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A Green Deal for water and sanitation utilities to rejuvenate the service delivery and financing model

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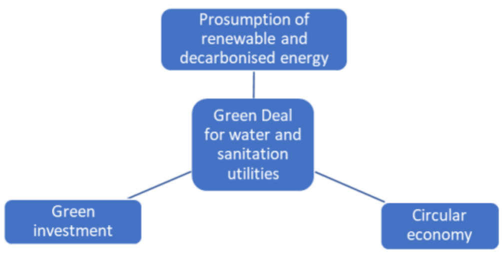
Executive Summary

As stated by the OECD, “water security in many regions will continue to deteriorate due to increasing water demand, water stress and water pollution.” Indeed water supply and sanitation (WSS) utilities in many countries are already and increasingly faced with pressing water risks which include the risk of “water shortages (including droughts), water excess (including floods), inadequate water quality, as well as the risk of undermining the resilience of freshwater systems (rivers, lakes, aquifers)” (OECD, 2013). These risks are exacerbated by climate change which increases the magnitude and frequency of extreme events. As a matter of fact, WSS utilities are already commonly faced with qualitative and quantitative pressures on water resources, the intensity of which varies over time and space. These developments, as well as the financial constraints on the services (limited capacity to increase the price of water in an inflationary context and strong constraints on post-covid public finances) are all elements that encourage operators to rejuvenate their economic and operating model in order to ensure the sustainability and resilience of the services in an environment now marked by threatened water security.

This paper gathers four case studies to illustrate some characteristics of this rejuvenated service delivery model. This paper identifies current practices implemented by two WSS operators (one in Belgium and one in England) to cope with falling billed volumes, diversify their activities and sources of income, and integrate into their investment policy a mix of green and grey investments, and/or investments aimed at decarbonization and the development of circular economy practices that ultimately aim to reduce operating costs. This paper then describes current practices employed by some regulators to support, incentivize and financially reward water and sanitation utilities that implement, voluntarily and beyond their regulatory obligations, water demand management strategies, decarbonization projects, climate change adaptation or resource conservation projects, and/or more stringent wastewater treatment efforts.

Building upon the learnings from these case studies, a rejuvenated service delivery and financing model is shaped. This model, aligned with the EU Green Deal, targets carbon neutrality and resource efficiency while aiming to generate additional revenues decorrelated from water volumes sold, and to foster improved operational efficiency to ensure sustainability of service quality and asset management. It is currently articulated around three main axes:

- Prosumption of renewable and decarbonised energy;
- Promotion of green investment and ecosystem services over grey investment whenever possible;
- Implementation of circular economy practices in the WSS sector.



This rejuvenated “Green Deal” model for service delivery seeks to reach financial sustainability through a mix including the traditional 3Ts (OECD, 2009), and additional revenue sources decorrelated from volumes sold as described above. Further complementary funding instruments are also explored. They include the willingness to pay from specific user categories, i.e., high income households or companies/industries connected to the public network; or the extended producer responsibility implementation to fund micropollutant treatment investment.

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1 Introductory words

As stated by the OECD, “water security in many regions will continue to deteriorate due to increasing water demand, water stress and water pollution.” Indeed water supply and sanitation (WSS) utilities in many countries are already and increasingly faced with pressing water risks which include the risk of “water shortages (including droughts), water excess (including floods), inadequate water quality, as well as the risk of undermining the resilience of freshwater systems (rivers, lakes, aquifers)” (OECD, 2013). These risks are exacerbated by climate change which increases the magnitude and frequency of extreme events. WSS utilities are also commonly faced with qualitative and quantitative pressures on water resources, the intensity of which varies over time and space. These developments, as well as the financial constraints on the services (limited capacity to increase the price of water in an inflationary context and strong constraints on post-covid public finances) are all elements that encourage operators to rejuvenate their economic and operating model in order to ensure the sustainability and resilience of the services in an environment now marked by threatened water security.

This paper gathers four case studies to illustrate some characteristics of this rejuvenated service delivery model. This paper identifies current practices implemented by two WSS operators (one in Belgium and one in England) to cope with falling billed volumes, diversify their activities and sources of income, and integrate into their investment policy a mix of green and grey investments, and/or investments aimed at decarbonization and the development of circular economy practices that ultimately aim to reduce operating costs (Sections 2 and 3).

This paper then describes current practices employed by some regulators (in Italy and Denmark) to support, incentivize, and financially reward water and sanitation utilities that implement, voluntarily and beyond their regulatory obligations, water demand management strategies, decarbonization projects, climate change adaptation or resource conservation projects, and/or more stringent wastewater treatment efforts (Sections 4 and 5).

2 Case study – Vivaqua (Belgium)

Additional sources of revenues and operational economic efficiency

Founded in 1891, the public operator Vivaqua has become one of the largest water companies in Belgium. It provides an average of 360,000 m³ of drinking water every day to the inhabitants of Brussels and of some parts of the Flemish and Walloon Regions. The operator operates 26 abstraction points, 3,000 km of drinking water pipes (Figure 1) and 2,000 km of sewers and implements permanent control over water quality through its laboratory. Since the early 2000s, Vivaqua also manages most of the storm basins in Brussels and fulfils flood control missions.

Figure 1 Vivaqua water supply network

Source: (Vivaqua, s.d.)

Until 2021, Vivaqua applied progressive block tariff for domestic uses, and linear pricing for non-domestic uses (Figure 2).

Figure 2 Domestic and non-domestic tariff applied in 2020 by Vivaqua (6% VAT included)

TARIF PROGRESSIF 2020

	Production/distribution	Gestion des égouts (assainissement communal)	Epuration (assainissement régional)	Prix global de l'eau/m³ (TVA 6% incluse)
DE 0 À 15M³ /HAB/AN	1,1401 €	0,6512 €	0,3237 €	2,1150 €
DE 16 À 30M³ /HAB/AN	2,0860 €	1,1246 €	0,5590 €	3,7696 €
DE 31 À 60M³ /HAB/AN	3,0914 €	1,6573 €	0,8239 €	5,5726 €
+ DE 60M³ /HAB/AN	4,5890 €	2,3678 €	1,1770 €	8,1338 €

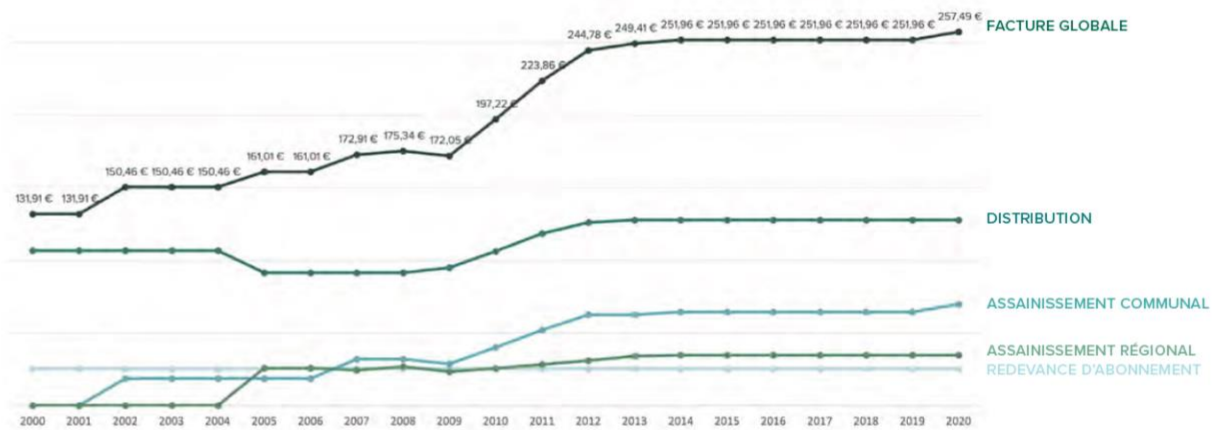
TARIF LINÉAIRE 2020

	Production/distribution	Gestion des égouts (assainissement communal)	Epuration (assainissement régional)	Prix global de l'eau/m³ (TVA 6% incluse)
	2,2846 €	1,1603 €	0,5885 €	4,0334 €

Source: (Vivaqua, s.d.)

Between 2000 and 2020, the average total annual invoice for two people doubled, and over the last decade, the increase reached 30% (Figure 3).

Figure 3 Evolution of the total annual average invoice for two people (2000-2020)



Source: (Vivaqua, s.d.)

Since 1st January 2022, the operator has implemented linear pricing for domestic and non-domestic consumption (Table 1). According to the simulations and all other things being equal, this tariff change should lead to an increased revenue from water sales.

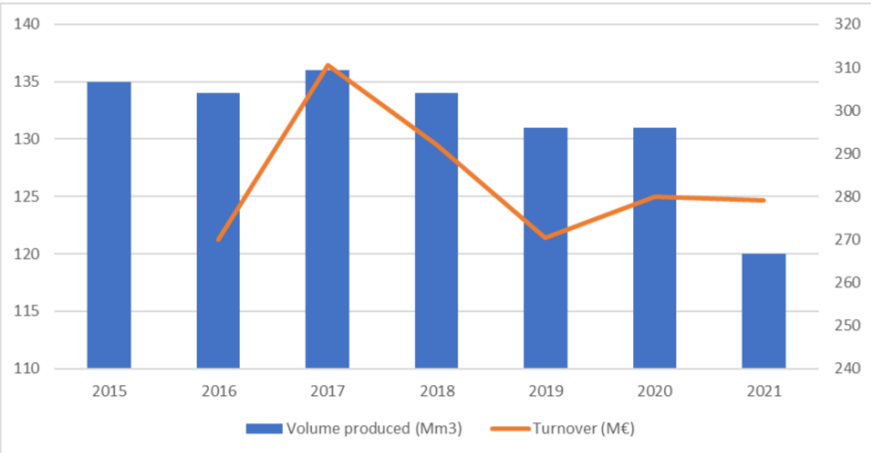
Table 1 Domestic and non-domestic linear tariff applied on 1st January 2022 (6% VAT included)

	Domestic	Non-domestic
Fixed term (per year)	29,02€	29,02€
Of which drinking water	*14,07€*	*14.07*
Of which sanitation part	*14,95€*	*14,95€*
Variable term (per m^3)	3,86€	4.70€
Of which drinking water	*1,88€*	*2,29€*
Of which sanitation part	*1,98€*	*2,41€*

Source: (Vivaqua, s.d.)

During the 2015-2021 period, the volume of water produced and distributed by Vivaqua fell from 135 million to 120 million m^3, which is the lowest level recorded by the operator. This decrease took place in stages, with a first drop of 3% in 2019-2020 (compared to the level of 2015), and a second drop of 8% in 2021 (compared to the level of 2020). Constantly decreasing, the average domestic consumption in Brussels is estimated at approximately 35 m^3 per year and per person (i.e., the equivalent of 96 l/d/inhabitant) and is well below the European average of 55 m^3. In parallel with this decrease in consumption, Vivaqua turnover also fell between 2017 and 2020, before stabilizing at around €280 million (Figure 4). It should be noted that the results for 2017 are special since Vivaqua merged with HydroBru (operator in charge of water and sanitation in the Brussels Region). The 2017 turnover therefore presents a consolidated view of the activities of these two operators. Then on 1st January 2018, 16 municipalities from the Flemish Braban took over the management of water and sanitation activities on their territory to entrust them to other operators.

Figure 4 Vivaqua volumes and sales (2015-2021)



Source: (Vivaqua, s.d.)

In this context of turnover erosion, Vivaqua must find additional means to fund its digital transition, to adapt to climate change and address associated risks, to maintain and preserve its infrastructures while meeting the expectations of its customers. This context calls for additional financing which cannot be based solely on the increase of water and sanitation tariffs. Thus, the operator has identified additional financing sources as well as sources of savings through improved operational efficiency, in particular with regard to energy costs.

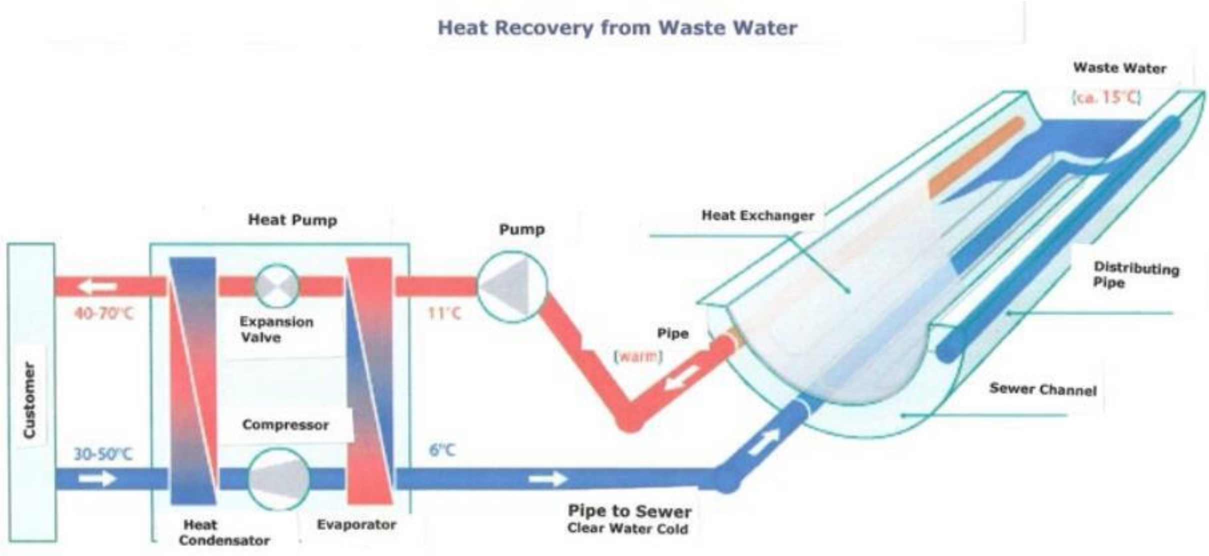
2.1 Paid service for fire hydrants

In 2021, the 19 municipalities from the Brussels Region served by Vivaqua signed an agreement which stipulates that the maintenance and replacement of fire hydrants will become paying services and will no longer be covered by the water invoice. Since 2022, Vivaqua is invoicing for these services which provides additional structural revenues.

2.2 Setting up heat recovery from wastewater

Vivaqua implements heat recovery from wastewater which consist of the recovery of residual heat from wastewater (bath, shower, dishwasher, washing machine, etc.) (Figure 5).

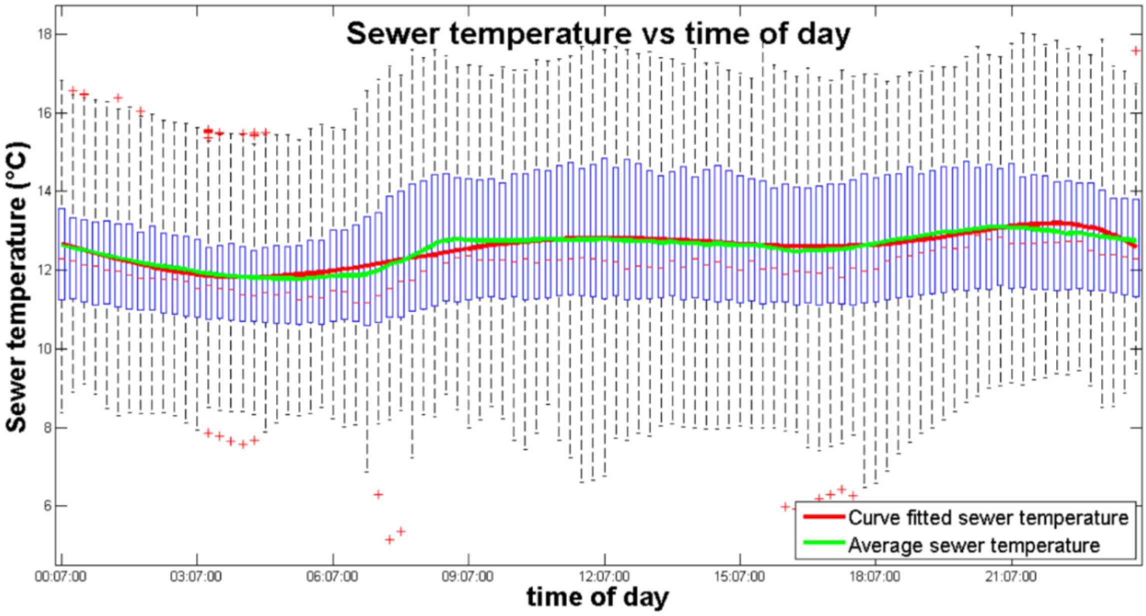
Figure 5 Principle of riothermy



Source: (Vivaqua, s.d.)

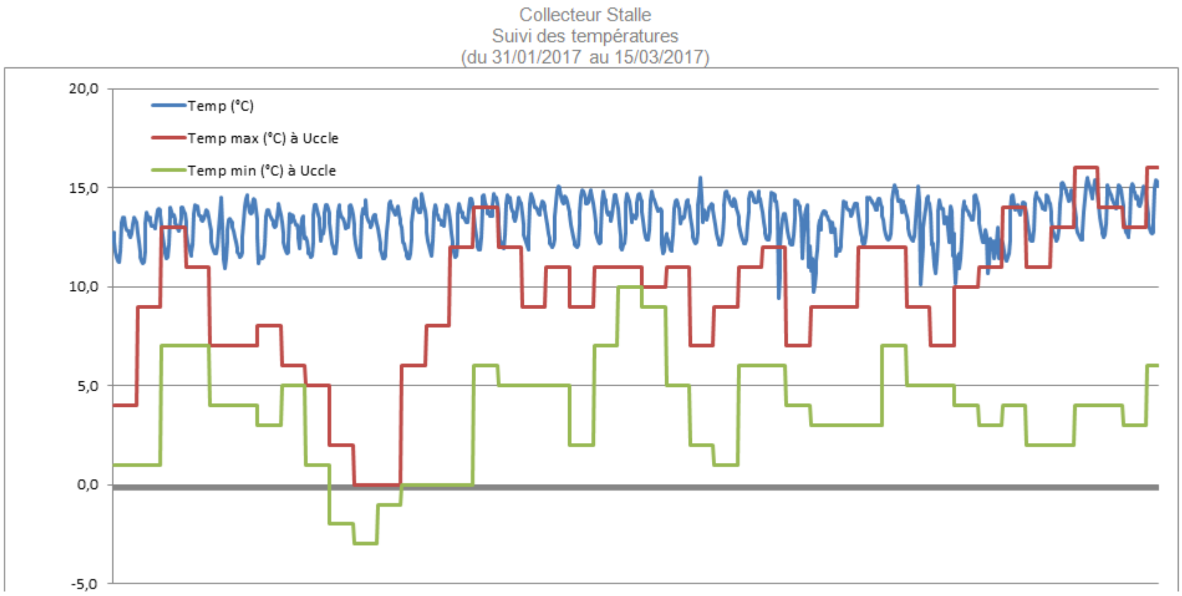
Wastewater flowing through sewers has a relatively constant temperature, not only throughout the day but also throughout the year, even when outside temperatures are low (Figure 6 and Figure 7).

Figure 6 Evolution of wastewater temperature during the day



Source: (Vivaqua, s.d.)

Figure 7 Evolution of wastewater temperature compared to outside temperature (January to March 2017)



Source: (Vivaqua, s.d.)

Thus, this wastewater can be used as a heat source in winter and as a cold source in summer. The operator has therefore planned to install heat exchangers in appropriate places during sewer renovations to heat buildings in winter and provide air conditioning in summer. This technology has been tested in a pilot project in the municipality of Uccle on the site of a municipal administrative centre of 5 buildings and 15,000m^2 of offices which requires a peak heating requirement of 425 kW in winter and 475 kW cooling peak in summer. The project provides for an installed power of 120 kW thanks to 16 exchangers of 6 meters, which should make it possible to cover 21% of cooling needs, 27% of heating needs, and reduce annual

CO_2 emissions by 60 tons, with a coefficient energy rating of 4.7. The investment of €130,000 should be recovered in 15 years.

2.3 Production of electricity by turbine

On several *Vivaqua* sites, regulation valves used for the pressure load on the network dissipate energy in vain. It is possible to recover this energy through turbines to produce electricity. *Vivaqua* is taking advantage of this opportunity in Spontin, where a dissipation valve has been replaced by a small turbine. The average monthly production of the turbine is currently 30 MWh which are reinjected into the electricity grid and billed to Elia (the electricity utility).

2.4 Solar power generation

As part of the SolarClick project, *Vivaqua* has started installing solar panels on some of its sites with the aim of covering all or part of the energy needs of these sites. After the roof of the Linthout site in Schaerbeek, where 30% of the site's needs are now covered by solar energy, it is the lawn of the Etterbeek reservoir which is hosting panels whose annual production of 170,000 kWh will cover half pumping consumption. Many examples of solar panels installation on treatment plant sites exist across Europe (Box 1).

Box 1 Leak reductions, solar electricity and biomethane to offset inflation

Clermont Métropole will significantly increase water and sanitation prices in 2023 (19% on average) to cope with the exponential rise in energy costs, i.e., between + 250% and 270% for the different stages of the water cycle, which will represent an increase of €6.4 million in 2023. To compensate this sharp increase, *Clermont Métropole* will keep on reducing water losses, even if the current level is already good (20%). It will also operate the drinking water plant at night and off-peak hours to reduce costs. The energy produced by the photovoltaic power plant project at the Trois-Rivières wastewater treatment plant in Aulnat will also offset part of the energy consumed. The creation of a biomethane unit equivalent to the heating of 1,400 homes is also underway.
Source: (Clermont Infos 63, 2023)

3 Case study – Anglian Water (England)

A carbon neutral strategy, and green investments to reduce operational costs

Anglian Water is the largest water and wastewater operator in England and Wales from a geographic perspective, covering 20% of the territory (27,476 km²). It supplies 4.3 million people (2.5 million households) and 110,000 businesses with drinking water by operating 425 boreholes, 143 water treatment plants, 38,185 km of water pipes, eight reservoirs, and 392 water storage points. It operates 1,128 wastewater treatment units and 76,000 km of wastewater network.

Anglian Water employs over 5,000 people, and around 8,500 direct and indirect employees work for the company. The operator has developed a strong corporate social responsibility policy and received several awards. It was named the best place to work in the UK in 2019 by Glassdoor. It received the Occupational Health and Wellbeing Award from the Business in the Community for 2019 and holds the Gold Award for Occupational Health and Safety from the Royal Society for the Prevention of Accidents (this is the 16th times that Anglian Water has been awarded by RoSPA).

3.1 Drought and quantitative issues

Anglian Water operates in the driest region of the UK which receives only two thirds of the national average annual rainfall (around 600 mm) (Figure 8). However, this region is growing rapidly, with an increase of 175,000 housing units expected by 2025. Due to this context of drought and population increase, Anglian Water has developed a water demand management policy which has made the operator the record holder in the UK for detecting and tackling leaks per km of pipe, with a level of leaks that is around half the industry average. Leakage reduction, and more generally water demand management allow the operator to use slightly less water in 2021 than in 1989, while the number of dwellings increased by a third. Water demand management is based on a pro-active metering policy with a rate of 92% of customers equipped (compared to 57% on average in the rest of the sector). At the national level, the Consumer Council for Water reports that installing a meter reduces water consumption by a quarter, from 166 litres per person per day to 126 litres. Anglian Water has estimated that installing a meter reduces domestic water consumption by 5-15%, representing an average saving of £171 (€196) on an annual bill.

Figure 8 Service territory of the operator Anglian Water

Source: (Anglian Water, s.d.)

The commitment to saving water is summed up in the company's motto: *Love every drop*. In 2020, Anglian Water succeeded in reducing leakage to the lowest level ever achieved by the company, and for the ninth consecutive year the operator exceeded its operational leakage target.

Anglian Water, like the rest of the water and sewerage operators in England and Wales[1], is subject to economic regulation by Ofwat and *Price Reviews* which take place every 5 years. The last *Price Review* which took place in 2019 covered the period 2020-2025.

In its investment plan 2020-2025, Anglian Water has planned a mix of grey[2] and green investments, including nature-based solutions (NbS) (Box 2). The green investments planned by Anglian Water are part of a roadmap that aims for carbon neutrality by 2030.

Box 2 Nature-based Solutions

NbS seek to promote the maintenance, enhancement and restoration of ecosystems as a means to simultaneously address a variety of social, economic and environmental challenges. The International Union for Conservation of Nature (IUCN) first defined the term in the early 2000s as *"actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"* (UICN, s.d.). The European Commission (EC) provides a complementary definition and defines NbS as *"actions inspired by, supported by or copied from nature and which aim to help societies address a variety of environmental, social and economic challenges in sustainable ways"*.

Nature-based solutions encompass several approaches such as ecosystem-based adaptation, eco-disaster risk reduction, green infrastructure and natural climate solutions.

[1]There are currently 11 regional water and sewerage operators, 6 water operators and 9 small water and sewerage operators licensed in England and Wales.

[2]Grey investments refer to "classic" investments that rely on civil engineering, as opposed to green investments that rely on nature-based solutions (ecological engineering).

Concept	Definition	Link to the concept of NbS
Green infrastructure	A strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate change mitigation and adaptation	Green infrastructure is a type of NbS. Although they can be used in rural context, they are most frequently associated with urban areas.
Ecosystem-based adaptation and eco-disaster risk reduction	Physical measures or management actions that utilise natural or ecosystem-like processes to adapt to a variety of climatic hazards	These NbS primarily focus on reducing vulnerability and build resilience to the impacts of climate change.
Natural climate solutions	Conservation, restoration, and improved land management actions that increase carbon storage and/or avoid greenhouse gas emissions across global forests, wetlands, grasslands, and agricultural lands	Natural climate solutions are NbS that focus on nature conservation and management actions that reduce greenhouse gas emissions from ecosystems and harness their potential to store carbon.
Capital and natural assets	The world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible	Natural capital can be considered the "asset base" on which NbS are built.

Source: (OECD, 2020)

3.2 Grey investments to secure supply and ensure efficient use of the resource

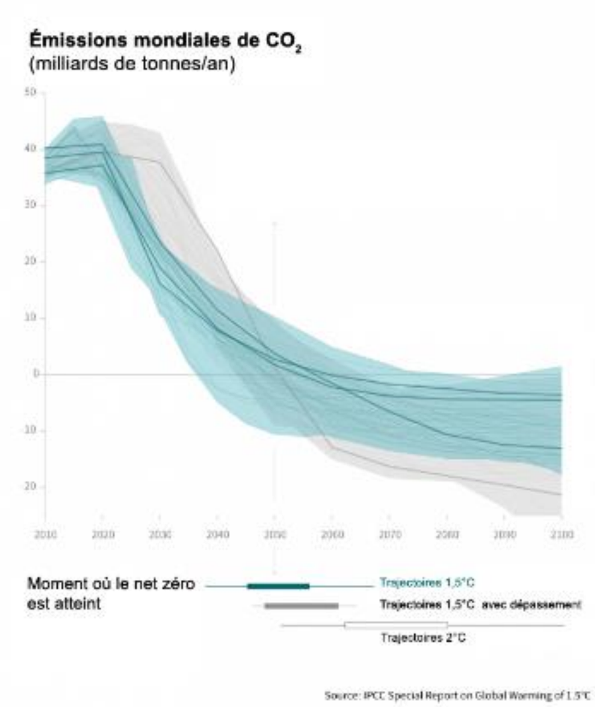
Between 2020 and 2025, Anglian Water plans to invest £6.5 billion (€7.45 billion) to secure water supply and improve service quality. This investment plan includes the construction of 500 kilometres of interconnected pipes to bring water from areas of abundant supply to areas with shortage; the construction of two new reservoirs, as well as investments to reduce the number customers relying on a single supply source; the deployment of more than one million smart meters; and an additional reduction of 22% of leakages.

3.3 *Net Zero* roadmap

In 2020, the UK water industry released its roadmap stating how the sector will achieve *Net Zero*, or carbon neutrality (Box 3), for operational emissions, in less than a decade. This is the first example in the world of an entire industry coming together to develop a sector plan to reduce emissions.

Box 3 What is Net Zero or carbon neutrality?

The phrase *Net Zero* means that no new amount of CO_2 can be added to the atmosphere. As this is a net emission, emissions can only continue if they are balanced by the absorption of an equivalent quantity of CO_2 present in the atmosphere, for example through reforestation or CO_2 capture. This negligible carbon footprint objective recommended by the IPCC for 2050 should make it possible to stabilize global warming at 1.5°C and would only be achievable by reducing global CO_2 emissions from the current 40 Gigatons per year to 0 Gigatons.



To achieve the *Net Zero objective*, all sectors of activity (energy production, industry, transport, housing, etc.) producing CO_2 must be decarbonized.

Overall, this requires:

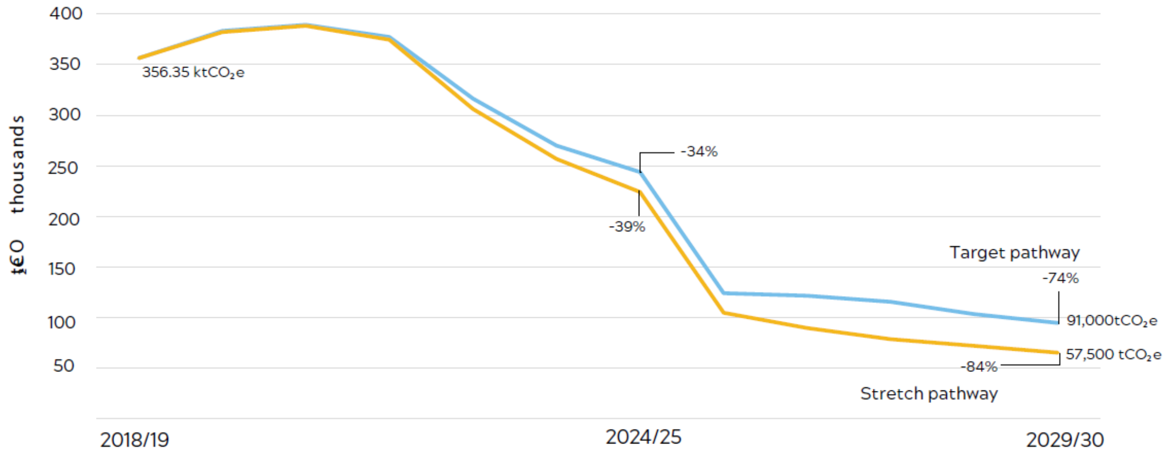
- reducing energy consumption through technological orientations and economically viable and socially acceptable policies;
- reducing the share of fossil fuels (coal, oil, gas) by replacing them with low-carbon energies, renewable energies (solar, wind, biomass) and nuclear energy;
- discovering new sources of carbon (biomass, CO_2) other than fossil resources for the development of the main materials (polymers, steel, cement, etc.) and the synthesis of a wide variety of organic compounds (medicines, for example) necessary even in a decarbonized economy.

Source: (Académie des Sciences, s.d.)

Anglian Water has also developed its own roadmap to become a fully carbon neutral company by 2030 (Figure 9). This strategy is based on three main axes:

- Manage and reduce emissions by installing monitoring equipment at four major Anglian Water sites;
- Decarbonize electricity supply and vehicle fleet, and develop green electricity supply;
- Remove or offset residual emissions by planting 50 hectares of woodland on Anglian Water sites, exploring nature-based solutions using wetlands, marshes and grasslands, and working with landowners to develop land management programs that avoid and remove emissions.

Figure 9 Stages of Anglian Water 's carbon neutral strategy



Source: (Anglian Water, s.d.)

3.3.1 Investing in nature-based solutions

Since 2018, the operator has invested in the self-purifying capacities of a wetland[3] built on unused agricultural land from 4 ponds, near the *Ingol River* which serves as an outlet for the wastewater treated. The ecological engineering implemented has been specifically studied to allow the reduction of levels of ammonia and other chemical products. Currently, the site can process 1.4 million litres per day. This cost-effective solution made it possible to avoid the construction of a new wastewater treatment plant. Anglian Water has created 3 other sites of the same type which will be operational in 2023 (Figure 10), and 26 additional sites should be built by 2030 for an amount of £50 million (€57 million). Wetlands are also effective flood expansion fields which Anglian Water wishes to develop as part of its climate change adaptation plan and flood management mission.

[3]A wetland can treat up to 700,000 litres of wastewater per day.

Figure 10 Wetlands created and being created by Anglian Water

Source: (Anglian Water, s.d.)

Anglian Water has also embarked on a policy of reforestation in an effort to combat flooding and the impacts of climate change. These natural flood management techniques reduce risk by allowing better control of high river flows during heavy rains. This reforestation policy is also implemented more widely by the entire water sector in England and Wales with a target of 11 million trees planted by 2030.

Anglian Water owns 47 natural and recreational sites on which the operator implements a policy to protect fauna, flora and biodiversity, in collaboration with the Environment Agency and local environmental protection associations.

Between 2020 and 2025, Anglian Water has planned to invest £800 million (€917 million) in environmental protection, which is more than double the amount invested in the previous five years.

3.3.2 Decarbonize the vehicle fleet

Anglian Water 's fleet of vehicles travel 20 million kilometres each year. As part of the carbon neutrality strategy by 2030, the operator will invest in 300 fully electric and hybrid vehicles, representing 90% of its fleet (60 hybrid vans with extended autonomy, 43 electric vans and 200 electric cars). By investing in these electric vehicles, the operator generates the possibility of using self-produced renewable energies on its own operational sites (see next section3.3.3) to recharge its fleet, and thus reduce its operating costs, while reducing its carbon emissions.

The company also plans to install 120 additional electric charging stations in the region, to charge its fleet but also allow its employees to use them for their personal cars.

Finally, Anglian Water planned the construction and use of an all-electric 4-tonne van for cleaning industrial sewers. This van will be quiet even when operational, allowing the company to minimize disruption and noise to local communities during late operations.

When going electric is not possible, the company plans to use alternative fuels such as hydrogen or self-produced biomethane. The company also plans to convert 55% of its trucks to Liquefied Natural Gas and to convert 100% of its diesel demand into hydrotreated vegetable oils.

3.3.3 Develop the supply of green electricity: bioresources, solar and wind

The flat geography of Anglian Water's operational area requires a huge amount of energy to abstract water, treat it and distribute it to customers. The same applies to the collection and treatment of wastewater. Producing electricity from renewable sources therefore allows the operator not only to reduce its carbon emissions, but also to reduce its operating costs. It is therefore a key step towards carbon neutrality in 2030.

In 2020, Anglian Water produced 131 GWh of energy from renewable sources through bio-resources, solar and wind. This saved 230,000 tonnes of carbon. The operator thus exceeded its carbon reduction targets by reducing the carbon linked to investments by 61% and the operational carbon by 34%. The green energy produced by Anglian Water currently accounts for around 30% of its energy needs. The objective is to reach 44% between 2020 and 2025.

3.3.3.1 Bioresources

Anglian Water 's ten sludge treatment centres use combined heat and power engines to create power from the gas released as a by-product of the sewage treatment process. Most of the renewable energy produced is used for on-site operations. These processes are becoming widespread among many public and private operators across Europe (Box 4). The surplus is exported to local power grids. Anglian Water also recovers nutrients from sludge for agricultural fertilization.

Box 4 From biogas to biomethane in Chambéry

Until October 2021, the *Grand Chambéry Agglomération* wastewater treatment plant was producing biogas by cogeneration. The electricity thus produced was sold to EDF while the heat was used on-site. In 2022, the wastewater treatment plant of the *Grand Chambéry Agglomération* acquired a biomethane production unit for direct injection into the network operated by GRDF (national gaz network operator). Works to modify the biomethane unit were undertaken at the same time as works to build the heat loop between the *Savoie Déchets* incineration plant and the district heating network. Residual sludge from the wastewater treatment plant is burned together with municipal waste from the *Savoie Déchets* plant. The residual heat from the oven thus heats the premises of the wastewater treatment plant, as well as the digesters where the biogas is produced. The total investment represented €3 million, and the return on investment is estimated at 3 to 4 years. The Water Agency granted a financial support of €1.4 million (i.e., 47% of the investment) as part of the *France Relance* plan. The expected financial gain is approximately twice that of the previous cogeneration installation. The *Grand Chambéry Agglomération* Territorial Climate Air Energy Plan, adopted in December 2019 for the 2020/2025 period, sets an ambitious target of greenhouse gas emission reduction of 17% by 2025 and 29% by 2030.The commissioning of this biomethane unit allows the achievement of 3% of the 2025 objectives of the Climate Plan.

Source: (Grand Chambéry, 2023)

3.3.3.2 Solar

Anglian Water has installed solar panels at some of its operational sites to generate renewable energy (Figure 11), and is also testing storage solution so that excess solar energy generated during the day can be used at other times, thereby reducing the operator's dependence on grid power. On the site of the wastewater treatment plant, the operator has just completed the installation of 3,312 solar panels which generate 36% of the site's energy consumption and reduce carbon emissions by more than 300 tonnes. While developing solar power, Anglian Water also undertakes comprehensive ecological studies to ensure that the solar panels will not harm local wildlife throughout their lifespan.

Figure 11 Installation of solar panels at one of Anglian Water 's operational sites

Source: (Anglian Water, s.d.)

3.3.3.3 Wind

Anglian Water has installed three wind turbines which generate around 14 GWh of energy per year.

4 Case study – Konkurrence- og Forbrugerstyrelsen (Danemark)

An increased revenue cap for operators conducting climate change adaptation projects

The Danish competition and consumers authority (*Konkurrence- og Forbrugerstyrelsen*) is a governmental agency under the Ministry of Finance and Industry. It hosts the Danish Water Regulatory Authority whose main functions include:

- Establishing the annual financial framework for the companies
- Calculating individual efficiency requirements through benchmarking for companies with a charged water volume of more than 800,000 m^3
- Conducting annual monitoring of company compliance with the financial framework
- Handling complaints related to the financial frameworks of the companies
- Supporting the companies' work to comply with the Danish Water Sector Act with guidance, advice etc.
- Handling and supervising municipal reports in accordance with the Danish Stop Act and related regulations

The Danish Water Regulation Authority sets revenue caps and efficiency requirements for all municipally owned water and wastewater companies as well as consumer-owned water utilities that supply, process or transport a minimum of 200,000 m^3 of drinking water per year to consumers and businesses. In 2019, this represented 334 operators[4]. For the large water and sanitation services (more than 800,000 m^3 billed), the regulatory authority also performs a benchmark.

The revenue cap is designed to ensure that:

- Consumers and businesses do not overpay for water and wastewater.
- The companies have sufficient funds to operate, maintain and develop their infrastructure to ensure continued high quality and security of supply (Figure 12).
- The companies are continuously streamlining their operations and systems in line with productivity growth in the rest of the Danish economy.

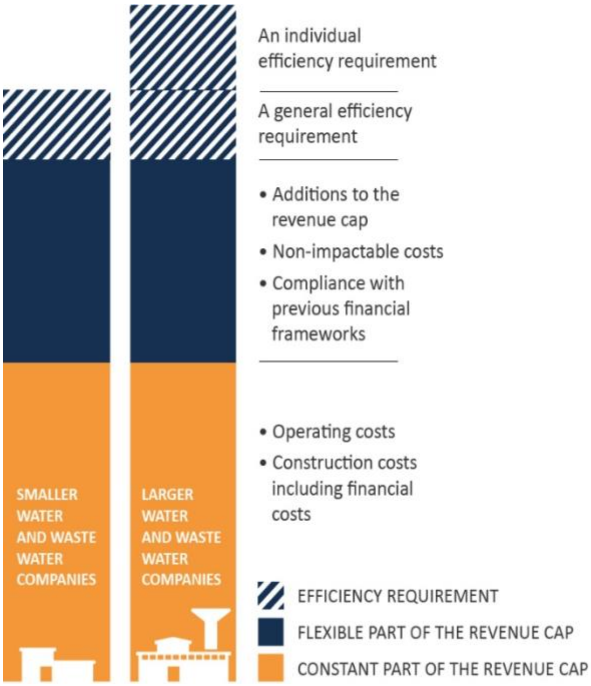
The water sector has a total cost base of approx. DKK 15 billion (€2 billion). Since 2011, efficiency requirements of DKK 2.3 billion (€310 million) were set for the sector.

In addition, the regulatory authority produces guides, analytical reports, and professional articles on the development of regulatory methods and economic models.

All water companies are also subject to environmental regulation, which falls under the responsibility of the Danish Environmental Protection Agency.

[4] Until 2010, in Denmark, water and wastewater services were not corporatized and were part of the municipal administration. Since 2016, they became autonomous entities, distinct from municipal services, under the status of public companies.

Figure 12 Detail of expenditure items authorized in the regulatory revenue cap



Source: (Konkurrence- og Forbrugerstyrelsen, s.d.)

A revenue cap consists of:

- a financial basis that includes the companies' operating, construction and financial costs as well as so-called fixed costs;
- correction of the fixed costs in relation to what the actual costs have been in the previous year;
- an individual, benchmarking-based efficiency requirement for the companies being benchmarked;
- a general efficiency requirement for all companies regardless of size;
- annual indexation;
- historical over or under-coverage. Any remaining over or under-coverage will be recognised up to and including 2020;
- compliance with previous financial frameworks;
- additions to the financial framework, if applicable. Additions are provided for climate adaptation projects and extensions of supply areas.

Notifications of regulatory decisions

Each year, notifications regarding regulatory decisions on new revenue caps are sent to water and sanitation operators for consultation before September 15th. On October 15th of the same year, operators receive regulatory final decisions, which include answers to questions raised during the consultation phase. Since 2011, all decisions are published (in Danish) on the regulator's website. Decisions can be appealed to the Competition Appeals Tribunal.

Revenue caps

Revenue caps are established on an ongoing basis for one regulatory period at a time.

Small water and wastewater operators are always given a revenue cap for a four-year regulatory period. Currently large water and wastewater operators have two-year regulatory periods but from 2022/2023 onwards, this regulatory period will also be extended to four years. For water operators, new revenue caps are prepared in even years, while for wastewater operators this happens in odd years.

During a regulatory period, operators receive annual status notifications stating their compliance with the applicable revenue cap, including whether the operator complied with its revenue caps of previous years.

Efficiency requirements

The individual efficiency requirement is based on a benchmarking model that compares the profitability of operators with each other. Thus, the level of individual requirement reflects the efficiency of the operator compared to other operators in the sector. The less efficient operators are assigned a higher individual efficiency requirement compared to the more efficient operators. The efficiency requirement thus reflects the potential of each operator to become as efficient as the most efficient in the sector.

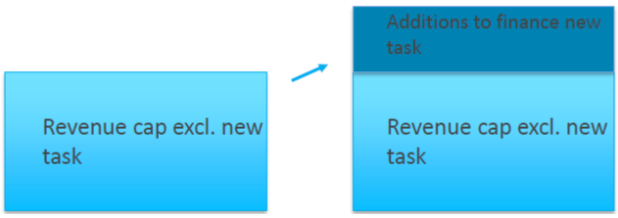
Regulatory data

According to the Danish law, all water and wastewater operators are required to produce and report data annually to the regulator for monitoring purposes and for revenue cap calculation. For large operators, additional data is collected for the benchmarking exercise. All data is collected through the "VanData" digital reporting system between March 1st and April 15th of each year.

Financial supplement to finance climate change adaptation projects

Some water or sanitation utilities may decide to implement and fund climate change adaptation projects, groundwater preservation projects, or more stringent wastewater treatment beyond regulatory requirements. All these projects generate additional costs that the regulator may decide to include in the operator's regulatory revenue cap in the form of a financial supplement (Figure 13).

Figure 13 Financial supplement authorized for financing climate change adaptation projects



Source: (Konkurrence- og Forbrugerstyrelsen, s.d.)

However, it is necessary to ensure that these projects, which on the one hand do not constitute regulatory obligations and on the other hand are not always part of the core business of water and sanitation services, are cost -beneficiaries for users, society and the environment. If costs can relatively easily be evaluated and compared with the costs of similar projects to prove the efficiency of the project, there are however significant difficulties in estimating benefits. To overcome these difficulties, the Danish regulator plans to use contingent valuation through stated preference methods, such as willingness to pay, to assess the benefits of the various projects. The regulator has already used estimates of willingness to pay during field experiments, using interviews and questionnaires, in 2021, to determine "the willingness to pay of users for an improvement of the water supply security and of the drinking water quality (beyond regulatory obligations)". Thus, following a cost-benefit analysis and to encourage water and sanitation services to carry out climate change adaptation projects, or resource preservation projects or wastewater treatment improvement, the regulator may grant an increased revenue ceiling for operators carrying out these projects.

5 Case study – ARERA (Italy)

Multiple incentive mechanisms to increase investment, to reduce water losses, to promote decarbonisation and to boost wastewater reuse

With the Law n°214 dated November 2011, the Italian government assigned the regulation of the water sector (Box 5) to the already existing independent Regulator for electricity and gas, the *Autorità per l'Energia Elettrica e il Gas* (AEEG – now ARERA, *Autorità di Regolazione per Energia, Reti e Ambiente*). For the water sector, the Regulator was specifically appointed to set rules and regulation concerning:

- revenue and tariff calculation
- general and specific standards for service quality
- technical and infrastructural quality regulation
- accounting clarity and information collection
- consumer protection
- enforcement and monitoring of the service provision conditions, with powers to demand documentation and data, apply sanctions, and determine cases in which operators can be required to provide refunds to consumers.

To fulfil its legal duties and exercise its mandate, ARERA makes use of a variety regulatory mechanisms and instruments, including segmentation of the market to incentivize investment increase, water demand management measures, or decarbonization and treated wastewater reuse (REUSE) support mechanisms.

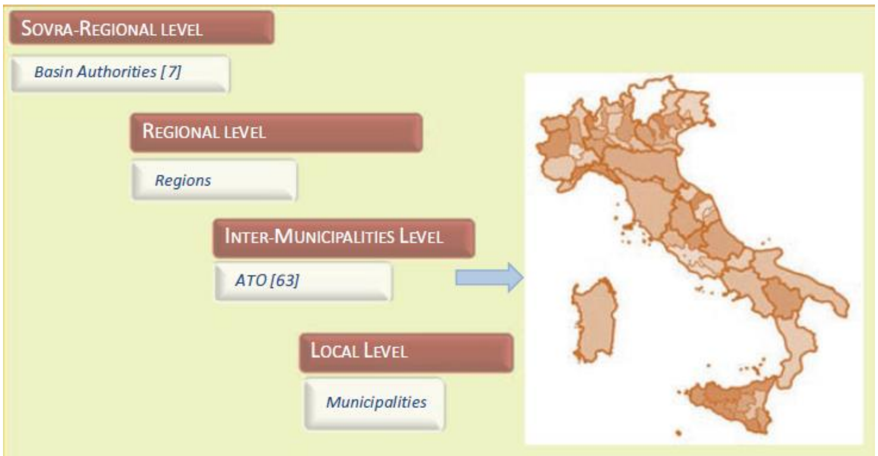
Since 2014, ARERA has been segmenting the water and sanitation market and allowing more revenue to operators making more investments. This incentive mechanism was improved during the second cycle which began in 2016.

In 2014 as well, ARERA also incentivizes water losses reduction through an environmental cost component as part of the tariff setting methodology. Since 2018, ARERA introduced an additional incentive for water losses reduction through the use and monitoring of performance indicators. Moreover, for its 3rd regulatory cycle expanding from 2020 to 2023, ARERA introduced incentives for wastewater reuse through a revenue sharing mechanism.

Box 5 Organisation and management of water services in Italy

On 18 May 1989, Law No. 183 was passed allowing for the consolidation of water services at a supra-municipal level on a voluntary basis. However, this law did not attract much interest from municipalities and no real consolidation of water services took place. Moving from a voluntary to a mandatory approach, a more prescriptive law was adopted shortly afterwards, in January 1994. The so-called Galli Law n. 36 introduced the notion of geographical aggregation of services through the establishment of Optimal Territorial Areas (*Ambiti Territoriali Ottimali*, ATO) (Figure 14) managed by autonomous authorities with legal personality called AATOs; each authority had to designate a single operator for each ATO. According to this law, once the AATO is in place, a thorough study of the existing water service infrastructure must be carried out and a business plan drawn up on the basis of this information. Following this, the single operator of the ATO can be appointed. The need to go through these preliminary steps before appointing the provider has led to significant delays and blockages in the reform. Thus, in 2004, ten years after the adoption of the law, only 38 of the 91 planned ATOs were actually in place. Among these 38 ATOs, 25 mixed joint-stock companies were appointed as operators, 12 fully public joint-stock companies, and only one concession contract (*Conviri* Report 2005).

Figure 14 Water sector institutional framework in Italy



Source: (Porcher & Saussier, 2019)

In 2009, amendments to the Galli Law were passed, and the Ronchi Decree required municipalities and provinces that manage water through public companies to put the service out to tender. Mixed public-private companies were also required to reduce the share of public capital to 30% by 2015. These changes launched a fierce social and political opposition, as they were perceived by opponents as an attempt to privatize WSS services. This opposition eventually led to a referendum, held in 2011, where the 2009 amendments were abolished. These elements and circumstances have increased legal uncertainty leading public and private decision-makers to adopt a wait-and-see strategy.

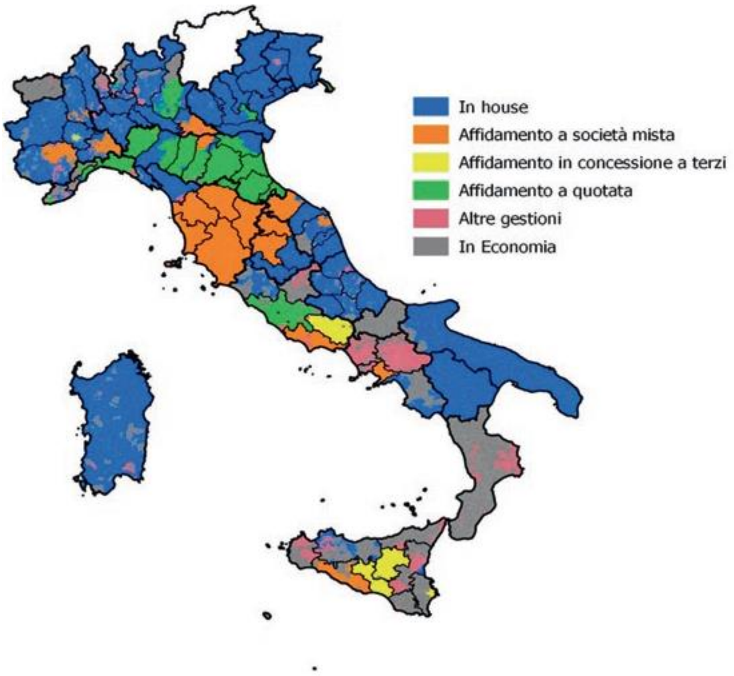
In 2014, the so-called *Sblocca* Italia law was passed, and stated mandatory rules for establishing *Ente di Governo di Ambito* (EGA), which are local territorial governments acting as local Regulators, responsible for appointing one service operator per ATO. The largest part of the EGAs in the North-East, the North-West (with the exception of the Valle d'Aosta Region), and in the Centre of Italy already appointed the operator(s). On the contrary, in the South of Italy and the Islands, a limited number of EGAs have chosen the water operator(s), thus underlining the long-lasting and well-known "Italian divide" phenomena between the North and the South.

The EGA should choose the governance arrangement of the water service among the three following options:

- a joint-stock company to which the service is awarded by a competitive tender,
- a mixed joint-stock company in which the private firm is chosen by a competitive tender, and
- a fully public company, that is, the so-called in-house option.

The Italian water services are locally provided in 48% of cases by in-house operators; 29% of cases by joint-stock companies, of which 12% are in the stock exchange; in 2% of cases by concessionaires; and the remaining cases, which are largely located in the South and Centre Italy, are managed through simplified forms inherited from the past regulatory settings (Figure 15).

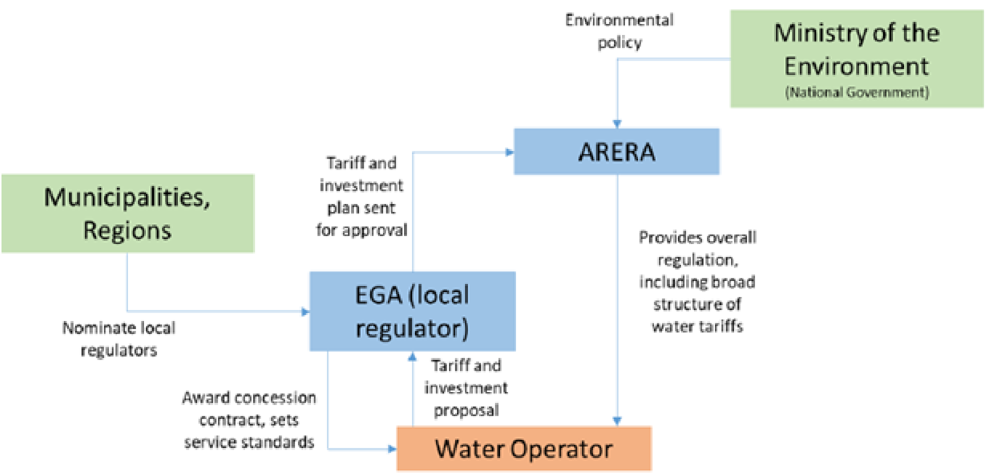
Figure 15 Management models in Italy



Source: (Porcher & Saussier, 2019)

The EGA[5] should present a water tariff proposal compliant with the regulation established by ARERA (Figure 16).

Figure 16 Water regulatory framework in Italy



Source: (Centre on Regulation in Europe, 2019)

ARERA, EGAs and water operators are all involved in the price setting review and approval process (Figure 17).

Figure 17 Tariff decision-making process in Italy

Source: (Porcher & Saussier, 2019)

5.1 An incentive regulation to increase investments

In December 2011, water and sanitation investment in Italy amounted to less than €1 billion per year—about one-third of the required level. As a result, increasing investment levels has been one of the key objectives of ARERA since the first regulatory cycle (2014-2015). To do so, ARERA used a menu regulation[6] which *de facto* relies on a segmentation of the market (Box 6).

Box 6 Models of menu regulation – Theoretical background

Laffont and Tirole show that regulators can determine the optimum regulatory contract by offering companies a menu of contracts with different cost-sharing provisions. If the menu is well designed, companies with more scope for cost reductions will automatically choose a contract with more powerful incentives than companies with less scope (i.e., contracts are tailored to the company's inherent cost opportunities, which are not observable by the regulator).

The simplest Laffont and Tirole model assumes that there are two types of company (high-cost and low-cost). The model shows that an optimum regulatory system can be obtained by offering the regulated company a choice between two contracts. One is a fixed-price contract that leaves some rent if the company is a low-cost type, but negative rent if it is a high-cost type (high-power scheme). The other is a cost-contingent contract that allows the company to make less effort but leaves no rent (low-powered scheme). Low-cost companies are better off opting for the high-powered scheme (and providing the optimal level of effort), while high-cost companies are attracted by the low-powered

[5] The local operator(s) can directly communicate decision about tariff proposal to the Regulator if the EGA does not act, i.e., if it does not proceed with the tariff proposal and the related investment/ financial plan. In addition, if even the local operator(s) does (do) not act, the Regulator can move on the decision-making process and also apply a 10% penalty on the tariff.

[6] Menu regulation is a system in which operators are presented with a choice of regulatory contracts.

scheme (providing less effort). An alternative version of this model shows that the same conditions apply when companies are offered a menu of continuum contracts.

Source: (Oxera, 2008) based on (Laffont, 1993)

In 2013, ARERA (then named AEEGSI) began a consultation phase to collect relevant information for the adoption of the 1st tariff setting methodology (MTI-1). Considering the heterogeneous service provision levels among operators, this methodology included a "Regulatory Matrix" designed to introduce a set of innovative and asymmetric rules that would provide different incentives to foster different levels of investments (Table 2). The two key entries of the "Regulatory Matrix MTI" were:

1. the ratio between the planned investment expenditure (net of grants) and the regulatory asset base (RAB). Depending on the value of this ratio (above or below "0.5"), different regulatory schemes apply to operators.
2. the scope and scale of activities provided by the water service operator[7].

Table 2 ARERA Regulatory Matrix MTI-1

Increased scope/scale of activities →

More investments ↓

		Operating costs	
		No variations in the operator's objectives or activities	Presence of variations in the operator's objectives or activities
Investments	$\frac{\sum_t^{t+3} IP_t^{exp}}{RAB_{MTT}} \le 0,5$	**Scheme I – ordinary case** ✓ *Opex*: more push on operating efficiency through a rolling cap, assuming the invariance over the period ✓ *Capex* recognised ex post using technical lives	**Scheme II** ✓ *Opex*: possibility to cover more *opex* motivating the request (and taking in consideration scale economies) ✓ *Capex*: same as ordinary case
	$\frac{\sum_t^{t+3} IP_t^{exp}}{RAB_{MTT}} > 0,5$	**Scheme III** ✓ *Opex*: same as ordinary case ✓ *Capex*: more accelerated depreciation admitted, together with (limited) anticipation on investments	**Scheme IV** ✓ *Opex*: possibility to cover more *opex* motivating the request (and taking in consideration scale economies) ✓ *Capex*: more accelerated depreciation admitted, together with (limited) anticipation on investments

Source: ARERA, 2013

Four regulatory schemes were thus defined according to which, each operator—on the basis of its own reported characteristics—is provided with precise rules to apply for water tariff setting (Table 3).

In scheme 1, operators have a low level of planned investments and no foreseen changes in the scope/scale of their activities. In scheme 2, operators have a low level of planned investments, and they foresee changes in the scope/scale of their activities. Operators in those two schemes have a price increase limit of 6.5%.

[7] At the time, the Italian water sector was going through an aggregation reform seeking to aggregate services to benefit from economies of scale and/or scope.

In scheme 3, operators have a high level of planned investments and no foreseen changes in the scope/scale of their activities. In scheme 4, operators have a high level of planned investments and no foreseen changes in the scope/scale of their activities. Operators in those two schemes have a price increase limit of 9%.

Table 3 Price cap according to regulatory schemes

	Cap to the variation of the tariff multiplier	
Schemes I e II	$\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 + rpi + K)$	6,5%
Schemes III e IV	$\frac{\vartheta^a}{\vartheta^{a-1}} \le [1 + rpi + (1+\gamma) * K]$	9,0%

Source: ARERA, 2013

The tariff evolution is thus regulated by a price cap taking into account:

- the retail price index (rpi);
- a factor K representing investment needs and equal to 5%;
- a reimbursement component γ equal to 0.5.

With this "menu regulation" approach, investment decisions have precise and measurable consequences on tariff levels, which are cost reflective as operators can pass on investment costs when they have actually borne those costs.

The implementation of the MTI-1 resulted in an average yearly increase of 4.04% in 2014 and 4.46% in 2015. In the meantime, the overall investments level rose by 55%, with sharper increases in the North and the Centre of Italy (Table 4).

Table 4 Evolution of water and sanitation net investments in Italy, from 2012 to 2015

	NET INVESTMENTS 2012 (€)	NET INVESTMENTS 2013 (€)	NET INVESTMENTS 2014 (€)	NET INVESTMENTS 2015 (€)
North-West	195.741.644	184.324.445	350.241.242	440.956.598
Nord-East	266.595.624	332.483.991	323.830.781	429.109.401
Centre	333.369.137	344.173.029	387.298.944	427.190.417
South	153.725.206	60.434.581	108.306.589	149.297.118
Islands	11.522.585	6.057.384	31.914.845	44.120.667
Italy	**960.954.196**	**927.473.430**	**1.201.592.401**	**1.490.674.201**

+55%

Source: ARERA, 2016

In December 2015, ARERA approved a second regulatory framework for the period 2016–2019, aiming at promoting investments and industry consolidation. In the "Regulatory Matrix MTI-2", six different regulatory schemes were defined based on:

1. the ratio between the planned investment expenditure (net of grants) and the regulatory asset base (RAB).
2. the level of Opex (relative to the national average value, OPM)

3. the possible changes in scope and/or scale of activities provided by the water service operator.

Schemes III and VI apply in the event of scope and/or scale changes in the operator's activities. Thus the "Regulatory Matrix MTI-2" incentivizes aggregation of utilities by providing the higher price cap for merging operators.

The price increase limit, determined for each of the six regulatory schemes, ranges from 5.5% to 9% (Table 5).

Table 5 ARERA Regulatory Matrix MTI-2

		No variations in the operator's objectives or activities		Variations in the operator's objectives or activities: • water system integration • improvements of quality
		$\frac{OPEX}{pop} \le OPM$	$\frac{OPEX}{pop} > OPM$	
Investments	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} \le \omega$	SCHEME I Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + K - X)$ **6.0%** Investment in relation to existing infrastructure: low Aggregation/new specific objectives: no	SCHEME II Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + K - 2X)$ **5.5%** Investment in relation to existing infrastructure: low Aggregation/new specific objectives: no	SCHEME III Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + K)$ **6.5%**
	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} \le \omega$	SCHEME IV Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + 1.5 * K - X)$ **8.5%** Investment in relation to existing infrastructure: high Aggregation/new specific objectives: no	SCHEME V Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + 1.5 * K - 2X)$ **8.0%** Investment in relation to existing infrastructure: high Aggregation/new specific objectives: no	SCHEME VI Limit to price variation: $\frac{\vartheta^a}{\vartheta^{a-1}} \le (1 - rpi + 1.5 * K)$ **9.0%**

Source: ARERA, 2015

As a result of the MTI-2 implementation, the water tariffs in Italy increased on average by 4.57% in 2016, with heterogeneous value in the different areas (i.e., 6.09% in the South, 5.39% in the North-East, 4.51% in the North-West, and 2.38% in the Centre of Italy).

5.2 A two-tier incentive mechanism to reduce water losses

ARERA has implemented incentives to reduce water losses through the regulatory formula for revenue cap setting and through the use and reporting of performance indicators.

5.2.1 Water losses reduction through environmental cost component

The regulatory tariff setting methodology is based on a revenue cap formula (VRG) that takes into account capex, cost components related to specific objectives (FoNI), opex, environmental and resource costs (ERC) as well as a component to recover costs from previous year balance (Rc):

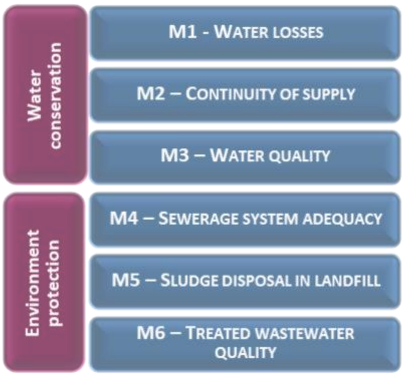
$$VRG^a = Capex^a + FoNI^a + Opex^a + ERC^a + Rc^a_{TOT}$$

The environmental and resource costs which include both operational and capital cost components, are used to promote WSS services sustainability and resilience. More specifically, some operational components of environmental costs are used to reflect and cover expenditure aimed at reducing or preventing water losses.

5.2.2 Water losses reduction through the use of performance indicators

Since 2016, ARERA has introduced 6 macro performance indicators with differentiated regulatory targets according to the operator's efficiency. Among these 6 macro-indicators, the indicator M1 is focusing on "water losses" (Figure 18).

Figure 18 The 6 regulatory macro-indicators



Source: ARERA

The macro-indicator M1 is composed of two components:

- Indicator M1a "linear water losses" and,
- Indicator M1b "percentage of water losses".

Macro-indicator M1 applies to all operators of water services, including wholesalers and bulk water providers. The five efficiency classes (from class A to class E) for M1 are defined according to the values of indicators M1a and M1b (Table 6).

Table 6 Class definition for Macro-indicator M1 "Water losses"

		Water losses per km (mc/km/day)				
		M1a <15	15≤ M1a <25	25≤ M1a <40	40≤ M1a <60	M1a ≥60
Leakage rate (%)	M1b <25%	A				
	25%≤ M1b <35%		B			
	35%≤ M1b <45%			C		
	45%≤ M1b <55%				D	
	M1b ≥55%					E

Source: (ARERA, 2021)

The improvement objectives established for the macro-indicator M1 for each class is described in Table 7.

Table 7 Regulatory targets for Macro-indicator M1 according to class

ID	Indicator	Tariff type	ID Class	Targets
M1	M1a – Water losses per km [mc/km/day] M1b – Leakage rate [%]	RES	A	Conservation
			B	-2% M1a yearly
			C	-4% M1a yearly
			D	-5% M1a yearly
			E	-6% M1a yearly

Source: (ARERA, 2021)

5.2.2.1 M1a - Linear water losses

The linear water losses are defined as the ratio between the volume of total water losses and the total length of the water network in the year *Y*, including the length of connections.

For each year *Y*, the M1a indicator for each water service operating area is calculated as follow:

$$M1a^a = \frac{WL^a_{TOT}}{365 \times (Lp^a + 0,22 * Ld^a)} \quad [mc/km/gg]$$

where

- $WL^a_{TOT} = \sum W^a_{IN} - \sum W^a_{OUT}$ represents the total water volume lost in the year *Y* by the operator, defined as the difference between the sum of the water volumes entering the water network system and the sum of the output volumes from the same network system (authorized consumption, billed or not billed, and exports to other systems). Provided that treatment losses are measured (not estimated), it is also possible to account for such losses as the difference between water flows going into and out of the treatment plant. The lost volume includes the so-called apparent losses (expressed in m^3);
- Lp^a is the total linear of the supply and distribution network (expressed in km), excluding connections, managed on the date of 31 December of the year *Y*;
- Ld^a is the total linear of the distribution network (expressed in km), excluding connection pipes, managed on the date of 31 December of the year *Y*.

It is possible for a local public authority, in accordance with its local water operator, to submit a specific request to ARERA to quantify the indicator $M1a^a$ taking into account the actual value of connections length, and not the proxy value by the parametric value ($0.22 * Ld^a$).

5.2.2.2 M1b - Percentage of water losses

The percentage of water losses is defined as the ratio between the volume of total water losses and the total water volume entering the transport & distribution system for a given year.

For each year *Y*, the M1b indicator for each water service operating area is calculated as follow:

$$M1b^a = \frac{WL^a_{TOT}}{\sum W^a_{IN}} \; [\%]$$

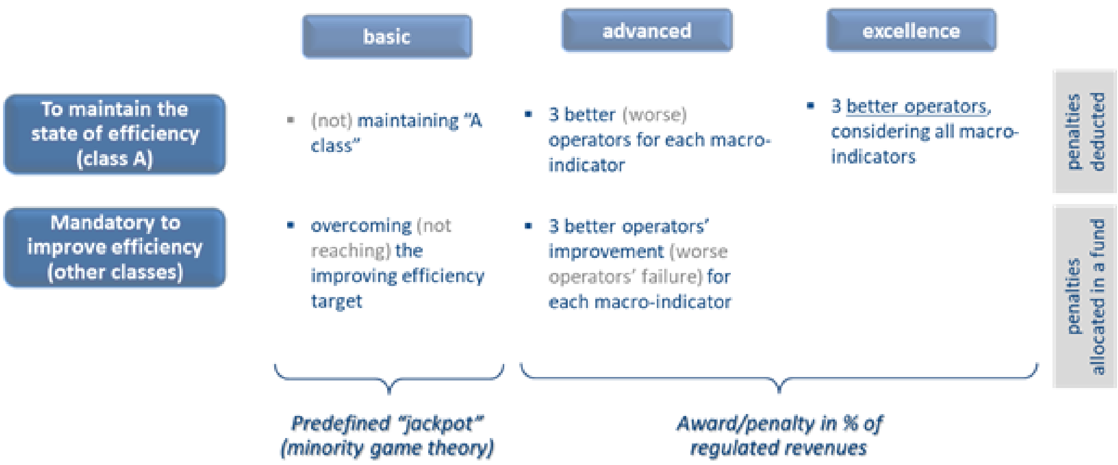
, where

- WL^a_{tot} represents the total volume lost in the year *Y* (expressed in m^3);
- $\sum W^a_{IN}$ represents the sum of the volumes entering the transport & distribution system in the year *Y*.

5.2.2.3 Financial incentives based on "water losses" performance

Since 2020, ARERA has introduced financial incentives based on utilities' performance and indicators level. When a utility is ranked class A for an indicator, it is financially rewarded (penalized) if it is among the 3 best (worst) performing operators of the class A. If the operator is ranked in any other class, it gets a financial reward (penalty) if it is among the 3 best (worst) improving operators for each macro-indicator. As such, water losses reduction (M1) is being financially incentive through this reward/penalty mechanism (Figure 19).

Figure 19 Financial incentive schemes based on utilities performance and macro-indicators level



Source: ARERA

In order to determine the operator's relative position within a specific class, the following calculations are made, which focus on (1) the reliability of the values of macro-indictor M1, and (2) the existence of innovative monitoring technologies.

1. Assessment of the reliability of the macro-indicator M1 value

$$G1.1^a_{ut} = \frac{WU^a_{val}}{WU^a_{tot}}$$

, where

- WU^{a}_{val} is the sum of the volumes consumed by end users (excluding indirect users) for which there is a number of validated readings (obtained with physical, remote or self-reading), in the year Y, at least equal to:

  - 2 readings for end users with average annual consumption up to 3,000 m^3;

  - 3 readings for end users with average annual consumption over 3,000 m^3;

- WU^{a}_{tot} is the sum of the volumes consumed by each end user (user volumes);

$$G1.1^{a}_{proc} = \frac{WP^{a}_{val}}{WP^{a}_{tot}}$$, where

- WP^{a}_{val} is the sum of the process volumes relevant for the calculation of the macro indicator M1 (including volumes traded with other operators) with at least 12 measures available and validated (including automatic detection systems);
- WP^{a}_{tot} is the sum of the process volumes (including volumes exchanged with other operators).

2. Existence of innovative monitoring technologies

$$G1.2^{a}_{ut} = \frac{WU^{a}_{sm\_tel}}{WU^{a}_{tot}}$$, where

- $WU^{a}_{sm\_tel}$ is the sum of the volumes consumed by end users (excluding indirect users) for which the measure was detected with remote reading (smart, excluding the semi-smart);
- WU^{a}_{tot} is the sum of the volumes consumed by each end user.

$$G1.2^{a}_{proc} = \frac{WP^{a}_{sm\_tel}}{WP^{a}_{tot}}$$, where

- $WP^{a}_{sm\_tel}$ is the sum of the process volumes relevant for the calculation of the macro indicator M1 (including volumes traded with other operators) measured with remote metering and reading (smart, excluding the semi-smart);
- WP^{a}_{tot} is the sum of the process volumes (including volumes exchanged with other operators).

For the following year (*Y*+1), the objective of the M1 indicator is defined as follows:

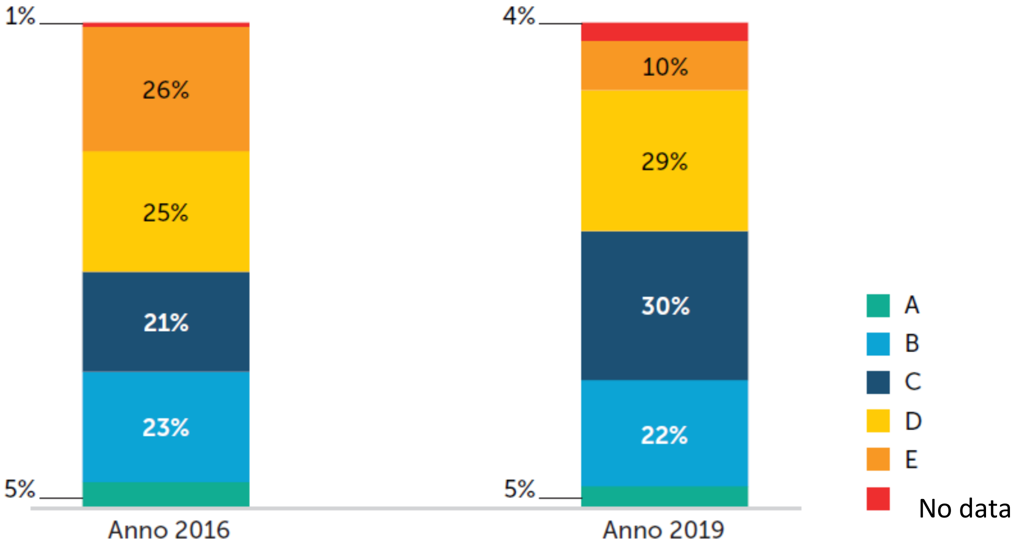
$$\overline{M1a}^{a+1} \leq M1a^{a} \cdot \left(1 - \sigma^{a+1}_{M1}\right)$$, where

σ^{a+1}_{M1} represents the goal for the year (*Y*+1), determined in reference to the operator’s class as defined in Table 7.

5.2.3 Monitoring water losses reduction from 2016 to 2019

From 2016 to 2019, a significant reduction in the share of the population served by low performing operators from "class E" (from 26% to 10%) can be observed, with the majority of the Italian population being served by utilities in "classes C and D" (59%) (Figure 20). Nevertheless, despite these positive outcomes, the share of population served by operators reaching less than 25% of water losses (class A) remains limited (5%) and stable over the regulatory period. Finally, there is an important increase in the share of population served by utilities which have failed to produce timely available and reliable measurement data (from 1% to 4%). This increase is attributable to the enlargement of the sample compared to 2016, and in particular to the presence operators located in the South and Islands areas, characterized by greater infrastructural deficiencies.

Figure 20 Population distribution according to the level of water losses



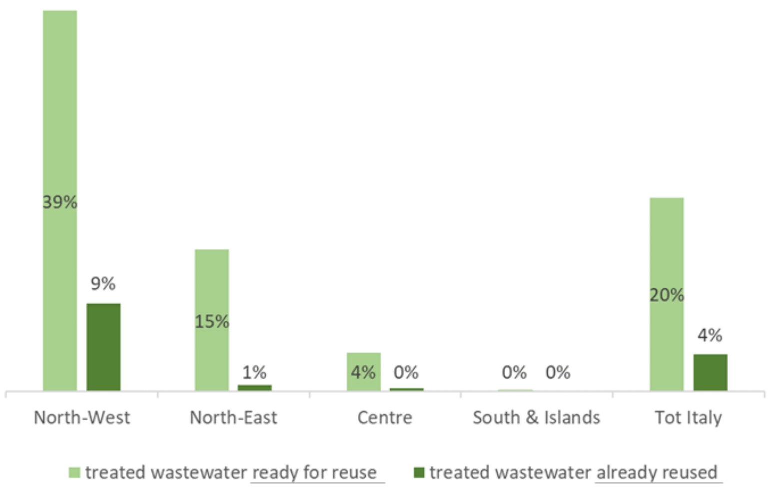
With class A representing less than 25% of water losses; class B between 25% and 35%; class C between 35% and 45%; class D between 45% and 55%; and class E above 55%. Source: (ARERA, 2020)

5.3 An incentive regulation to boost decarbonisation and wastewater reuse

Taking stock of the untapped potential for wastewater reuse (Figure 21), ARERA introduced for the third regulatory cycle[8] expanding from 2020 to 2023, specific incentive mechanisms to promote innovative and multi- sector measures, including wastewater reuse for agricultural and industrial purposes, or for technical purposes in wastewater treatment plants, so as to ensure efficient water resource use, in particular in contexts characterized by droughts.

[8] Resolution on the Tariff Methodology MTI-3 (decision 580/2019/R/idr, modified by decision 639/2021/R/idr)

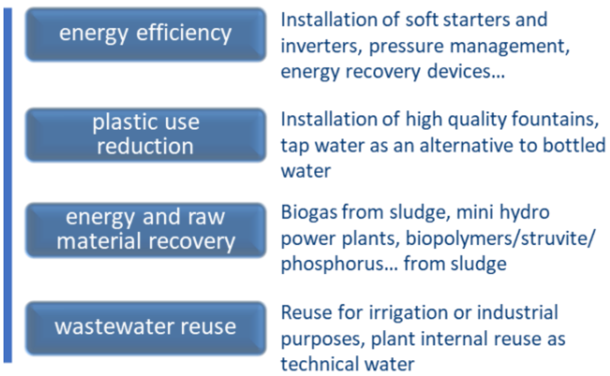
Figure 21 Untapped potential for wastewater reuse in Italy



Source: ARERA

Innovative and multi- sector measures, aimed at energy and environmental sustainability, include energy efficiency, plastic use reduction, energy and raw material recovery, as well as wastewater reuse (Figure 22). Operators are not compelled to implement such measures as they are not considered by ARERA as being part of mandatory water and sanitation services standards. However, these measures are incentivized through a revenue sharing mechanism affecting a component used to assess Rc^{a}_{tot} (see section 5.2.1). The revenue share amounts to 75% if innovative and multi- sector measures are implemented by the operator, compared to 50% when no measures are implemented. The impacts and outcomes of this incentive mechanism will be analysed at the end of the current regulatory cycle (i.e., 2023).

Figure 22 Innovative and multi-sector measures aiming at energy and environmental sustainability

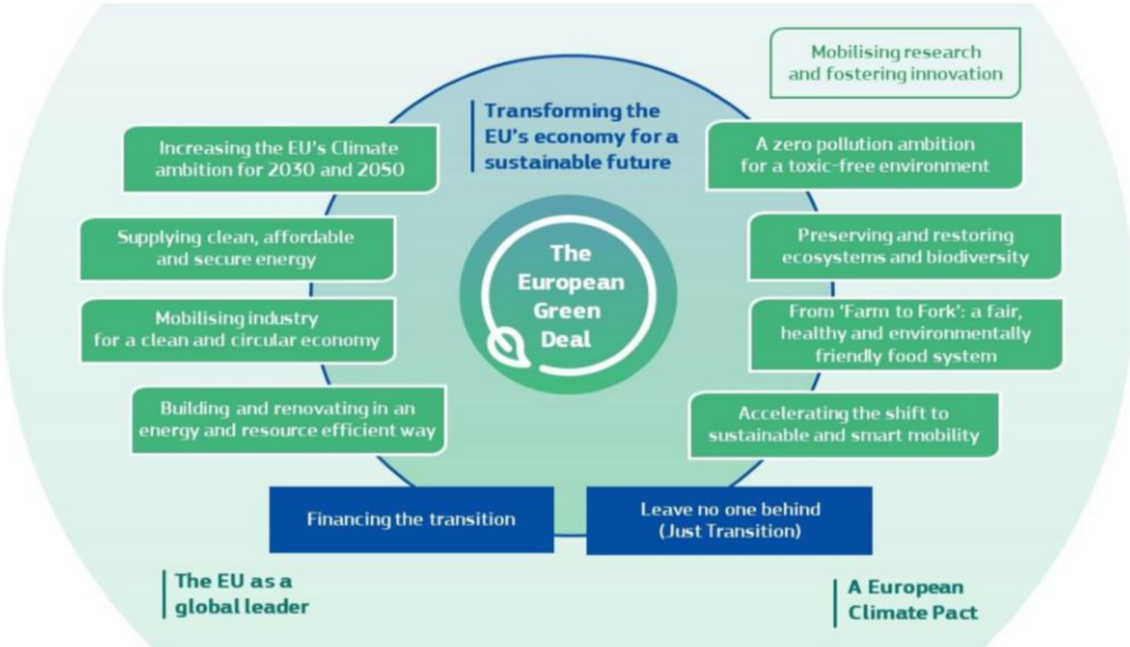


Source: ARERA

6 Concluding remarks

Building upon the learnings from the case studies presented in this document and taking into account the need to adapt to climate change, to manage increasing water risks and to develop WSS services resilience, WSS operators and regulators are shaping a rejuvenated service delivery model. This model, aligned with the EU Green Deal (Figure 23), targets carbon neutrality and resource efficiency while aiming to generate additional revenues decorrelated from water volumes sold, and to foster improved operational efficiency to ensure sustainability of service quality and asset management.

Figure 23 The EU Green Deal

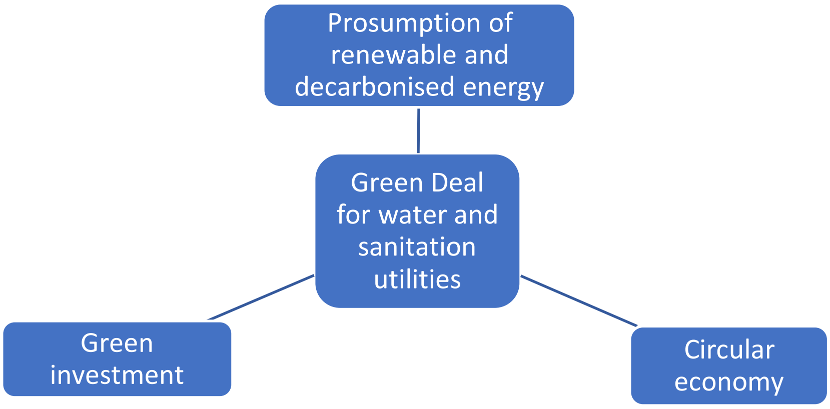


Source: EU Commission

This rejuvenated "Green Deal" model is currently articulated around three main axes (Figure 24):

- Prosumption of renewable and decarbonised energy;
- Promotion of green investment and ecosystem services over grey investment whenever possible;
- Implementation of circular economy practices in the WSS sector.

Figure 24 Green Deal model for WSS utilities



Source: Author's elaboration

Prosumption[9] of renewable and decarbonised energy relates to entities (natural or legal persons, public or private) that consume and produce these renewable energies and/or offer energy services to the centralized system, such as flexibility or storage. Prosumption can both generate new revenues for the prosumers and/or help develop self-generation of energy. The adoption of prosumption activities will help achieve carbon neutrality while promoting clean, affordable and secure energy supply, as required by the EU Green Deal. The table below recaps concrete examples of prosumption application to water and sanitation utilities taken from the case studies and beyond (Table 8).

Table 8 Examples of prosumer activities developed by WSS utilities

Type of Prosumer Activities	Examples from the case studies and beyond
Wind energy	Anglian Water
Solar energy	Vivaqua, Anglian Water, Clermont Métropole, Métropole Nice Côte d'Azur
Electricity from pressure dissipation valve	Vivaqua
Heat recovery from wastewater	Vivaqua, Section de l'Assainissement de Paris, Bordeaux Métropole

Source: Author's elaboration

Green investments are designed and managed to deliver a wide range of ecosystem services including, for instance, water purification. In most cases, green investments are more cost-effective solutions than conventional "grey" investments and require less capex and opex. The development of green investments will help achieve the EU Green Deal objective of ecosystems and biodiversity preservation and restoration. After a pilot project relying on the self-purification capacities of a wetland located along the *Ingol* river, *Anglian Water* has decided to build 29 other sites of the same type (Table 9).

Table 9 Example of green investment developed by WSS utilities

Type of Green Investment	Example from the case studies
Wetlands water purification capacity	Anglian Water

Source: Author's elaboration

Many types of **circular economy practices** can be developed by WSS utilities to generate new sources of revenues and/or increase operational economic efficiency (see Annex 8.1).

[9] To know more: *Energy Prosumers in Europe*, European Environment Agency, 2022

These practices include, for instance, treated wastewater reuse, or biogas and/or biomethane production as prescribed by the Urban Wastewater Treatment Directive (UWWTD) revision orientations (see Annex 8.2). The adoption of such practices will help achieve the EU Green Deal objectives of clean and circular economy, clean, affordable and secure energy supply, and climate neutrality. These practices are currently implemented by several WSS utilities (Table 10).

Table 10 Examples of circular economy practices developed by WSS utilities

Type of Circular Economy Practices	Examples from the case studies and beyond
Biogas	Anglian Water, Grand Chambéry Agglomération,
Biomethane	Clermont Métropole, Anglian Water, Métropole Nice Cote d'Azur, Nîmes Métropole
Treated wastewater reuse	MM Spa (Milan), Aguas de Murcia

Source: Author's elaboration

This rejuvenated "Green Deal" model for service delivery seeks to reach financial sustainability through a mix including the traditional 3Ts (OECD, 2009), and additional revenue sources decorrelated from volumes sold as described above. Further complementary funding instruments are also explored. They include the willingness to pay from specific user categories, i.e., high income households or companies/industries connected to the public network (as currently tested in Denmark); or the extended producer responsibility implementation to fund micropollutant treatment investment (as prescribed by the UWWTD revision orientations; see Annex 8.2).

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8 Annexes

8.1 Examples of circular economy practices in the water and sanitation sector

The section below is a non-exhaustive sample of the types of circular economy practices that could be developed by WSS utilities to generate new sources of revenues and/or increase operational economic efficiency. For a more comprehensive meta-study of CE opportunities in the WSS sector one should refer to that produced by Guerra-Rodríguez et al. (Guerra-Rodríguez, 2020).

8.1.1 Sludge Reprocessing (Biogas, Fertilizer, Resource Harvesting)

The treatment of sewage sludge is necessary before water can be returned to the hydrosphere after its extraction and use. However, the residual sludge itself is rich in nutrients, organic matter, minerals, and chemicals that can be transformed, harvested, and reused. Aerobic digestion is widely used in WWTPs to stabilise, sanitise, de-odorise, and reduce the volume of wastewater sludge. It achieves this by breaking down organic matter – converting it into methane which can be used to generate power and heat for WWTPS and their surrounding users (Bachmann, 2015). This biogas is considered under *EU Directive 2018/2001* to be a renewable energy source, and as such, is subject to the legal and financial benefits that come with such classification. Further, high value materials including phosphorus, nitrogen, and sulphur can be screened or otherwise extracted from sludge; allowing for their reuse and reducing the demand for virgin resources (Solon, 2019). The biogas and resource extraction processes can be complementary if methane is used as an electron doner for denitrification (Noyola, 2006). The remaining biomass can be incinerated to produce sewage sludge ash (SSA) which, when used as agricultural fertiliser, produces similar comparable yield results to conventional phosphate fertiliser (Franz 2008). SSA also has potential use in the construction industry as a replacement aggregate for use in concrete and mortar (Smol M. K., 2015).

8.1.2 Recycling Water Distribution Pipes

The choice of material for water pipes comes down to a variety of factors including the life-cycle cost (LCC) (covering both upfront purchasing and ongoing maintenance costs), impact on water quality and safety, surrounding environmental factors, durability/longevity, and suitability relative to the volume and chemical characteristics of water being supplied (Eyran). In the context of ecological transition, the life-cycle energy cost (LCEA) (Filion, 2004) and life-cycle carbon footprint (LCF) (Alsadi, 2020) of pipes of varying materials may also be considered.

While a CE perspective of water distribution pipe material choice should take into consideration LCEA and LCF, it should also consider the opportunity to use pipes produced from recycled materials, the recyclability of the pipes themselves following decommission, and the *repairability* of pipes. The length of water pipe segments (i.e., the degree of concatenation across the network) may also play a role in repairability; with shorter individual segment lengths allowing for reduced material waste where a leakage necessitates pipe replacement.

Water distribution pipes are constructed from a range of materials including metals (steel, galvanised iron, cast iron), cements (cement concrete, asbestos cement), and plastics (PVC and HDPE) (Eyran). The recyclability of each material, both in terms of the limits of material transformation as well as the associated environmental and financial costs, varies greatly. Key for CE is the fact that the recycling technique can produce different resource outputs. For example, Ragaert et al (Ragaert, 2017) in their comparison of eight PVC recycling technologies found that chemical recycling could yield a range of valuable outputs including naphtha and precursors in the generation of UP resins, polyurethanes, textile dyes, antibacterial drugs, and epoxy resins.

In addition to secondary resource recycling an extraction, there are opportunities for water distribution pipes to be better integrated into a 'closed loop' system. For example, Juan et al. (Juan, 2020) found that while 100% recycled HDPE is not yet utilised in pressure pipes due to structural bearing load requirements, there are compositions of recycled HDPE and virgin materials that can meet the standards. However, this depends on the quality and manufacturing processes used to create the initial HDPE pipes in the first place; meaning that WSOs need to include such considerations in procurement processes. In an efficient and ideal CE system, it would not be inconceivable that fly ash from the thermal conversion of wastewater sludge (Rutkowska, 2021) could be serve as a component in the production of concrete pipes or pipe-bearing buttresses used to transport water.

8.1.3 Heat Recapture

Water consumed for domestic and commercial use is often heated for comfort and utility, thereby consuming energy in the process. Recapturing this heat using heat exchange technologies from light greywater in dwellings and commercial buildings (showers, bathtubs, WC basins) can reduce the financial and environmental costs of water-heating (Piotrowska, 2020). Greywater heat capture was identified in Directive (EU) 2018/2001 as an ambient energy source (Article 2) and measures to preserve the value of heat would reduce natural resources consumed in producing said heat, and thereby constitute a CE practice.

While several variables contribute to thermal loss and overall return on investment, including investment costs, water usage patterns, heating and capture technology (Kordana, 2017); domestic grey water heat recovery systems can achieve recovery rates of up to 50% (Piotrowska, 2020) (Stec, 2015). Regulation may therefore consider incentivising the installation of greywater heat capture technologies; particularly where centralised greywater capture is used in high-capacity institutions (hospitals, prisons, etc) and heated water-intensive commercial structures (dishwashers, laundromats, etc.). More directly, there are opportunities for WSS regulators to incentivise water operators themselves to invest in heat-capture technology to increase energy efficiency. Given that the optimal digester temperature at WWTP is between 35-40 degrees (Spriet, 2018), such heat could be captured and re-used for general infrastructure heating needs. Temperature differentials in incoming greywater and treated effluent discharge may also be captured for internal re-use (Henriques, 2017).

8.1.4 Kinetic Capture

The kinetic energy of water flowing through a network can be captured and harnessed by WSS operators to offset and reduce their energy costs, increasing overall system efficiency and preserving energy value. The concept is referred to as 'small', 'mini', or 'micro-hydro', contrasting with large-scale hydroelectricity projects. It relies on taking advantage of water speed differentials and increases in water flows following weather events are potential renewable energy-source in WWS, both throughout the system as well as at WWTPs. (Gaius-obaseki, 2010). As an energy source, micro-hydro in water networks has several advantages, including the fact that it does not generate emissions and the lack of a need to divert surface water and maintain additional reservoirs as required of mainstream hydrogeneration (Bousquet, 2017).

The key technology for consideration for water operators is pump-as-turbine (PaT) (alternatively referred to as a 'reverse-running pump)'; and while an almost century-old technology, its use by water operators has been limited compared to other energy generation sources such as biofuel (Gaius-obaseki, 2010). Pérez-Sánchez et al. (Pérez-Sánchez, 2017) list a range of benefits associated with PaT for their application in the WSS network; including their ability to dissipate excess flow energy, high efficiency, existence of strong computational methods for determining viability, low investment costs, and high number of available machines. One WSO in Southern Germany operates six PaTs at its reservoir which generate between 170 and 230kW which is used to meet the WSOs own energy requirements; contributing to total energy cost savings of between 25% and 28% (Budris, 2011).

WWTPs can also benefit from PaT and micro-hydro. Power can be generated from speed differentials in effluent inflows and outflows which can supplement power needed for heating in waste treatment (Henriques, 2017). Additionally, impulse turbines may also produce positive secondary effects which reduce the cost of water treatment by increasing dissolved oxygen concentrations in effluent outflow and reception streams (Zakkour, 2002) (Bousquet, 2017).

8.1.5 Solar Power

An opportunity to reduce the use of chemicals and energy in the water treatment process exists in the form of solar-enhanced 'advanced oxidisation processes' (AOP), whereby WWTPs can harness photocatalysis techniques to oxidise and mineralise chemicals and pathogens in water; reducing the conventional treatment load (Tsydenova, 2015) (Zhang Y. a., 2018).

In contrast to the use of solar-enhanced AOP which is a relatively new technology that has not yet been scaled, solar power as a desalinisation process (both indirect and direct) is currently being practiced. Direct solar desalinisation, whereby solar energy is directed as brackish or sea water to cause evaporation, which is condensed and recaptured, is a more appropriate technology for use in rural or water scarce areas to replace or supplement standard water supply. While such direct solar desalination is not efficient for use in large-scale water supply; indirect desalinisation certainly is in certain circumstances (Zhang Y. a., 2018). In an indirect capacity, solar power is converted into electricity or captured as heat which serves as an input in the conventional reverse osmosis process to replace or supplement regular electricity from a grid. Indirect or solar-supported desalinisation is most applicable in regions where surface freshwater is scarce, and both solar power and saline water are plentiful. For this reason, the government of Saudi Arabia in 2019 completed the construction of the world's largest solar reverse osmosis desalinisation plant, which has 60% of its energy requirements met by photovoltaic capture and produces 60,300m^3 of water per day from the Persian Gulf[10].

[10] 'Solar Saline Water Reverse Osmosis Al-Khafji' available at https://www.savener.es/en/proyectos/solar-saline-water-reverse-osmosis-al-khafji/

8.2 Revision of the urban wastewater treatment Directive: circular economy practices, carbon neutrality, and micropollutant treatment

The UWWTD revision proposes several measures that will be progressively applied until 2040. Among these measures, some target the development of circular economy practices (reuse of treated wastewater), or the promotion of carbon neutrality, while other focus on micropollutant treatment with financial contribution of pharmaceutical and cosmetic industrial groups.

- To further reduce pollution, the new rules enlarge the scope of the current Directive (which applies to cities with over 2,000 inhabitants) to cover all cities with more than 1,000 inhabitants. The new rules will also cover rainwater and will require EU countries to establish integrated urban wastewater management plans in large cities (over 100,000 inhabitants initially, as well as later for cities from 10,000 inhabitants, where needed). This will reduce direct emissions of organic matter, nitrogen and phosphorus to water bodies, but also litter and microplastics captured by urban runoff. It also introduces better control of individual systems such as septic tanks, stricter standards for nutrients, and standards for micropollutants. It also requires the monitoring of greenhouse gas emissions and microplastics.

- To make sure that the wastewater sector not only improves water quality but also moves towards climate-neutrality and circularity, the revision introduces a binding energy neutrality target for the whole sector, at Member State level. This means that urban wastewater treatment plants will have to significantly reduce their energy consumption and produce energy through renewable sources (e.g. solar, wind and in particular biogas production). This will be achieved through energy audits and by replacing fossil fuels with renewable energy. EU countries will also be required to track industrial pollution at the source to increase the possibilities of re-using sludge and treated wastewater, thus ensuring that valuable resources are not lost. The proposal also provides a mandate for the Commission to fix minimum recovery rates for phosphorus.

- To improve governance in the wastewater sector and ensure transparency between operators and the public, the new rules will ensure that operators make public key performance indicators. Through the enforcement of the polluter-pays-principle, the revised directive will introduce extended producer responsibility. This means the industry will be asked to pay for the treatment of the harmful pollutants that are released from the use of their products. Currently the pharmaceuticals and the cosmetics sectors are jointly responsible for 92% of the toxic load in wastewaters. For both sectors, there is sufficient evidence on the existence of micropollutants from these products in wastewater and there are treatments to remove their harmful residues. In the long term, the Commission will assess if other sectors can be added to the extended producer responsibility scheme.

- In the EU, according to Eurostat, approximately 2% of the population have no access to indoor, flushing toilets and around 10 million people still lack access to basic sanitation services. This lack of access to sanitation disproportionally affects the most vulnerable and marginalised people and means the EU is failing to implement

Sustainable Development Goal 6, which aims to ensure "access to adequate and equitable sanitation and hygiene for all". Therefore, under the new rules, EU countries must take measures geared to improving access to sanitation, especially for vulnerable and marginalised people across the EU. To do so, Member States should consider setting up sanitation facilities in public spaces and for the most affected to provide them free of charge or at low cost.

- Finally, the COVID-19 crisis has shown that viruses can be tracked with high reliability in wastewater, so the proposal introduces health parameters to monitor pandemics.

If properly implemented, the new rules are expected to have several positive effects by 2040. Across the EU, they are expected to save almost €3 billion per year, reduce greenhouse gas emissions by 62.5% compared to 1990, decrease water pollution through reduction of more than 365,000 tonnes of organic matter, nitrogen and phosphorus and cut microplastics emissions by 9% through better storm water management.

	2025	2030	2035	2040
Storm water overflows and urban runoff (rain waters)	Monitoring in place	Integrated plans for agglo. > 100.k p.e. + areas at risk identified	Integrated plans in place for agglo. at risk between 10 and 100k p.e.	Indicative EU target in force for all agglomerations > 10.000 p.e.
Individual appropriate systems	Regular inspection in all MS + Reporting for MS with high IAS	EU standards for IAS		
Small-scale agglomerations	New thresholds of 1.000 p.e.	All agglo.> 1.000 p.e. compliant		
Nitrogen and phosphorus	Identification of areas at risk (agglomerations 10 to 100k p.e.)	Interim target for N/P removal in facilities > 100 000 p.e. + New standards	N/P removal in all facilities above 100k p.e. + Interim target for areas at risk	N/P removal in place in all areas at risk (between 10 and 100k p.e.)
Micro-pollutants	Setting up extended producer responsibility schemes	Areas at risk identified (10 to 100k p.e.) + Interim target for facilities above 100.k p.e.	All facilities > 100k p.e. equipped + interim targets for areas 'at risk'	All facilities at risk equipped with advanced treatment
Energy	Energy audits for facilities above 100k p.e.	Audits for all facilities above 10k p.e. Interim target	Interim target for energy neutrality	Energy neutrality met and related GHG reduction met

Implementation planning for the main measures of the preferred option

Source: (European Commission, 2022)

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