible information, interactive feedback tools, and community-based initiatives. Partnerships with schools, NGOs, and local organizations can further expand the reach and impact of these efforts.
- **Financing and economic instruments**: Financial and economic instruments are well-established tools for influencing consumer behavior. By adjusting prices, consumers can be guided in the right direction without the need for lengthy explanations or education. So, identifying and mobilizing diverse funding streams to support strategy implementation is imperative. Mechanisms may include government subsidies or taxes, green bonds, user fees, development grants, and public-private partnerships. Introduction of incentives for households, developers, and industries to invest in water-saving technologies and practices. Ensuring financial models are equitable, transparent, and sustainable over the long term.

4.2 Policy recommendations and regulatory frameworks

4.2.1 Types of policies supporting circular water management

Regulatory policies establish the legal foundation for implementing circular water practices by setting standards, obligations, and compliance mechanisms.

- *Water quality and reuse standards*: define the acceptable quality levels for treated wastewater and greywater used in irrigation, industrial processes, or even for non-potable indoor use (e.g., toilet flushing).
- *Reuse mandates and minimum requirements*: new buildings or developments must include systems for rainwater harvesting or greywater reuse.
- *Pollution control and discharge limits*: regulations that restrict contaminants entering water bodies promote resource protection and make water reuse more feasible.
- *Building and plumbing codes*: local or national codes may require dual plumbing systems or fixtures that allow for water recycling and reduced demand.
- *Environmental permitting systems*: required for the operation of water reuse and recycling infrastructure.

Economic and financial policies aim to shift the economic balance in favor of water efficiency, reuse, and innovation by using prices and incentives.

- *Water pricing reforms*: setting/adjusting tariffs that reflect the real economic, environmental, and social cost of water promotes conservation and efficient use.
- *Subsidies and incentives*: financial support (e.g., direct support or lowering tax) for installing water-saving technologies, such as greywater treatment systems or smart irrigation, makes adoption more attractive.
- *Polluter-pays and user-pays principles*: disincentivize overuse or contamination of water resources through fees, penalties, or usage-based pricing.
- *Green bonds and public investment schemes*: funding mechanisms that enable large-scale water reuse and recycling infrastructure projects.
- *Tax relief or depreciation allowances*: can encourage private sector investment in circular water technologies by lowering the total cost of capital.

Planning and land-use policies integrate circular water strategies into the spatial, physical, and strategic planning of urban and regional development.

- *Integrated water resources management*: a coordinated approach to managing water, land, and related resources for equitable and sustainable outcomes.
- *Zoning and development regulations*: require or promote the use of water-sensitive urban design, like permeable pavements or green roofs that enhance water infiltration and reuse. In the case of zoning, for example, certain water-intensive activities may be restricted in a specific zone or encouraged in zones where water is a more abundant resource.
- *Water-sensitive urban design and the “sponge city” planning*: these approaches manage water sustainably at the urban design level, capturing and reusing rainwater

while reducing runoff and flood risk by converting the city into a "sponge" via nature-based solutions.

- *Climate adaptation and resilience planning*: include water reuse strategies to increase the robustness of water supply under climate stress.

Technical and operational policies establish performance standards, guidelines, and procedures to ensure that circular water systems are safe, efficient, and interoperable.

- *Design and engineering standards*: regulate how systems for greywater reuse, rainwater harvesting, or decentralized treatment should be built and operated.
- *Technology approval and certification schemes*: ensure that water reuse systems meet safety, health, and environmental standards before they're adopted.
- *Monitoring and control frameworks*: require regular testing, reporting, and transparency for treated water quality and system performance.
- *Digital water policies*: support the use of smart meters, sensors, and internet-based data platforms to optimize circular water flows and detect leaks or inefficiencies.

Institutional and governance policies define the structures, responsibilities, financial support, and coordination mechanisms needed for circular water initiatives to succeed.

- *Clear role assignment*: clarifies which institutions are responsible for planning, financing, regulating, and managing circular water systems.
- *Decentralized governance*: building on the principle of subsidiarity, this level of governance empowers local governments, communities, and utilities to adopt context-specific water reuse practices that fit local conditions.
- *Multi-level coordination*: facilitates collaboration among national, regional, and local authorities, as well as cross-sectoral alignment (e.g., with energy, agriculture, housing).
- *Public-private partnerships (PPPs)*: facilitate investment and innovation by allowing private actors to collaborate in infrastructure projects or service delivery.

Educational and behavioral policies support public awareness, acceptance, and behavior change, which are essential for circular water systems to be effective and socially accepted.

- *Awareness-raising campaigns*: educate the public about the benefits and safety of water reuse, conservation, and responsible consumption.
- *Water literacy in schools and communities*: build long-term understanding of water cycles, sustainability, and user responsibility.
- *Behavioral incentives and nudges*: encourage households or businesses to reduce water use through tools like real-time consumption feedback, water-saving competitions, or loyalty programs.

- *Participatory governance and citizen engagement*: involve users in monitoring, planning, and decision-making, building trust and co-ownership of water initiatives.

4.2.2 Examples of regulations from cities with successful water management programs

a) **Singapore – The NEWater Program:** Singapore has long faced significant water scarcity challenges. With no abundant natural freshwater resources, the country historically relied heavily on water imports (especially from Malaysia) to meet its growing demand. But the goal is to become fully self-sufficient by 2061, when the last water deal with Malaysia ends. To make this happen, the country came up with a strategy called the "Four National Taps". Its elements: rainwater collected locally, imported water, desalinated seawater, and recycled used water (a.k.a. NEWater). The NEWater initiative is the most well-known component of this strategy. It involves treating used water through a rigorous three-step purification process: microfiltration, reverse osmosis, and ultraviolet disinfection. The result is ultra-clean, high-grade reclaimed water that exceeds drinking water standards set by important professional organizations (WHO, USA EPA). Currently, Singapore operates five NEWater plants that together meet around 40% of the country's total water demand. By 2060, this proportion is expected to increase to 55%, significantly reducing reliance on external sources. Importantly, the success of NEWater is not only technical. Public communication campaigns were critical in shaping perceptions about drinking reclaimed water. When the program started in 2002, public surveys showed 98% acceptance, with many citizens expressing a willingness to drink NEWater directly. The government avoided terms like "recycled sewage" and instead promoted NEWater as a national achievement. Singapore has also invested in an extensive network of 17 reservoirs, collects rainwater over two-thirds of its land area, and maintains one of the lowest non-revenue water rates in the world. In addition, water pricing and water-saving education are key parts of the overall demand management system.

b) **California – Orange County Water District:** Orange County has long struggled with water shortages. To fix this, two local agencies teamed up to build the Groundwater Replenishment System (GWRS) which is the world's largest advanced water recycling plant for drinking water. Launched in 2008, GWRS started by producing 70 million gallons of purified water per day. After expansion in 2015 and 2023, it now delivers up to 130 million gallons daily, enough for nearly 1 million people. The process is high-tech: wastewater goes through microfiltration, reverse osmosis, and UV light with hydrogen peroxide, removing everything from dirt and bacteria to pharmaceuticals. The result is ultra-clean water that exceeds drinking standards. Instead of sending it straight to taps, the water is used to refill underground aquifers and prevent seawater from contaminating wells. This reduces the need to import water from faraway sources like the Colorado River. The system is also energy-efficient and cost-effective in the long run. Public education helped win support, and the project has received global recognition, even a Guinness World Record for the most wastewater recycled into drinking water in 24 hours.

c) **China – The "Sponge City" Concept:** As China's cities grew fast, they experience bigger and bigger water problems: more floods, less groundwater, and poor stormwater management. In 2015, the government launched the Sponge City Initiative, aiming to turn cities into water-smart systems that absorb, reuse, and clean rainwater instead of just draining it away. The idea is simple: use nature-based solutions like permeable pavements, rain gardens, green roofs, wetlands, and urban lakes to soak up stormwater, reduce flooding, recharge aquifers, and make cities greener and more livable. Unlike traditional concrete-heavy infrastructure, sponge cities slow water down, store it, and let it filter naturally. It started with 16 pilot cities, and by 2020 had spread to over 30, including big names like Shanghai, Shenzhen, Wuhan, and Chongqing. The national goal: reuse or absorb 70% of rainwater, and upgrade urban areas to meet sponge standards. Wuhan became a model sponge city. Over 20 km² got a green makeover, with results: stormwater runoff fell by 70%, flooding was cut by 60%, and the city saved around $150 million per year in flood damage. Lingang New City in Shanghai also swapped concrete for grass, absorbent paving, and wetlands around Dishui Lake. It brought better drainage, less flooding, more biodiversity, and nicer public spaces.

d) **Saudi Arabia – Solar-Powered Seawater Desalination:** Saudi Arabia lies largely within desert terrain and possesses extremely limited natural freshwater resources. To satisfy water demand, the country relies heavily on seawater desalination, currently providing about 60–75% of its urban drinking water. However, conventional desalination technologies, especially thermal methods like multi-stage flash and multiple-effect distillation, are extremely energy-intensive, contributing significantly to carbon emissions and environmental impacts in the Gulf region. To reduce costs and emissions, Saudi Arabia has begun deploying solar-powered desalination plants, aligning with its national Vision 2030 goals. A flagship project is the Al Khafji Desalination Plant, inaugurated in 2018. Powered in part by photovoltaic solar energy, it produces up to 90,000 m³ per day of potable water and has already treated over 7 million cubic meters. The plant uses solar energy to reduce average costs by 40% and cut GHG emissions by approximately 14,000 tonnes, along with saving around 1.1 million barrels of crude oil. Another major initiative is the Jubail 3A "Jazlah" plant, which began operations in 2023. It integrates 45.5 MW solar

PV, providing about 20% of its energy needs for reverse osmosis desalination. This facility produces 600,000 m³/day, serving around 3 million people. It reduces emissions by roughly 60,000 tonnes per year and demonstrates world-class efficiency. Saudi officials report a 50% reduction in desalination costs and an 80% improvement in energy efficiency over recent years.

e) **Australia – Household Rainwater Harvesting Incentives:** In Australia, governments at both federal and state levels have actively promoted the installation of rainwater tanks in households to alleviate the impacts of recurrent drought and reduce dependence on centralized water supplies. From 2009 to 2011, the National Rainwater and Greywater Initiative provided rebates (up to AUD 1,500 per household) for rainwater harvesting systems intended for non-potable uses such as toilet flushing and irrigation. Over 14,600 systems were installed, with around 32% of eligible households in capital cities adopting rainwater tanks during that period. Although the federal rebates ended in 2011, several state governments maintained subsidy schemes and regulations. In Victoria, installing a tank connected to toilets earned homes additional energy rating stars; South Australia, New South Wales, Queensland, and Tasmania provided varying rebate levels. These programs led to increased tank adoption rates in urban areas. Rainwater harvesting helps households significantly reduce mains water use and lowers stormwater runoff, supporting urban flood mitigation and infrastructure maintenance.

f) **Berlin, Germany – Green Roofs and Rain Gardens:** Berlin is a European leader in green roof implementation and stormwater-sensitive urban design. With over 5.4 km² of green roofs covering 3–5% of all buildings, these installations absorb rainfall, reduce sewer burden, cool urban microclimates, and support biodiversity. For instance, the Potsdamer Platz redevelopment features extensive green roofs, underground cisterns, bioretention ponds, and reuse systems, handling about 23,000 m³/year of stormwater and cooling summer temperatures by up to 2 °C. Collected water is reused for irrigation and toilet flushing. Moreover, Berlin's funding incentives like the GründachPLUS (formerly "1,000 green roofs") subsidize greening on existing buildings to alleviate stormwater flow charges. Rainwater fees are calculated based on impervious area, and green roofs can halve that counted surface area, reducing costs for owners who install them.

g) **Canary Islands, Spain – Membrane-Based Desalination Technologies:** The Canary Islands, with limited fresh water and high tourism demand, rely heavily on desalination, with over 300 desalination plants producing 700,000 m³/day of water - nearly 95% using membrane technology. Since around 2011, LG NanoH_2O membranes (featuring thin-film nanocomposite designs) have powered roughly 45% of desalination capacity. These advanced membranes offer energy savings, improved boron rejection, and high-quality permeate, supporting sustainable water supply for residents and tourists alike. El Hierro (the smallest major Canary Island) has also pioneered using renewable energy (wind and pumped hydro storage) to power its desalination plants, making it nearly energy-self-sufficient while meeting the freshwater needs of its population.

h) **Israel – Netafim and Precision Drip Irrigation Systems:** With its dry climate and limited water resources, Israel had to find a better and smarter way to farm. Traditional flood irrigation was just too wasteful. The breakthrough came in 1965, when engineer Simcha Blass and Kibbutz Hatzerim launched Netafim, introducing drip irrigation, a system that delivers water directly to plant roots, reducing evaporation and waste. This method had a vast impact on agriculture worldwide. Drip irrigation can cut water use by about 50% and still increase crop yields. In rice farming, it can even save up to 70% water, cut methane emissions to nearly zero, and match or beat traditional yields. The benefits go beyond water: growing corn with drip irrigation, for example, can lead to fewer carbon emissions, less fertilizer use, and higher yields. Thanks to innovations like Netafim's, Israel now reuses about 80% of its treated wastewater, mostly for farming. Around 75% of Israeli agriculture uses drip irrigation (the global rate is around 5%). Today, Netafim transfers the technology and operates in over 110 countries, irrigating more than 10 million hectares, and has become a global leader in sustainable farming. In 2013, Netafim won the Stockholm Industry Water Award for its major impact on global water management.

4.3 Community engagement and raising public awareness

Successful implementation of circular water management in cities relies not only on technical solutions but also on public support and behavioral change. Since cities are densely populated areas with many residents and much infrastructure, they bear lots of responsibility, but also lots of opportunity for radical change. Engaging communities and raising awareness help create a shared understanding of water challenges, foster long-term commitment, and encourage the adoption of water-efficient practices. This section explores practical ways to involve the public through education, partnerships, and trust-building strategies.

4.3.1 Organizing public workshops and educational campaigns

The price of water (especially drinking water for the public) in many countries does not reflect its real value. Despite (and in some ways precisely because) it is a basic requirement for life, it is typically (and artificially) quite cheap, which does not encourage frugal use. It is therefore very important to raise awareness in people's minds that water purification and supply cause serious environmental pressure and may lead to supply problems in many regions due to climate change. Educational efforts are essential to help residents understand the natural circulation of water, its sustainability aspects, the importance of conservation, reuse, and its role in the circular economy. Public workshops and campaigns can:

- provide useful, practical knowledge about topics such as water-saving techniques, technologies like household greywater reuse and urban rainwater harvesting;
- show success stories from other countries, communities or local pilot projects;
- address common misconceptions or resistance toward new systems;
- use easily understandable, engaging formats such as exhibitions, interactive sessions, school programs, or public art installations.

These initiatives should be inclusive, using simple language, visual tools, and multilingual resources to ensure accessibility across different age groups and education levels.

4.3.2 Partnering with local organizations and stakeholders

Collaboration with existing community actors can multiply the impact of awareness and engagement efforts. These partnerships could include:

- schools and universities: integrating water topics into curricula, supporting student-led initiatives, and organizing field visits;
- environmental NGOs and civil groups: co-hosting events, distributing materials, and mobilizing volunteers;
- religious, cultural, or neighborhood organizations: using their trusted position to reach communities and promote water stewardship;
- private sector partners: encouraging water-efficient practices in local businesses or co-developing community programs.

4.3.3 Strategies for building trust and encouraging citizen participation

Gaining and maintaining public trust is critical, especially when new practices and methods are introduced. When citizens feel involved, respected, and informed, they are more probable to support, maintain, and advocate for any sort of case, so, for circular water initiatives too.

Clear and transparent communication is a key starting point. Citizens should understand why a project is being implemented, how it works, and what benefits it is expected to bring. This also includes openly discussing possible risks or concerns and explaining how they are being managed. When information is shared honestly and in plain language, it reduces uncertainty and builds confidence.

Active involvement in planning further strengthens trust. Inviting residents to participate through consultations, surveys, or workshops allows them to express their needs, share local knowledge, and contribute to decisions that affect their community. This sense of ownership makes people more willing to engage and take responsibility for outcomes.

Showing clear and visible results is equally important. Early successes can be demonstrated through small pilot projects, public information boards, online dashboards, or open days at water facilities. Seeing real improvements helps people understand that their efforts and contributions lead to tangible benefits.

Recognizing and rewarding participation can also motivate wider involvement. Public acknowledgment, certificates, small incentives, or even friendly competitions can make participation more attractive and enjoyable. Finally, creating easy ways for citizens to provide feedback ensures that their voices continue to be heard. Accessible channels for questions, suggestions, or complaints help identify problems early and show that public input is valued and acted upon, reinforcing long-term trust and cooperation.

5 PRACTICAL GUIDELINES FOR CITY RESIDENTS

5.1 Simple household water-saving measures

Households play a vital role in reducing urban water consumption. Many simple actions, when applied consistently, can lead to significant savings in daily water use. These small changes require little effort but can make a big difference – both for the environment and for household bills. Households can consider implementing the followig measures[2]:

Keep the water system efficient and check for hidden leaks.

- It is estimated that with a dripping tap, up to 5 litres per day are lost.

Close the tap properly to prevent water from flowing uselessly.

- In this way, while we are washing our hands in one minute we avoid wasting at least 6 litres of water, while we brush our teeth up to 30 litres and while shaving up to 20 litres.

Use basins, instead of running water, for food preparation or washing vegetables.

- It is estimated that for drinking and cooking, approximately 6 litres of water per person per day are consumed and for washing dishes by hand at least 40 litres. However, the waste can reach up to 12 litres per minute if the tap is not closed.

Always use dishwashers and washing machines with a full load and prefer washing programs at low temperatures (40-60° C).

- It is estimated that for a dishwasher load (class A) without pre-washing, up to 15 litres are used (7 litres in class A+++), while for a washing machine load (class A) 45 litres are used.

Prefer taps with sensors or with aerators.

- This will reduce the flow of water and have greater washing efficiency. Take care to maintain them in efficiency.

[2] The following list has been translated and adapted from the text of the 20 tips for saving water and energy, developed by ENEA.

Install dual-button flushes for the toilet.

- This allows you to save up to 100 litres per day, considering that each use of models with a single button uses up to 16 litres of water.

Choose a shower instead of a bathtub.

- It is estimated that a bath in a tub consumes on average between 100 and 160 litres of water, while a 5-minute shower consumes a maximum of 40 litres, even less if you turn off the tap when soaping yourself up.

Turn off the central system in the event of prolonged periods of non-use, for example when you go on holiday.

Use timed, drip or sub-irrigation systems for irrigation, due to their greater efficiency.

Cover the surface of swimming pools with sheets to prevent evaporation.

In the garden, around plants, carry out adequate mulching, in order to keep the water in the soil as much as possible.

- Also, prefer plants that require smaller quantities of water and be careful not to irrigate impermeable areas.

5.2 Home-based water reuse solutions

Water saving and reuse could be achieved also by recycling rainwater both in single-family houses and in apartment buildings, for non-potable purposes, such as plant and garden watering, car washing and outdoor spaces (courtyards, pavements, streets), fire systems, ornamental fountains. This practice could grant surface and underground water saving as well as economic and infrastructural benefits, as the lightening of water network load and, consequently, a lower price of water resource for citizens.

Rainwater could be gathered from coverings, obtaining a cleaner stream, or balconies and terraces. The basic devices for rainwater recycling are represented by a filter and a collection tank, which makes the systems quite simple to realize.

Besides rainwater, also greywater, that is, the water generated by personal hygiene operations, could be recycled using more innovative technologies; greywater consists in sink, bidet, bath, shower and washing machine plumbing. Generally, greywater recovery is associated with rainwater recycling; however, while rainwater could be used externally, greywater could be used only internally, especially for toilet flushing, and requires dedicated devices for their treatment before reuse. Obviously, both systems need not only investment but also operational costs.

A fundamental step for the implementation of these systems is their acceptance among citizens who, in some cases, could consider the use of recycled rainwater and greywater as unsafe or expensive in terms of costs; on the contrary, the use of water recycling systems has been widely demonstrated in many cases, different for climate and applications.

Moreover, not all water used at home needs to be drinking quality. Reusing water for non-potable purposes – such as cleaning, flushing toilets, or watering plants – can greatly reduce overall consumption. With simple practices and appropriate systems, it's possible to safely and efficiently reuse water that would otherwise go to waste. The following tips show how to make the most of available water resources while protecting health and the environment[3]:

- Collect unused cold water when you are waiting for hot water and do the operations that require cold water first (for example, brushing your teeth) and then those that require hot water (for example, shaving).
- Reuse the water from cooking pasta or washing vegetables to rinse dishes before putting them in the dishwasher or to water (when it is not salty).
- Install rainwater collection systems for non-potable uses (toilet washing, car washing) and for watering (rainwater is less hard and is more pleasant for plants), avoiding doing it during the hottest hours to reduce evaporation.
- Avoid washing your car using drinking water. This way we could save 400-500 liters of water.
- Recover condensation water from air conditioners or dryers for domestic uses, such as for the iron.
- Diversify the use of water according to its quality (drinking, rain, grey, black).
- Use, where possible, technologies for the reuse of grey water, i.e. water generated by personal hygiene operations. A system dedicated to the recycling of water from showers, sinks and bathtubs and, in some cases, from condensation from air conditioners or boilers, guarantees its treatment for subsequent use for "secondary" uses such as flushing the toilet, irrigating green areas, washing operations.

5.3 Outdoor and garden water management

Optimizing water use for irrigating public and private green areas such as lawns, gardens, terraces, and parks requires a combination of smart design choices and everyday good practices. Thoughtful planning can significantly reduce water consumption while keeping green spaces healthy and attractive.

[3] The following list has been translated and adapted from the text of the 20 tips for saving water and energy, developed by ENEA.

One important step is limiting the growth of weeds, which compete with plants for water. This can be done by using natural mulches, such as bark, or mulching sheets made from plastic or biodegradable materials. Another effective approach is to select plant species that naturally outcompete weeds, reducing the need for frequent watering and maintenance.

The way plants are grown also has a strong impact on water efficiency. In indoor or controlled environments, closed-loop systems such as hydroponics or aquaponics are much more water-efficient than traditional pots or planters, where excess water is often lost. On balconies and terraces, a simple solution like placing saucers under pots can help collect and reuse surplus water instead of letting it drain away.

Choosing the right irrigation method is one of the most important factors in water saving. Manual watering often leads to overuse, as it is difficult to control the exact amount of water applied. In contrast, drip irrigation systems with timers and soil moisture sensors deliver water directly to plant roots and adjust watering based on soil conditions and weather, making them highly efficient. Spray or sprinkler systems are much less sustainable, as a large portion of the water is lost through evaporation or drains away before plants can absorb it.

Garden design also matters. Large areas of lawn typically require much more water than gardens designed with shrubs, trees, or perennial plants. Reducing lawn size and diversifying plant types can therefore lead to substantial water savings. Timing is another simple but effective factor: watering should always be done during the coolest parts of the day, such as early morning or late evening, when evaporation is minimal.

Additionally, selecting plants that are well adapted to local conditions greatly improves water sustainability. Drought-resistant species, known as xerophytes, require less water and are better suited to dry conditions. When choosing plants, it is important to consider soil characteristics, such as pH, salinity, and drainage, as well as the local climate. Features like waxy or hairy leaves, or the presence of thorns, often indicate good resistance to drought. Together, these measures help create greener spaces that use water more responsibly.

Finally, you can consider implementing one or more of the following solutions for sustainable lawn and garden irrigation, such as:

- **Rainwater collection tanks**

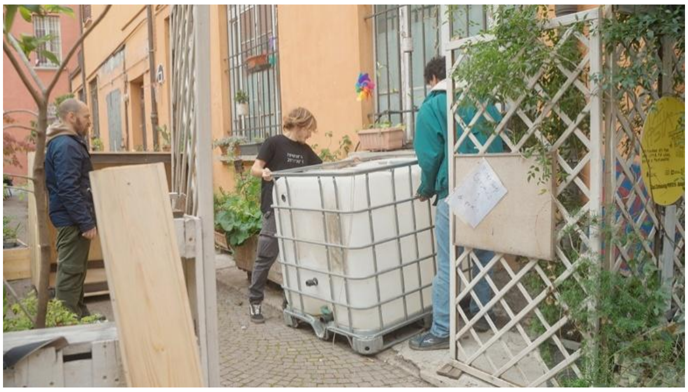

Figure 3 Rainwater collection tank being installed in Bolonia. Source: ENEA

The natural presence of water in our territories has not been taken for granted for some years due to climate change, pollution and the not always rational and sustainable use by an ever-growing population.

Heat, drought and water shortages shed light on the problem of water scarcity especially in summer but it is in the cold seasons that we have a greater possibility of doing something to prevent the problem.

While in summer it is important to implement all the measures that allow us to save water and contain water waste, it is in the other months that we have the possibility of storing it more easily and with even limited investments.

The use of an above-ground tank connected to a gutter placed on the side of a roof, for example, allows us to intercept rainwater and store it for irrigation purposes.

Tanks can have a purpose not only of storage, but also a decorative purpose if a "grow bed" type cultivation system is created on their top. A “grow bed” can be for example a waterproof planter, filled with expanded clay and hosting phytoremediation plants. The plants are automatically irrigated by rainwater and the layer of expanded clay and the roots of the plants also act as a mechanical and biological filter for the water which, once cleaned, is then stored in the tank below.

- **Wicking beds**

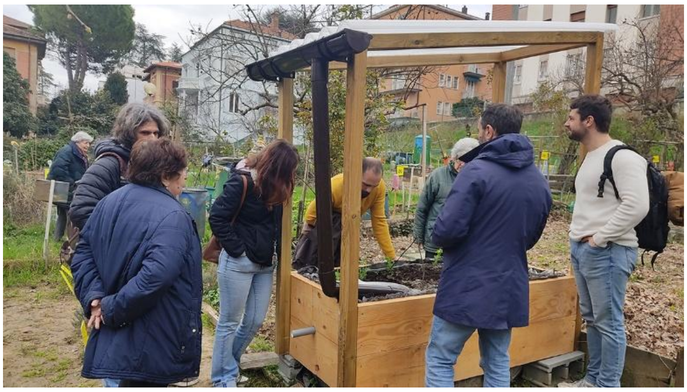

Figure 4 Wicking bed installed in Bologna. Source: ENEA

The positive impact of urban gardens on society is now proven, the advantages they offer are various, both environmental and social.

From an environmental point of view, urban agriculture allows to protect agricultural biodiversity and promotes a short agri-food chain without the use of pesticides. Furthermore, urban gardens promote the recycling of organic waste, used as fertilizer, and like all green areas they improve the local microclimate and combat phenomena such as the heat island effect.

However, urban gardens are also affected by summer drought and, even in these cases, the storage of rainwater is decisive in the hottest periods.

One solution is represented by the raised garden with a roof that uses the “wicking bed” system, that is, the creation of a layer of water reserve placed under the normal layer of soil used in any raised garden.

The water reserve layer consists of a base of about 20 cm of expanded clay separated from the soil by a sheet of non-woven fabric.

In the rainiest periods, the water that wets the vegetable garden roof enters, through a gutter, directly into the water reserve layer without soaking the growing substrate. Furthermore, to prevent the growing layer from rotting in the event of heavy rainfall, on the side of the tank there is an overflow hole placed at the height of the beginning of the soil layer, from which excess water can escape.

As the roots of the plants remove water from the soil, by capillarity, the water contained in the water reserve layer rises towards the substrate, automatically irrigating the plants in the vegetable garden by sub-irrigation.

This system not only allows you to use rainwater instead of drinking water, but also allows you to save a significant amount of water by limiting the effect of evaporation of water from the substrate.

- **Home hydroponic kit**

The desire to grow your own vegetables often clashes with the lack of a garden or an outdoor space large enough to do so.

A solution, not only in terms of space but also of water saving and production efficiency, is vertical hydroponic cultivation which allows you to grow even 20-30 plants in a limited space such as a small balcony and with minimal water consumption.

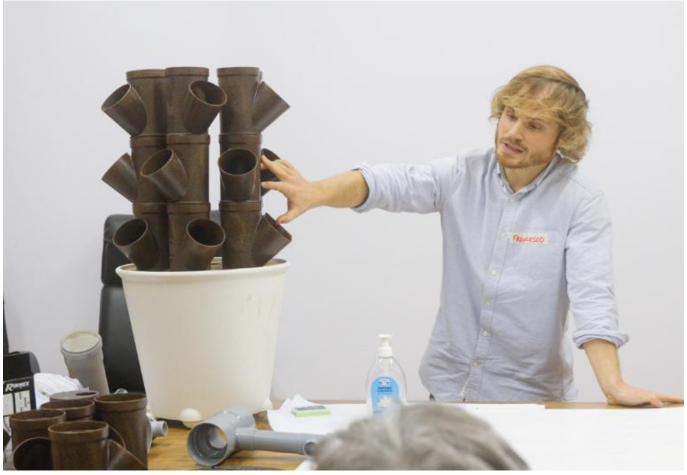

Figure 5 Home hydroponic kit presented during a workshop in Bologna. Source: ENEA

There are ready-to-use kits that consist of a small 10-liter tank containing water and nutrients and a "tower" with 25 spaces where the plants are positioned, previously transferred into specific netted pots for hydroponic cultivation.

Thanks to a small pump and a series of capillary tubes, the water and nutrients are passed inside each pot, keeping the roots without substrate constantly moist.

The hydroponic method in fact consists of constantly wetting the bare roots of the plants to promote the assimilation of nutrients and therefore speed up growth and maximize the production of leaves and fruit.

Despite using only water, hydroponic cultivation allows water savings of up to 90% compared to traditional open-field cultivation because the water that is not immediately intercepted by the roots falls into the starting tank and then returns to circulation in the next irrigation.

Differently, during open-field irrigation, most of the water given to a plant evaporates or penetrates into the deeper layers of the soil, thus becoming unavailable to the plants.

5.4 Getting involved in community initiatives

5.4.1 Participating in local water-saving campaigns, workshops, or neighborhood projects

Through this type of action, it is possible to involve private citizens, large consumers and institutions in becoming aware of the need to use water responsibly. It is a crucial step towards awareness and the change of behaviors and attitudes that leads to reducing water consumption and using water resources in a more conscious way.

In Europe and in the rest of the world there are many examples of initiatives in this direction, with different targets and operating methods, such as:

- competition among cities to see who uses water better: https://www.mywaterpledge.com/
- initiatives to help young people to create territorial networks composed of schools, institutions, citizens and civil society organizations that collaborate to reduce direct and indirect water consumption: https://sites.google.com/cevi.ngo/bluecommunities/home-page
- environmental education projects in schools on the topics of drought and water saving, activated in Italy: https://www.source-international.org/schools-for-water
- collections of sector-specific international best practices for water saving: https://ambiente.regione.emilia-

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- advertising campaigns of companies that promoted water saving: https://www.webuildvalue.com/en/infrastructure-news/water-crises-campaigns.html
- water saving campaigns promoted by water management companies:
  - https://www.ofwat.gov.uk/regulated-companies/water-efficiency-fund/
  - https://magalieswater.co.za/awareness-campaigns/
  - https://www.gruppoacea.it/media/acea-scuola/educazione-idrica
- workshops to promote responsible use of water organized by municipalities:
  - https://www.comune.casalecchio.bo.it/upload/casalecchiodireno_ecm6/gestionedocumentale/catalogo%20cospeacqua%202009_784_7380.pdf
  - https://www.cocopa.it/progetti/progetti-in-cconclusi/60-acqua-in-comune-progetto-sul-risparmio-idrico-ed-il-diritto-all-acqua

5.4.2 Collaborating with local authorities and organizations to promote sustainable practices

Working together with local authorities and local organizations plays an important role in promoting water saving and water reuse. Individual actions matter, but real change becomes possible when citizens act collectively and engage with decision-makers.

Being proactive as a community member helps create a shared sense of responsibility and builds the momentum needed to improve local water management. This can start with simple actions, such as reporting water leaks, system failures, or other malfunctions to the municipality or local water service providers, helping to prevent unnecessary water losses.

Active participation in neighborhood meetings is another effective way to stay informed and contribute to discussions about more circular approaches to water use. These meetings offer an opportunity to raise concerns, share ideas, and encourage local solutions that support sustainable water practices.

In municipalities that offer participatory budgeting, residents can also propose projects focused on water efficiency and reuse, such as rainwater harvesting systems or green infrastructure. Finally, forming or joining local associations with others who share an interest in sustainable water management can significantly strengthen dialogue with public authorities. Acting together makes it easier to be heard and increases the chances of turning ideas into concrete, long-lasting improvements.

5.5 Monitoring, maintenance, and continuous improvement

The result of applying suggestions for water saving could quantified in different ways, for example by filling a table like the one presented below, to register and quantify the water saving achieved daily and weekly by all family members:

Measure	Daily water saving per person (litres)	n°of person applyng the practice	Weekly water saving (litres)
Tap closing during teeth washing	30	1	30
Tap closing during hand washing	20	2	40
Tap closing during shaving	20	1	20
Washing fruit in buckets instead of running water	5	1	5
Using dishwasher and washign machine only when full	50	1	50
Having shower instead of bath	100	0	0
TOTAL SAVING (LITRES)			145

In addition to changing daily habits, regular checks of household water systems and equipment are essential to avoid unnecessary water losses.

Check for visible leaks once a month. You can check your water meter after making sure all faucets and utilities are turned off, then check the meter again for any hidden leaks.

Toilets are one of the most common causes of high water use, and they often leak silently. If the toilet does not make any noise in between flushes and water is not flowing into the overflow tube, water may still be leaking through the flapper. To check, put either a colored dye tab or a few drops of food coloring in the tank. Wait 15 minutes without f lushing, then check to see if the dye has seeped into the water in the bowl. If it has, the flapper needs to be replaced.

The aerators on taps, especially if the drinking water is particularly hard, tend to lose their effectiveness due to the accumulation of limescale residues. In this case, it is necessary to maintain the jet breakers by removing the limescale that has deposited over time using a scraping key.

If you cannot find any sign of leaks indoors, there may be an irrigation leak outside. Here are some quick tips for identifying irrigation leaks: 1. check your irrigation line branching off from the main water line; if you can feel water moving through the pipes when the sprinkler system is off or if the pipes are cold to the touch, there may be a system leak; 2. check all hose spigots on the outside of the house for leaks; 3. walk the property and look for signs of water leaking from any sprinkler heads or soft/wet spots in the grass; either of these signs could indicate a leak or break in the underground line.

Water consumption for toilet flushing can be easily and economically reduced with one of these two tips: 1. the storage bag: this is a plastic bag that once filled with water is inserted into the toilet flushing tank, and leads to a reduction in the volume of the tank up to 4 liters; 2. a heavy body: it is installed in the toilet flush tank so that it fills with a smaller amount of water than the volume of the tank itself.

In case you decide to replace old taps and sanitary ware, since 2009 the first European classification system for taps has been created, through the WELL – Water Efficiency Label". The WELL is used, in fact, for bathroom and kitchen taps, shower heads, urinal and toilet flushing systems and accessories making the efficiency of taps immediately recognisable in terms of water and energy saving. To date, 80 products from 15 manufacturers have been classified.

6 RESOURCES AND FURTHER READING

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