WATER IN FIGURES

2022 DENMARK

EXTENDED EDITION
IWA WORLD WATER CONGRESS & EXHIBITION 2022

STATISTICS & BENCHMARKING

TEXT: CARL-EMIL LARSEN/ PHOTO: DANVA

Welcome to Denmark

The Danish water sector is a natural mainstay in society. The key figures from the water companies presented in "Water in Figures, 2022" places Danish water solutions in a leading position on a global scale. This will be on expo at the IWA World Water Congress & Exhibition, being held for the first time in Denmark in Copenhagen (11 – 15 September). The IWA congress is hosted by DANVA and IWA-DK and is organised by a united Danish Water Sector together with IWA, and it ensures the exchange of water knowledge between water professionals from the entire world. We expect to welcome approx 8000 delegates, exhibitors and visitors.

Globally unique, in Denmark we pump all our drinking water directly from below ground. After a simple treatment process, this cool and delicious groundwater is delivered to the taps of our consumers without any use of chlorine.

"Water in Figures, 2022" shows that the average Dane used 105 litres of water per day in private households. This is an increase of one litre since 2020 and four litres since 2019. This modest increase in consumption is probably due to shutdowns and many employees working from home during the coronavirus crisis. Globally, however, the Danish water consumption is still very low, which, among other things, can be explained by the ever-growing awareness of the value of drinking water, resulting from the Danish tax and payment structure. The water companies are also very efficient in reducing water loss. As a result, in Denmark, there is a loss of only 7.22 percent of all the drinking water that is transported through the country's 45,000 kilometres of drinking water pipes. It is very unique and a consequence of high ambitions and world-leading solutions.

The Water Sector in Denmark has a stated common goal of becoming energy and climate neutral by 2030. This goal supports the national climate agenda and has accelerated the development and implementation of green water solutions. The key figures for the water sector's energy consumption show that the water companies are already well on their way. The primary emissions from the wastewater sector are from nitrous oxide and methane from treatment processes, and the utilities has a challenge and a task to implement solutions in order to fulfill national requirements and overall climate goals.

Reducing combined sewer overflows is another challenge for Danish utilities, and a lot of work is being done to reduce the effects of these in the water environment. The key figures show that the number of combined sewer overflow structures are reduced, while separate sewerage systems has increased in number. In 2010, 61% of the Danish sewer systems were separate sewerage systems, while in 2020 there has been an increase to 68%. Urban wastewater flows into the aquatic environment through wastewater treatment plants that removes nutrients before it is led to the environment. Less than 10% of the total discharge of nitrogen into Denmark's water environment comes from municipal wastewater. The majority (60-70%) comes from agriculture. Climate change increases the challenges with floodings and overflows, and in addition treatment of micropollutants is a new task where Danish utilities are working to find solutions. In Copenhagen congress participants can meet the Danish water companies and learn more about how we work to solve the challenges of today and tomorrow.

The IWA World Water Congress & Exhibition in Copenhagen in September is a once-in-a-lifetime event in Denmark. DANVA welcomes all delegates, visitors and exhibitors and we look forward to a fantastic congress.

Water is and will be the natural mainstay in society in Denmark and the rest of the world. ■

DANVA Benchmarking and Statistics

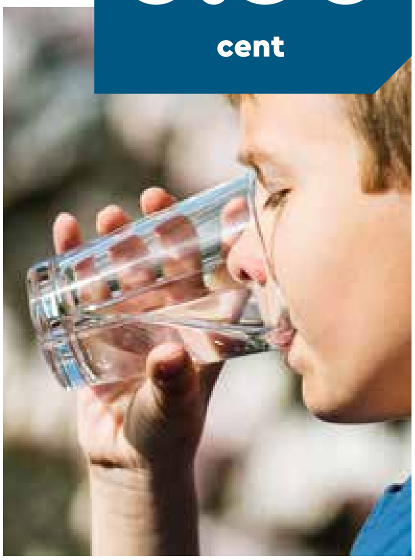
DANVA, the Danish Water and Wastewater Association, is an industry organisation for drinking water companies and wastewater companies in Denmark. DANVA is a non-profit association, funded by its members and through commercial activities.

DANVA has been offering benchmarking to its members for almost 20 years. Benchmarking is a tool to provide an overview of the company's performance and to identify areas where efficiency can be improved. The reporting to DANVA Benchmarking and Statistics forms the basis for the preparation of this publication. In total, 77 drinking water companies and 91 wastewater companies have reported data from 2021 to "Water in Figures 2022". The participating drinking water companies supply water to approx. 60 % of the Danish population, while the participating wastewater companies treat water coming from approx. 80 % of the Danish population.

Half a litre of drinking water from the tap costs

0.50

cent



How much does your water cost?

On DANVA's website, you will find an interactive map "Water prices on the Map of Denmark", which shows the water prices charged by the 200 largest water companies and about 100 wastewater companies who are subject to the Danish Water Sector Act. The map shows the prices of drinking water and wastewater per m³ as well as the cost for households with an average consumption of 50 m³, approximately 83 m³ as well as 170 m³. The map can be found at www.danva.dk/vandprispaadanmarkskort

How much does water cost?

The price of water is not the same throughout the country. On the one hand, there are structural differences such as geological conditions, different customer bases and large differences in investment needs, and on the other hand, price composition may vary from company to company. "How much does water cost?" and "why does it cost what it does?". These are two good questions which DANVA is often asked, and they are not quite so easy to answer.

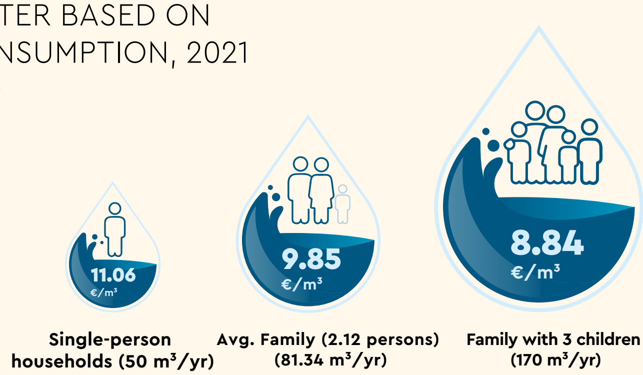
The legislation stipulates that companies are permitted to charge a fixed annual administration fee as well as a variable charge per m³ of water consumption for drinking water and the removal of wastewater. The pricing scheme therefore has a major bearing on the cost of one m³ of water consumed. Some companies levy a fixed annual base charge on water and/or wastewater, while others only charge for the amount of water consumed, which results in considerable variation when calculating the price per one m³ of water consumed. The fixed annual base charge is paid per household rather than per person, so if the household is large and is using lots of water, the fixed charge only accounts for a small part of the price when it is recalculated into price per m³ consumed. If, on the other hand, the household only has small consumption, the fixed charge per m³ consumed will be higher. Therefore, when replying what a m³ of consumed water costs, a set consumption amount must therefore be assumed in order to be able to state the cost.

We calculate an average price, which is the price that an average household would pay based on average consumption. In this way, we can compare the price across companies regardless of the pricing scheme that is used by each company.

The average price of water in Denmark in 2021, based on an average household size of 2.12 people with an average household consumption of 105 litres per person per day, stood at € 9.85 per m³. The average price per m³ of water for a household with small consumption, for example a single person, was somewhat higher, namely € 11.06 per m³ for an assumed consumption of 50 m³. The average price per m³ for a family with three children, based on an assumed annual consumption of 170 m³, is somewhat lower, namely € 8.84 per m³. The average water price rose by 1.3 % compared to last year. ■

AVERAGE PRICE OF WATER BASED ON CONSUMPTION, 2021

€/M³



Simple average, based on 208 drinking water companies and 97 wastewater companies. The price is inclusive of VAT and taxes. The average water price for 2022, based on the same water consumption as in 2021, is expected to be € 9.91/m³ for an average family.

Water consumption has fallen since 1987

In October 1986, the TV Avisen newscast showed pictures of Norway lobsters that had died due to lack of oxygen caused by the enormous discharge of nutrients into the aquatic environment. They became the symbol of the introduction of the first Action Plan for the Aquatic Environment in 1987. The first Action Plan for the Aquatic Environment required substantial reductions in nutrient discharges from Denmark's wastewater and resulted in major extensions and new construction of Danish wastewater treatment plants.

For many Danes, the picture of the Norway lobsters turned into an eye-opener for our impact on the aquatic environment. The aquatic environment came into greater focus, and water was regarded as a resource to be conserved.

Water conservation campaigns were launched, and water-saving toilets, taps and showers were introduced onto the market. Together with the increase in water prices and the introduction of a green water tax on piped (tap) water, this has entailed a steady decrease in water consumption since 1987. Water consumption in 1987 stood at 172 litres per person, dropping to a level of just over 100 litres in the last couple of years.

The graph below shows some of the laws and regulations that are believed to have influenced this decline in water consumption. At a first glance, it appears that it was, in particular, the first Action Plan for the Aquatic Environment, with its increased environmental awareness among consumers combined with an increase in the wastewater tariff, that led to the decrease in water consumption. At the same time, the installation of water meters had a major impact on citizens' ability to keep track of their consumption and see the effects of conserving water. A requirement was introduced in 1996 for everyone to have a water meter installed, which gave water companies a greater insight into consumption, waste and leaks and enabled them to compute water loss from the distribution system. The focus was further intensified with the introduction of a penalty on water loss of more than 10 %.

Water consumption in 2021

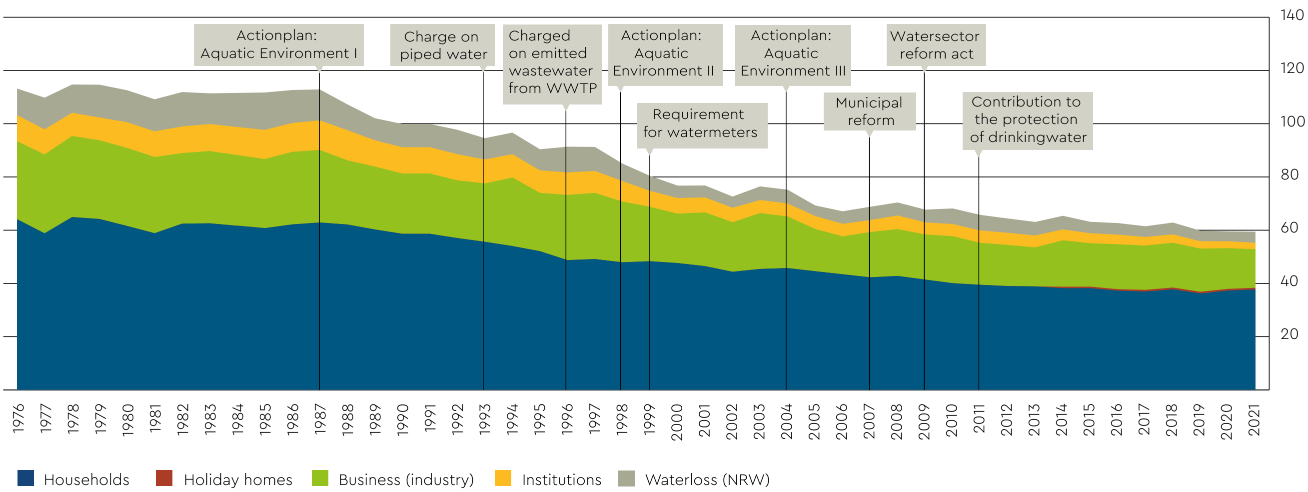
The total water consumption for 2021, divided into households, holiday homes, businesses, institutions and water losses, stood on average at 59.43 m^3 per person per year. Households accounted for 69 % of the total volume of water sold. An individual uses an average of 38.37 m^3 per year, corresponding to 105 litres per day.

The development has evened out during recent years with small fluctuations and there is an expectation that there are not many more water savings to pick up as regards physical installations since toilets, showers and taps, washing machines and dishwashers have gradually been replaced with water-saving versions. Personal hygiene still accounts for almost half of the daily water consumption in households. ■

105
litres is the average amount of water a person uses per day in a household.

CONSUMPTION OF DRINKING WATER, 1976 - 2021

M^3/PERSON/YEAR



Since 2014, a new category of "holiday homes" has been introduced, which is factored into the household figures.
1976–1998: Master project: Modelling of water demand in Denmark by Nana Sofie Aarøe – data from 14–30 companies.
1999–2021: Data from DANVA's calculations for "Water in Figures" — data from 33–116 companies.
The statement for 2021 is based on statistics supplied by 72 drinking water companies, which together serve 3.636 million inhabitants.

Selected regulations, national plans and reforms that have had an impact on the price and water consumption of a family:

- 1987: Action Plan for the Aquatic Environment I – the plan was intended to protect the aquatic environment, both groundwater and surface water. The Action Plan for the Aquatic Environment gave rise to the need for major construction and upgrading of wastewater treatment plants.
- 1993: Tax on tap water (€ 0.67/m^3) as well as a penalty for drinking water companies with a water loss of over 10 %, Act No. 492 of 30/06/1993 (Danish Ministry of Taxation).
- 1996: Tax for wastewater – Act No. 490 of 12/06/1996 (Danish Ministry of Taxation).
- 1996: Requirements for installation of water meters – Executive Order No. 525 of 14/06/1996 (Danish Ministry of Climate, Energy and Utilities).
- 1998: Action Plan for the Aquatic Environment II – the plan was mainly intended to reduce nitrogen emissions.
- 2004: Action Plan for the Aquatic Environment III – further reduction of nitrogen and phosphorus emissions.
- 2007: The municipal reform reduced the number of municipalities from 271 to 98, resulting in the merger of many water utilities.
- 2009: The Danish Water Sector Reform Act – the separation of municipal water and wastewater supply activities into municipally owned public limited companies (water companies) and the introduction of price ceilings and efficiency requirements – Act No. 469 of 12/06/2009 (Danish Ministry of Climate, Energy and Utilities).
- 2011: Introduction of the drinking water charge by Act No. 1384 of 28/12/2011 (Danish Ministry of Taxation).

Evolution of the **household cost of water**

An estimate of the cost of water and wastewater since 1985 indicates that the cost rose sharply, in particular, in the first ten years after the introduction of the first Action Plan for the Aquatic Environment, when all wastewater companies were developing their wastewater treatment capacity and treatment efficiency.

As regards drinking water, the expenditure of drinking water companies has remained nearly constant converted to 2021 prices throughout the period. Nevertheless, a leap can be observed from 1994 to 1998, in connection with the gradual phase-in of the charge on piped water of € 0.67 per m^3.

In addition to the impact of the first Action Plan for the Aquatic Environment, wastewater has required a constant increase in tariff in order to cover the investments in climate initiatives meant to ensure the best possible way of managing the greater rainfall.

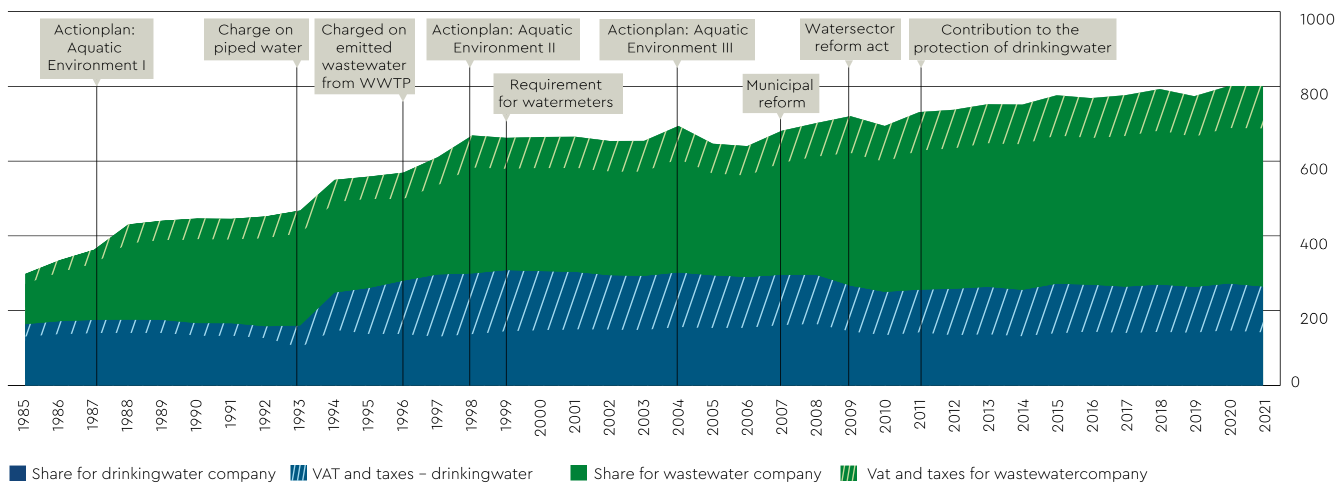
Even if tariffs have been rising, this increase is offset by a fall in water consumption, which has caused a household's overall cost of drinking water and wastewater to remain at an almost constant level in recent years.

What drinking water and wastewater companies have in common is that tariffs go up when water consumption drops, because a large part of the companies' operating costs are fixed and therefore do not depend on customer consumption. As a rule of thumb, 70 % of the overall costs of any drinking water company are estimated to be fixed, while this percentage goes as high as 85 % for wastewater companies.

In 2021 the expenditure for drinking water and discharge of wastewater in an average household was € 801.21. ■

AVERAGE HOUSEHOLD EXPENCES, 1985 - 2021

€/YEAR (2021 PRICES)



An average family's household water costs are based on 2.12 persons per household and the annual individual water price and consumption. Data for 1985 to 2008 is based on 32–50 suppliers and from 2009 onwards on 60–200 water suppliers and 60–97 wastewater companies. Changes are evident on the graph for 2008 to 2009.

Water creates attractive urban environments as seen here in the centre of Aarhus. Photo: Colourbox.dk / Mikkel Vognæs

Why are there **differences** in the water price?

The price of water depends on which water company you are affiliated with. There are more than 2,500 water utilities and 98 wastewater utilities in Denmark. Contact your local water company to get your water prices.

The price of drinking water covers the cost of groundwater protection, abstraction, processing and distribution of drinking water from the waterworks to customers. The price of wastewater covers the operation and maintenance, renovation and extension of the sewer network, climate-proofing, operation and maintenance of treatment plants as well as checks to ensure compliance with discharge requirements.

Why does the price of water vary?

There is a spread between the lowest and the highest prices among the water companies. The difference in the overall prices may be owing to several circumstances:

- It may be comparatively less expensive to supply major industrial consumers than small customers, such as holiday homes.
- Geological conditions may make it more expensive or cheaper to collect water from below ground.
- Geographic differences, where large distances between consumers signify longer pipes.
- In some places, groundwater pollution and scarcity of water resources may mean investing in new source sites for water extraction.
- Some drinking water companies spend more than others on groundwater protection. Other companies are "born lucky", as their water abstraction sites are already in protected natural areas.
- The treatment requirements for wastewater depend, in particular, on the natural setting of the point of discharge for the treated water. Requirements are often higher for discharge to vulnerable recipients in freshwater areas than for discharge into the sea.
- Decentralised wastewater treatment in smaller plants is usually more expensive than central wastewater treatment at larger ones.
- Environmental conditions requiring additional measures.
- There is a significant difference in the level of investment from company to company. Currently, many companies are investing in new climate measures in order to respond to the increase in rain volumes.
- The older a plant is, the more maintenance it requires.
- Differences in the level of service are determined by the municipalities and/or the companies themselves.

The water price consists of a total of five elements:

- Fixed charge for drinking water (if any)
- Cubic metre price for drinking water
- Fixed charge for wastewater (if any)
- Cubic metre price for wastewater
- VAT and other taxes ■

Water price composition

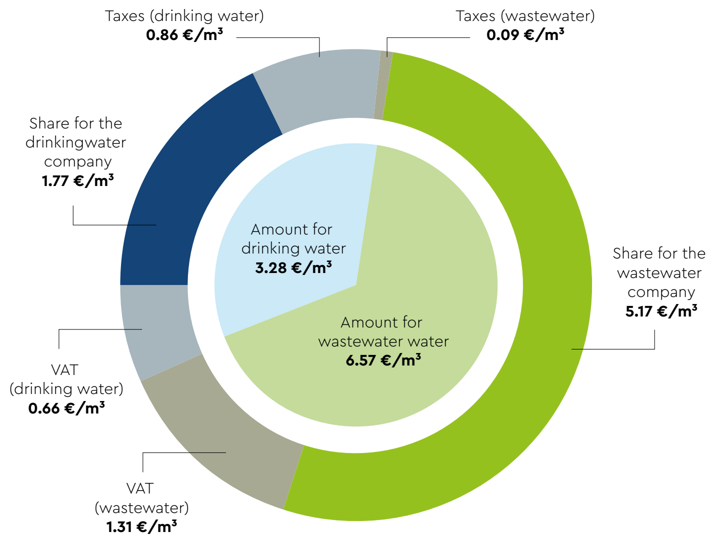
The average water price can be split into the part charged by the drinking water company and the part charged by the wastewater company, plus VAT and other taxes, such as tax on piped (tap) water and wastewater tax. Out of the total water price of € 9.85 per m³, 18.0 % go to the drinking water company, 52.4 % to the wastewater company, while 29.6 % go to the State in the form of VAT and other taxes.

Splitting the total water price into prices for drinking water hence wastewater, the price of drinking water comprises 33.3% of the total average water price. This corresponds to a price of € 3.28 out of which € 1.51 is VAT and other taxes. Wastewater makes up 66.7 % of the total average water price, corresponding to € 6.57 out of which € 1.40 is VAT and other taxes.

34% of the drinking water companies' income comes from fixed charges, while 66% comes from cubic metre prices. 93% of all water companies apply fixed charges.

The income of wastewater companies is split with 12% coming from fixed charges and 88% from cubic metre prices. 63% of all wastewater companies apply fixed charges. ■

COMPOSITION OF WATER PRICES, 2021



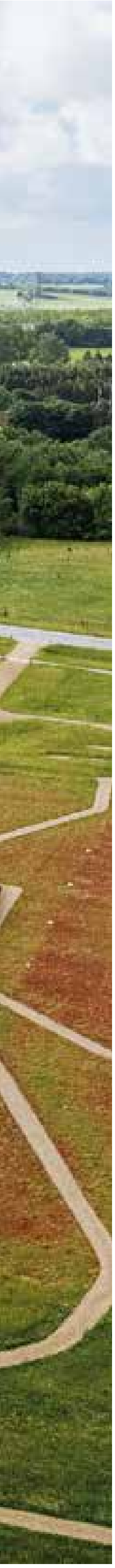
Wastewater discount to large consumers

Based on a growth plan adopted in April 2013, a political decision was made to introduce a wastewater discount scheme for major industrial consumers. The discount scheme, termed the three-step tariffs model (an incremental model), was phased in from 2014 to 2018 and is based on 3 incremental levels:

- Level 1 is the wastewater companies' regular tariff for the discharge and treatment of wastewater from households and businesses.
- Level 2 entails a 20 % discount on the Level 1 tariff for water consumption of between 500 and 20,000 m³.
- Level 3 provides a 60 % discount on the Level 1 tariff on water consumption over 20,000 m³ of water.

The three-step tariffs model has affected the wastewater companies in varying ways. It has been particularly important for those wastewater companies that have a greater proportion of large business customers using lots of water and have therefore had to give discounts on a large part of their income base. The political decision assumed that the discount would be covered by greater efficiencies, but experience indicates that residents paid for some of the discount, as the tariffs for Level 1 have risen more than the average for the companies' large industrial customers.

The covered wastewater treatment plant in Hillerød blends discreetly in with its surroundings. Photo: Hillerød Forsyning, Dorte Tuladhar



Only 1.41% of the income spend on water and wastewater

The UN's UNDP Development Programme recommends that no more than 3 % of the gross income of a household should be spent on clean drinking water and no more than 5 % on drinking water and wastewater. According to Statistics Denmark (FU09), the average Danish household gross income for 2020 stood at € 89,184, while the disposable income of an average family stood at € 62,075. According to Statistics Denmark, an average family spends € 606 of their gross income on water and wastewater.

A HOUSEHOLD'S ANNUAL LIVING EXPENSES — SELECTED CATEGORIES

Share of a family's consumption:	
Dental services	0.82%
Waste disposal	0.88%
Fastfood/takeaway	1.37%
Drinking water and wastewater	**1.41%**
Telephony and Internet	1.78%
Petrol and diesel	1.85%
Electricity	2.06%
Clothing	3.58%
District heating	3.16%
Insurance	4.99%

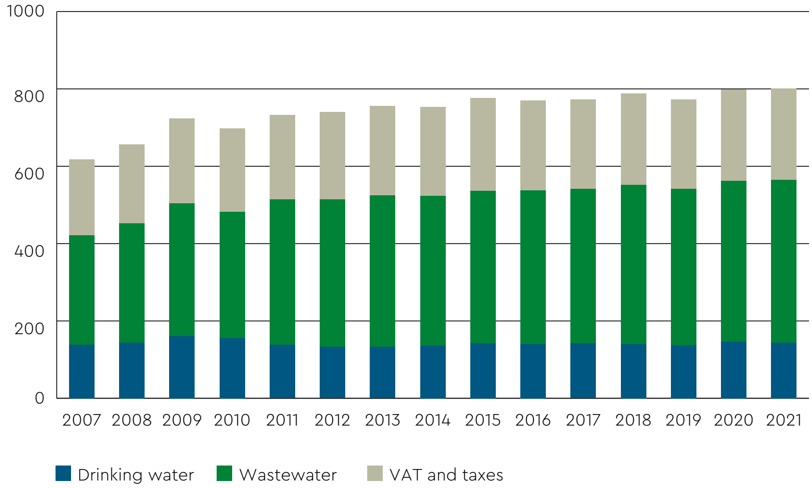
Data from statistikbanken.dk/FU02 — data for 2020. The example covers an average family with a consumption of € 42,836.

The household water cost **remains** at the same level

The household's water cost for drinking water and wastewater for 2021 for an average Danish family of 2.12 people, with an average water consumption of 105 litres per person per day, corresponding to a consumption of 81.34 m³ per year, stood at € 808.21. In general, an average family household's expenditure on water and wastewater has been at a very stable level for many years now. ■

AVERAGE HOUSEHOLD'S EXPENSES, 2007 - 2021

€/M³ (2021 PRICES)



The estimate is for an average family of 2.12 persons with an average consumption of 38.77 m³ per year per person.

TEXT: JENS PLESNER, THOMAS SØRENSEN AND MADS VOLQUARTZ, DANVA / **ILLUSTRATION:** JTO, THOMAS SØRENSEN AND MADS VOLQUARTZ, DANVA

THE DANISH WATER SECTOR

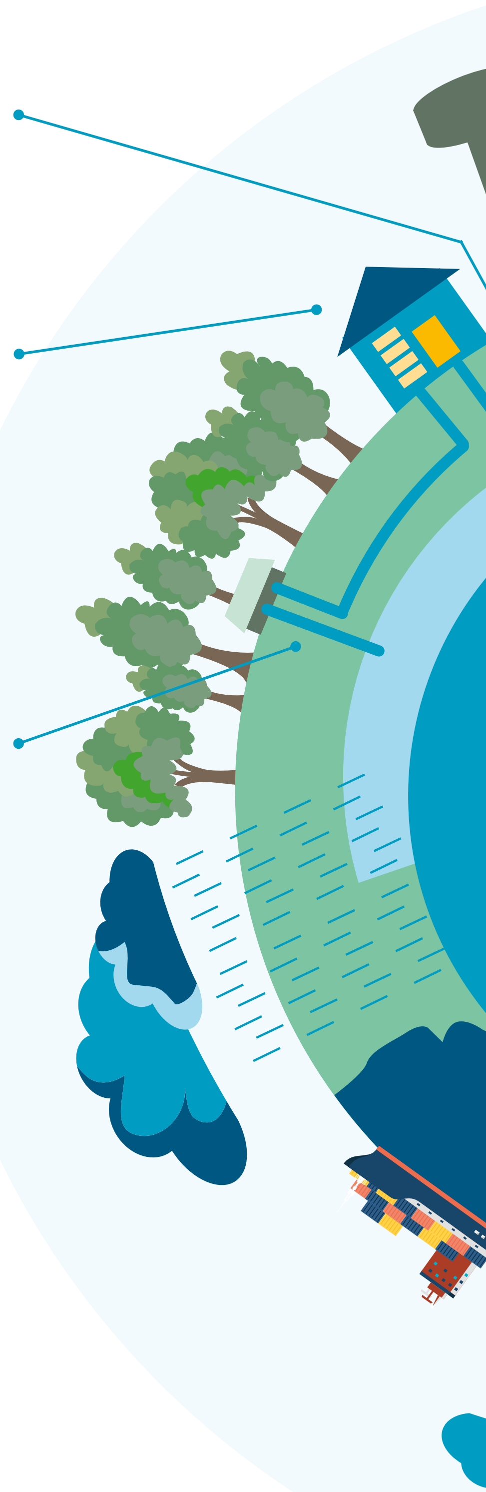
All drinking water in Denmark comes from groundwater, with the exception of a small desalination plant on Christiansø. The water sector has a decentralised structure and consists of some 2,600 waterworks and 701 wastewater treatment plants.

The Water Sector Act includes 226 drinking water companies, which together in 2021 sold approx. 274 million m^3 water. In 2021, the companies turned over approx. € 661.2 million, had operating costs of € 203 million and made investments totalling € 282 million. The Water Sector Act covers a total of 109 wastewater companies, which in 2021 together treated approx. 282 million m^3 water sold from their catchment areas. They had a turnover of approx. € 1.29 billion, invested some € 827 million and had operating costs of € 448 million.

Drinking water sold to customers[5]:
Approx. 310 million m^3
Total distribution network for drinking water[5]:
60,000 km

Number of waterworks in Denmark[2]:
Approx. 2,600
Municipally owned water companies[5]:
87
Waterworks owned by municipal water companies[5]:
Approx. 340
Own water supply to individual households[2]:
Approx. 50,000

Volume of water (drinking water) abstracted[2]:
By general waterworks:
379 million m^3
Commercial irrigation:
239 million m^3
Companies with own abstraction:
51 million m^3
Surface water:
18 million m^3

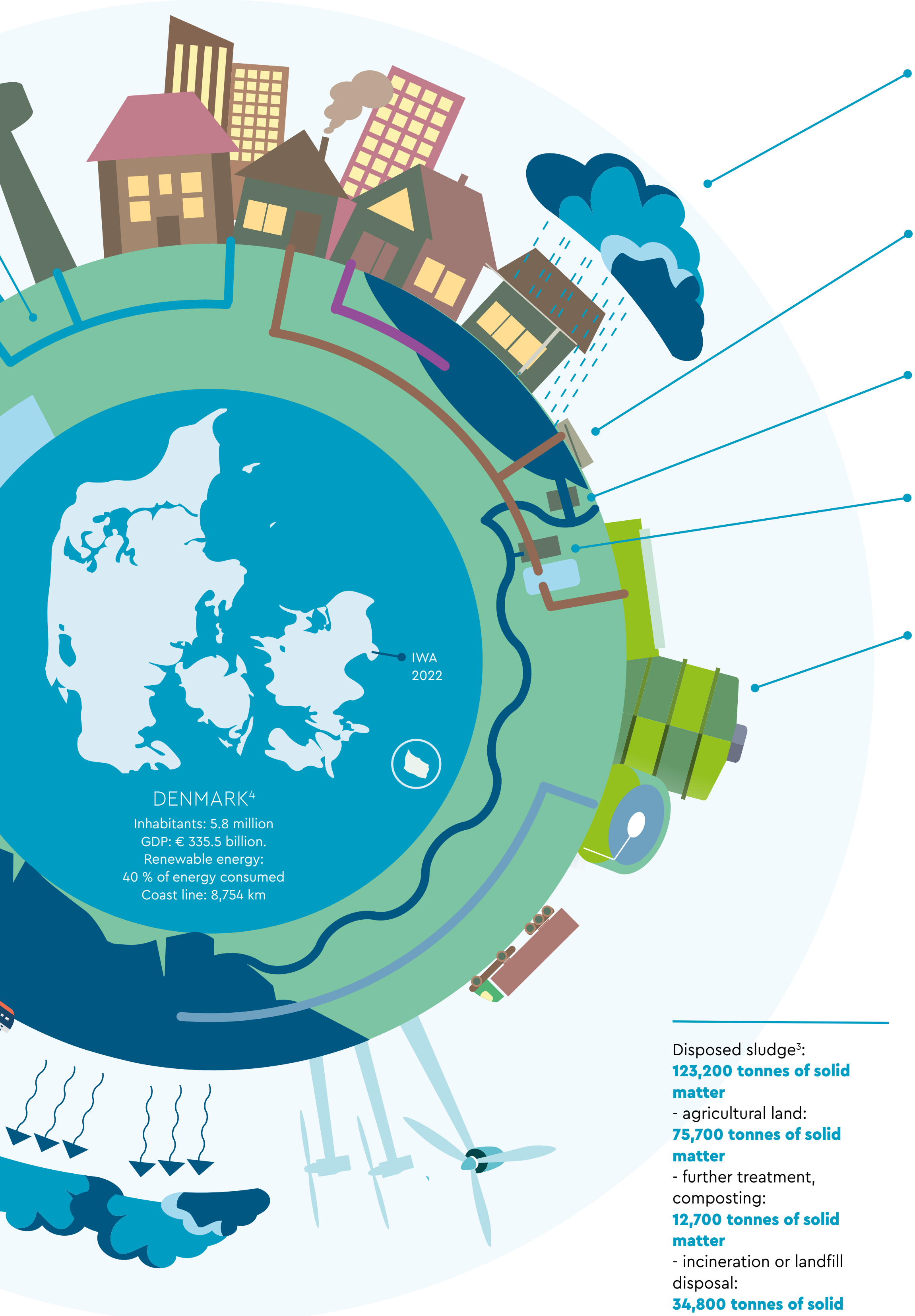


WATER COMPANIES are based on the break-even principle

As a rule, the water sector is based on the so-called break-even principle. This means that a water company's expenditure and income must balance, measured over a number of years. Water companies are 100 % financed through tariffs, and all activities, investments and operating costs are paid by the customers.

However, to prevent socio-economic waste and stimulate development, innovation and climate-friendly energy production, water companies are permitted, in addition to their water and wastewater activities, to sell services, residues and energy with a certain profit, provided that such sale is closely linked to their drinking water and/or wastewater activities.

Sources:
1: Miljøstyrelsen: Punktkilder 2020
2: GEUS: Grundvandsovervågning 1989–2020
3: Forsyningssekretariatet – Benchmarking 2020
4: Danmarks Statistik and Geodatastyrelsen
5: DANVA Benchmarking



Precipitation at country level[1]:
770 mm
Average rainfall in the last 10 years[2]:
759 mm

Total sewer network, incl. connectors[3]:
85,850 km
Pumping stations[3]:
37,700

Total number of rainwater discharges[1]:
16,219

Total number of overflow structures from common sewer systems[1]:
4,222

Wastewater treatment plants[1]:
701
Treatment plants over 30 PE[1]:
643
Total wastewater treatment plant capacity[1]:
12.2 million PE
Total effective load of wastewater treatment plants[1]:
7.5 million PE
Share of wastewater purified by means of tertiary treatment[1]:
95%
Discharged treated wastewater[1]:
683 million m³

Disposed sludge[3]:
123,200 tonnes of solid matter
- agricultural land:
75,700 tonnes of solid matter
- further treatment, composting:
12,700 tonnes of solid matter
- incineration or landfill disposal:
34,800 tonnes of solid matter

Municipally owned wastewater companies[5]:
109
Discharge from dwellings and holiday homes without public sewerage[1]:
281,465
Number of industriel discharges with own wastewater treatment[1]:
150

TEXT: ANDREAS ALBERS AND BERTEL IFVERSEN, DANVA

Financial regulation of the Danish water sector

Water and wastewater companies in Denmark are natural monopolies. Therefore, consumers cannot choose which water company they would like to receive drinking water from or which wastewater company they would like to discharge their wastewater to. To create market conditions similar to those on the competitive markets and thus limit the companies' monopolistic practices, the water sector is subject to financial regulation.

In order to ensure stable water prices and improve the overall productivity of the water sector, the Danish Water regulatory Authority lays down a cost-based revenue framework for all municipally owned water and wastewater companies as well as consumer-owned water companies that supply more than 800,000 m³ of water[1)] annually.

Because a company's overall revenues must not exceed the announced revenue framework, the revenue framework indirectly limits the scope of changes to water prices. If a company needs to perform new tasks (e.g., invest in climate adaptation or other critical infrastructure projects) that have been required or approved by a relevant public authority, the company may apply for a financial supplement to the revenue framework. If the supplement application is approved by the Water regulatory Authority, the water company may raise the water price in order to finance the costs associated with such tasks.

Annual efficiency requirements are placed on the revenue framework in order to create a level playing field. The efficiency requirements consist of an index-based general efficiency requirement, which is supposed to reflect the expected overall productivity changes, and a benchmark-based individual efficiency requirement, which is supposed to reflect the acquisition of efficiency potential. The efficiency requirements are formulated as annual reductions of the revenue framework, and water and wastewater companies must therefore reduce their costs correspondingly over time, because there will be less revenue available to cover the total costs every year. Thus, the purpose of the efficiency requirements is to give companies an incentive to improve the efficiency of their existing operations, while investing efficiently.

1) Consumer-owned companies supplying below 800,000 m³ of water per year fall within the scope of the "break-even" principle, which implies that revenue and expenditure of companies must balance over a number of years. Thus, local consumers can supervise small companies more easily, whereas the administrative costs for participating in the revenue framework regulations for these companies are relatively high. Therefore, these companies are not subject to any other forms of financial regulation than the "break-even" principle.

Need for modernisation

Financial regulation is supposed to ensure stable water prices, raise the efficiency of the water sector and promote innovation and the green transition. Moreover, regulation is supposed to support the water sector's ability to maintain and further develop security of supply. Therefore, the ambitions with the financial regulation are very wide-ranging, and the regulation increasingly appears to be challenged by compliance with these, especially in a forward-looking perspective.

The regulation and, in particular, the transformation of municipal utilities into actual companies, have contributed to the professionalisation of the water sector and has simultaneously placed the overall focus on corporate finances and efficiency. The financial gains from easily achievable efficiency improvements and innovation solutions were realised at a rapid rate in the course of the first year of the regulation, when water companies often kept ahead of the set efficiency requirements. After a long period of efficiency improvements in the water sector, it is difficult to continue making efficiency improvements at the same rate. Therefore, the water sector does not consider the regulation in its current form to be a long-term solution to the future challenges of water companies with regard to the rising needs for reinvestment and the requirements for green transition and climate adaptation. The prospect of the water sector's long-term finances is namely characterised by substantial uncertainty. An uncertainty that is, in part, owing to the very high efficiency requirements (also in an international perspective) and in part to the fact that the revenue framework is firmly fixed to a historical cost level that cannot accommodate the rising need for reinvestments that companies are confronted with in the future. Therefore, the water sector is eagerly looking forward to the planned revision of the revenue framework regulations that will hopefully become the first step towards more dynamic regulations that to a higher extent support the growing demands of society for efficiency, innovation as well as the green transition. ■

Debt in the water sector **is continuously growing**

New investments in drinking water and wastewater companies are much more likely to be financed through borrowing than was previously the case. This is a consequence of the regulation of the water sector, where politicians and authorities prefer that investments by the companies in new plants, pipes, climate measures and other assets to a greater degree be based on loan finance, in order to keep the drinking water and wastewater tariffs down. It is also evident from the graph below that the debt of water companies with KommuneKredit, other mortgage finance institutions and banks has been steadily increasing since 2010. Loan finance from KommuneKredit in particular has been on the increase. In 2021 the collective debt of the water companies was € 4.84 billions.

Prices in line with costs

Water companies may only charge what it costs to deliver water to their customers. Given that investment in individual water companies varies from year to year, loan finance is an important tool for ensuring a stable price for customers. Because plants in the water sector last for a good many years, it is important that the bill is split appropriately between the generations. This happens automatically if customers pay for the annual costs incurred in delivering water to them and removing wastewater from their premises. These are, in other words, the annual operating costs, wear and tear at the plants and financing costs. This is referred to as "cost-oriented pricing" and is something we in Denmark are extremely good at maintaining compared with other countries, where prices are often subsidised.

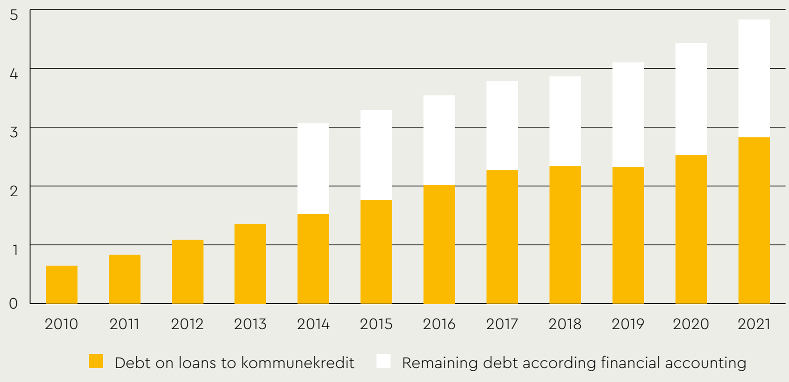
Lifetimes in the regulation are far from reality

Water company revenues are regulated via the Danish Water Sector Reform Act. Under this regulation, water companies are obliged to charge for pipes based on a technically feasible pipe service life of 75 years. In other words, the regulation assumes that pipes wear out at an extremely slow rate and that the water companies will therefore not need to charge very much each year to cover the costs of pipes. The problem with this is that the actual service life is considerably shorter. DANVA's analysis indicate that the average weighted service life of excavated pipes is 56,8 years for drinking water pipes and 51.5 tears for wastewater pipes in the period from 2016 to 2021. The reason for the shorter service life may be poor quality of the old pipes, but it is often due to the fact that the surroundings are under continual change, so that pipes are not in the ground for their entire technical service life. For instance, the sewer network is currently seeing major rerouting due to increasing levels of rainfall. Applying a too long service life in connection with the levying of charges is problematic, as present customers are not paying for the full costs of wear and tear at the plants.

Our debt just keeps on going up, but if you imagine ameliorating the debt of a single year by imposing it on the variable tariff, then in 2014, € 18/m^3 would have been added to the tariff. By 2021, this figure had increased to € 27/m^3. ■

DEBT ON LOANS TO WATER COMPANIES

BILLIONS €



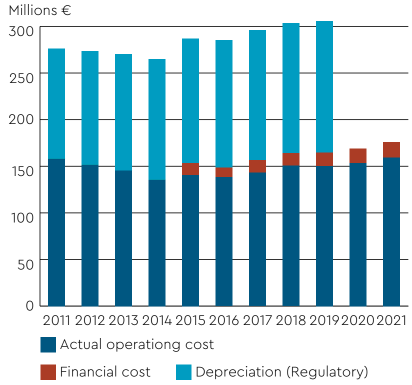
The outstanding debt on loans to the water sector based on the companies' annual accounts. The data derives from the balance sheets of the financial statements of all municipally owned water companies, as well as TREFOR Vand A/S, Verdo Vand A/S, Rønne Vand A/S, Videbæk Vand A/S and Vildbjerg Vand A/S. A total of 181 CVR numbers. The graph makes it possible to ascertain that a large share of the debt of water companies is made up of loans from KommuneKredit, or the credit association for municipalities and regions in Denmark. In addition to debts from KommuneKredit, a number of companies also have debts from mortgage credit institutes and banks. Finally, a smaller proportion of the overall debt of water companies consists of short-term debt, such as trade creditors, payables to group enterprises, mortgages and several smaller items.

DIN Forsyning has built a new waterworks in Esbjerg. Photo: DIN Forsyning

Economic development

Danish water and wastewater companies are by their very nature monopolies which are regulated in order to imitate competitive conditions. The revenue of all water and wastewater companies operating with a water volume in excess of 200,000 m^3 per year as well as municipally owned water companies is regulated by means of financial frameworks. If expenditure exceeds revenue in certain periods, loans may be taken out for plants and, for municipal companies, for operational purposes (but only to a very limited extent). This is because municipal companies are subject to the "overdraft facility rule". Therefore, the Danish water sector has a significantly greater need for working capital than sectors that are not subject to the overdraft facility rule. The following economic development graphs include all drinking water and wastewater companies that are covered by the Danish Water Sector Reform Act and that have a billed water volume greater than 800,000 m^3 per year. These companies are further subject to TOTEX benchmarking. The benchmarking compares the companies' cost-effectiveness, which can result in an individual efficiency requirement if the company's general revenues exceed its effective cost levels. The benchmarking model compares the companies' actual costs (FATO; actual operating, plant and financial expenses) with their TOTEX net volume targets (OPEX and CAPEX net volume targets). ■

AFFECTED COST DRINKING WATER

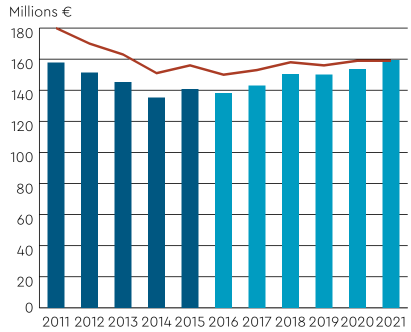


Total actual costs (FATO) are the costs on which the companies are benchmarked in the Utility Secretariat's TOTEX benchmarking.

The depreciation of water companies for 2020 and 2021 will not be known until the Utility Secretariat issues benchmarking decisions in the autumn of 2022. While the depreciation for wastewater in 2021 is released in autumn 2023.

AFFECTED COST WASTEWATER

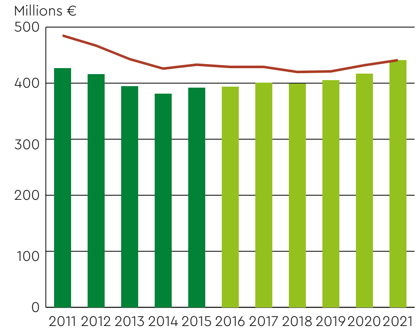
ACTUAL OPERATING COST DRINKING WATER



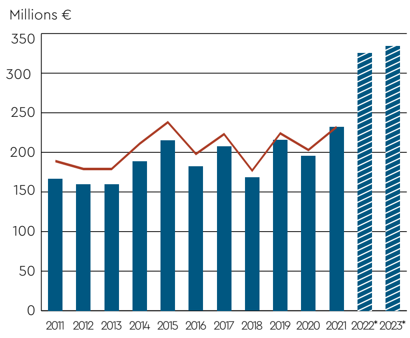
Actual operating costs shows the part of the operating costs that are used in the overall financial benchmarking of the Utility Secretariat.

Actual operating costs are calculated as operating costs from the audited financial statements excluding depreciation, less debtor losses, non-controllable costs, adjustment of provisions included in operating costs, and operating costs from associated activities and the emptying scheme, which is included in the general accounts. The definition of actual operating costs was revised in 2016, so that it is not completely comparable with previous years.

ACTUAL OPERATING COST WASTEWATER



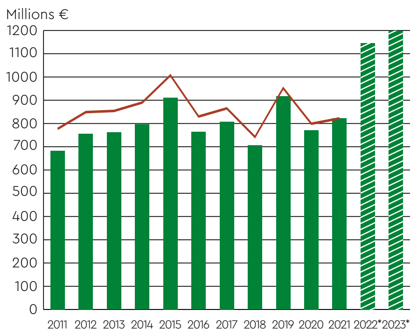
INVESTMENTS DRINKING WATER



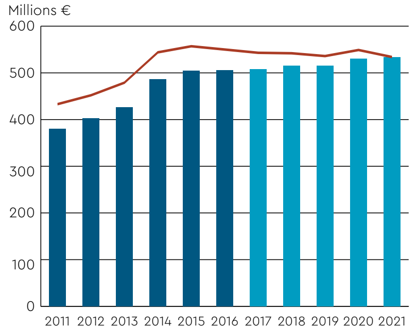
Investments are an expression of the investments made by the companies during the year. This explains the relatively high fluctuations over the years, while depreciation has significantly smaller fluctuations, as investments must be depreciated for up to 75 years.

* The investments for 2022 and 2023 are budgeted investments reported to DANVA.

INVESTMENTS WASTEWATER



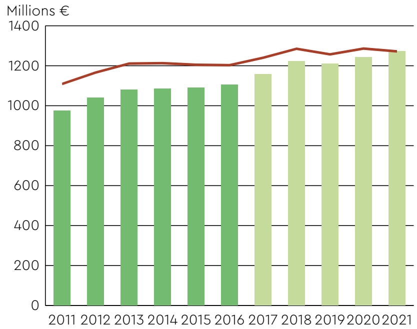
INCOME* DRINKING WATER



The income consists of:

- Income from principal activities in the abstraction, processing, transport and delivery of water
- Transport, treatment and diversion of wastewater
- Other income from principal activities
- Financial income
- Profit from affiliated companies
- Profit from activities with statutory requirements for independent accounting included in the principal activities.
- The total revenues for drinking water include the tax on piped (tap) water.

INCOME* WASTEWATER



* The Utility Secretariat changed the definition of income in 2017. Prior to 2017, total income from primary activities was calculated in such a way that connection charges and other items were netted. Since 2017, the definition of income has been changed to: "Total income from primary activities" to "Actual income". One of the major changes is the recognition of connection charges, which is assumed to be one of the reasons for the significant increase in income from 2016 to 2017. Data for the tables above cover all water and wastewater companies with a billed water volume in excess of 800,000 m³. This means it only applies to those companies that are covered by the TOTEX benchmarking of the Utility Secretariat. These involve 74 drinking water companies and 103 wastewater companies. The bars in the graphs are presented at current prices, whereas the curves are at fixed prices.

TEXT: KATRINE RINGGAARD JØRGENSEN, DANVA

Denmark's holistic model is to inspire and invite the global water sector

Nordic water companies are featured exceptionally well in the densely packed programme of the IWA World Water Congress & Exhibition 2022 that is waiting for up to 8,000 water experts from the entire world. After all, Denmark has vast experience within the theme of the Congress, and the special Danish holistic approach to solutions to global water challenges is supposed to show the way ahead for greater global cooperation.

The UN's Sustainable Development Goals run as a common thread throughout the theme of the World Congress, "Water for Smart Liveable Cities", whereby IWA wants to shed light on how smart, holistic and liveable urban solutions enable people to adapt to climate change, while simultaneously reinforcing the quality of life in the cities. This Danish solution approach takes advantage of synergies between various players and intelligent systems, which can be the key to achieving the objectives.

According to Helle Katrine Andersen, chairperson of IWA Denmark and head of DANVA's Secretariat, the IWA Congress constitutes an important milestone for global knowledge sharing and new common agendas.

"We cannot find solutions to today's and the future's global challenges alone, which is why the IWA Congress is important to all participants regardless of their competence and experience. The Congress creates a platform where people can meet across countries and continents and exchange knowledge, experience and solutions. It is my hope that the Congress will provide a basis for new international partnerships and solutions that can fulfil the sustainability goals towards 2030," says Helle Katrine Andersen.

And it is exactly many examples of partnerships that are observed in the Danish water sector. The water companies in an ever increasing number of Danish cities cooperate closely with municipalities, research institutions as well as private enterprises in order to incorporate water into urban planning, and this has resulted in an ocean of innovative hi-tech solutions forming the cornerstone of new urban spaces and sustainable Danish cities. Eight good examples on the following pages describe the potential of the "Water for Smart Liveable Cities" theme that can serve as a source of inspiration for the world.

They constitute a pick of many Danish water solutions that have been created in cross-sectoral cooperation between public and private organisations. ■

East of Kolding, you will find Denmark's, and presumably the world's, first wastewater turbine, that is developed in partnership by BlueKolding, Aarsleff and EnviDan and produces 100 % climate-neutral power. The turbine is fitted at the end of the wastewater treatment plant's discharge pipe and, given the 35-metre drop, the annual discharge of 11 billion litres generates such an enormous pressure that the turbine produces, via a generator, power equivalent to the consumption of approx. 150 households. At the same time, there has been an annual reduction in CO2 emissions of 3,700 tonnes.

PHOTO: BLUEKOLDING

Lakes, rivers, fjords and seas account for a substantial part of Denmark's area as well as Danes' perception of themselves, and clean bathing water is therefore a high priority. Thus, when the harbour bath at Islands Brygge in Copenhagen opened in 2002 at the former commercial harbour, a ground-breaking opportunity for bathing arose right in the middle of the bustling city. The harbour baths that currently exist in several major cities in the country are the most visual example that confirms that clean water raises the quality of life in the city, which is clearly reflected in the price per square metre at the harbour at Islands Brygge. HOFOR's initiative and cooperation with the Copenhagen Municipality shows the decisive role of water companies in the development of the cities.

Cities are growing

At present, more than half the worlds population lives in cities, and this figure is expected to grow to 70 % by 2050. This places demands on the way we want to develop our cities in and requires acute action and global cooperation.

Låsby Sea Park is a model example of successful citizen involvement in the city's climate adaptation. The Skanderborg water utility has chosen, in collaboration with the municipality, to integrate the technological solution that protects the city against extreme rainfall events with local development and recreational activities. Nowadays, the park functions as a local meeting and activity area for the citizens of the city, with water as a central focal point. The big commitment of the local residents served as a driver for the entire process.

In Randers, Vandmiljø Randers cooperates with the municipality on the urban development project, Flodbyen (The Riverine Town). Its vision is to create an urban structure, with water as a central gathering point, that is associated with the necessary climate adaptation of the city. One of the main concepts has to do with changing the way climate adaptation and flood control are perceived — from an urban challenge to realisable gains and new recreational urban areas, where citizens and guests experience nature right next to them.

VISUALISATION: C.F. MØLLER ARCHITECTS

Wastewater has been used to monitor the development of COVID-19 in Denmark since the autumn of 2021. Wastewater companies take samples weekly at 83 wastewater treatment plants (previously 200 plants). In larger cities, samples are also taken in the sewer network in order to further split the area. Wastewater monitoring has covered up to 90 % of the population, and the method is very cheap in relation to human testing. During the pandemic, Denmark has had a very extensive programme for human testing that has provided fantastic data and has formed, together with the wastewater samples, the basis for the preparation of valid models. At the same time, this opens up opportunities for monitoring other infectious diseases, thus making it possible to react on time.

10 municipalities and four water companies along the Harrestrup Å creek on Zealand have established the largest Danish cloudburst mitigation partnership. The project plan, which has a duration of 20 years, accommodates a holistic approach to climate adaptation in projects, where water flows across municipal boundaries. Even the first experiences indicate better and cheaper management of the massive water masses from the rising rain volumes, while the joint solution simultaneously provides greater intimacy with nature for the citizens.

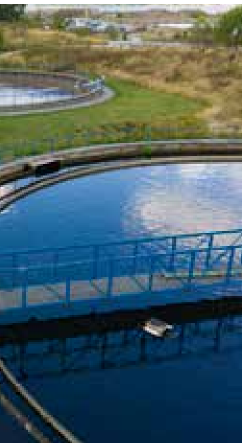
PHOTO: PER BILLE

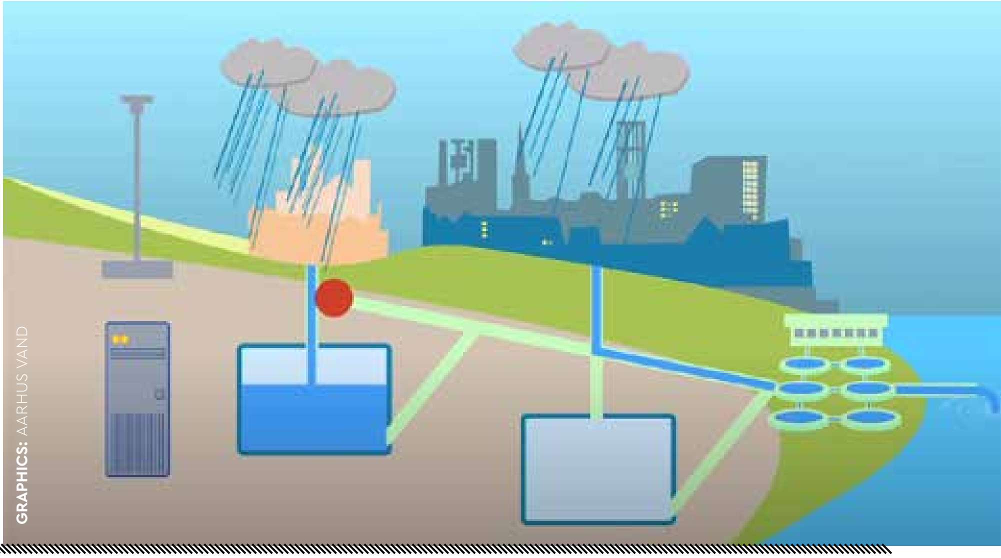
PHOTO: AARHUS VAND

A newly established district in Aarhus combines climate adaptation and water recycling. Stormwater from the area is guided away via gutters and channels into a stormwater pond and on to a wastewater treatment plant. The water then supplies the residents' toilets and washing machines via a separate distribution network. The solution conserves approx. 40 % of the groundwater.

PHOTO: VANDCENTER SYD

In Denmark, all drinking water can be tapped and consumed directly from the tap, which is regarded as a matter of course by Danes. To raise the availability of drinking water, water companies in several major Danish cities have opted to establish publicly available drinking fountains. VCS Syd and the Odense Municipality have erected fountains in the city in order to promote health and in a desire to help reduce plastic waste from bottled water.





GRAPHICS: AARHUS VAND

Aarhus Vand is well under way in the struggle against flooding. Using data and automated digital management, the company has achieved, among other things, equitable utilisation of its drainage system and water treatment plant in connection with heavy downpours. The numerous development projects that will provide Aarhus Vand with long-term real-time overview of the entire water cycle have been realised in partnership with private and knowledge actors.

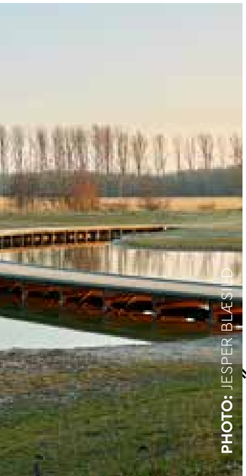


PHOTO: JESPER BLÆSILD

DRINKING WATER COMPANIES in DANVA Benchmarking and Statistics

In 2022, 77 drinking water companies reported data to DANVA Benchmarking and Statistics. Together, the companies have more than 1,899 water abstraction wells, comprising 153 source sites, 253 waterworks and 32,843 km of supply pipes. The participating companies abstracted about 231 million m³ of drinking water and supplied well over 3.708 million people. The total investments amounted to approximately € 228 million, and the actual operating costs were just over € 156 million. (see the participants' basic data and overall key figures at the end of this publication).

Actual operating costs are maintained at the same level

Drinking companies' actual operating costs (FADO) are governed by the efficiency requirements of the Danish Water Sector Reform Act and form the basis for comparing the companies' efficiency. The actual operating costs, exclusive of VAT and taxes, non-controllable costs and any associated activities, stand at € 0.65 per m³ of drinking water for 2021.

Since the implementation of the price cap regulation under the Danish Water Sector Reform Act in 2010, companies have only been subject to efficiency requirements for their actual operating costs so that they would aim to continuously minimise their operating costs. Since 2016, in connection with the implementation of the TOTEX regulation, there has been a change in the calculation of actual operating costs, which now includes operating costs for environmental and service objectives, part of the previous 1:1 costs and any selected related activities. With the TOTEX Regulation, the efficiency requirement was extended to include both operating costs and investments, and thus, there was no longer the same focus on unambiguously reducing operating costs. It is always a balancing act between whether the companies should maintain their current equipment or invest in new equipment.

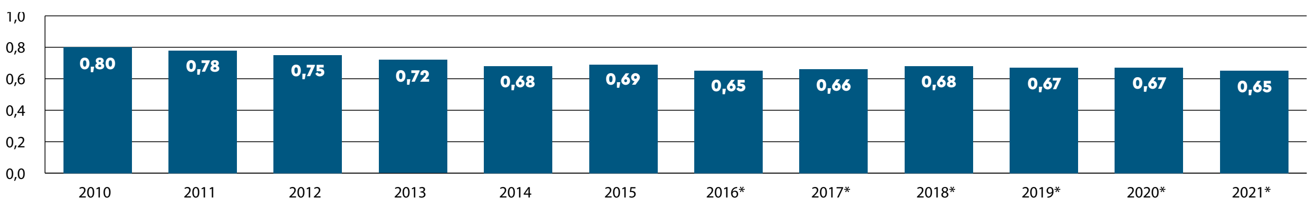
Drinking water companies' actual operating costs were split into 33 % for production of clean water (boreholes, source sites and waterworks), 34 % for water distribution, 10 % for customer service and 23 % for general administration. They are at almost the same level as for the previous year.

Total investments on the rise

The statement of investments made by drinking water companies in 2021 indicates fluctuations in the "investment drive" that vacillates

OPERATING COSTS, 2010 - 2021

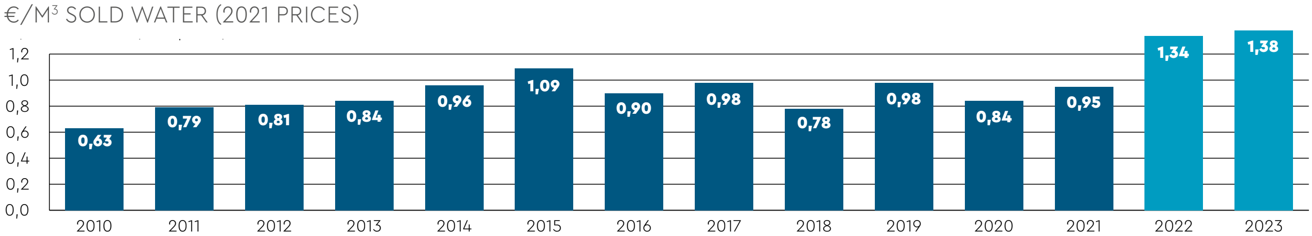
€/M³ SOLD WATER (2021 PRICES)



2010–2021: Actual operating costs (57–77 companies). *: New calculation of actual operating costs (FADO)

INVESTMENTS, 2010 - 2023

€/M³ SOLD WATER (2021 PRICES)



2010–2021: Investments and renovations (54–77 companies). 2022–2023: Planned investments and renovations (77 companies)

Population density and the condition, size and age of water pipes are some of the factors that cause operating costs to vary a lot between utilities. Photo: DIN Forsyning

quite a bit from one year to another. Investments stood at € 0.95 per m³ for 2021, which is a 20 % increase compared to 2020. Investments are expected to rise sharply in 2022 and 2023 towards 40-45 % of the level for 2021.

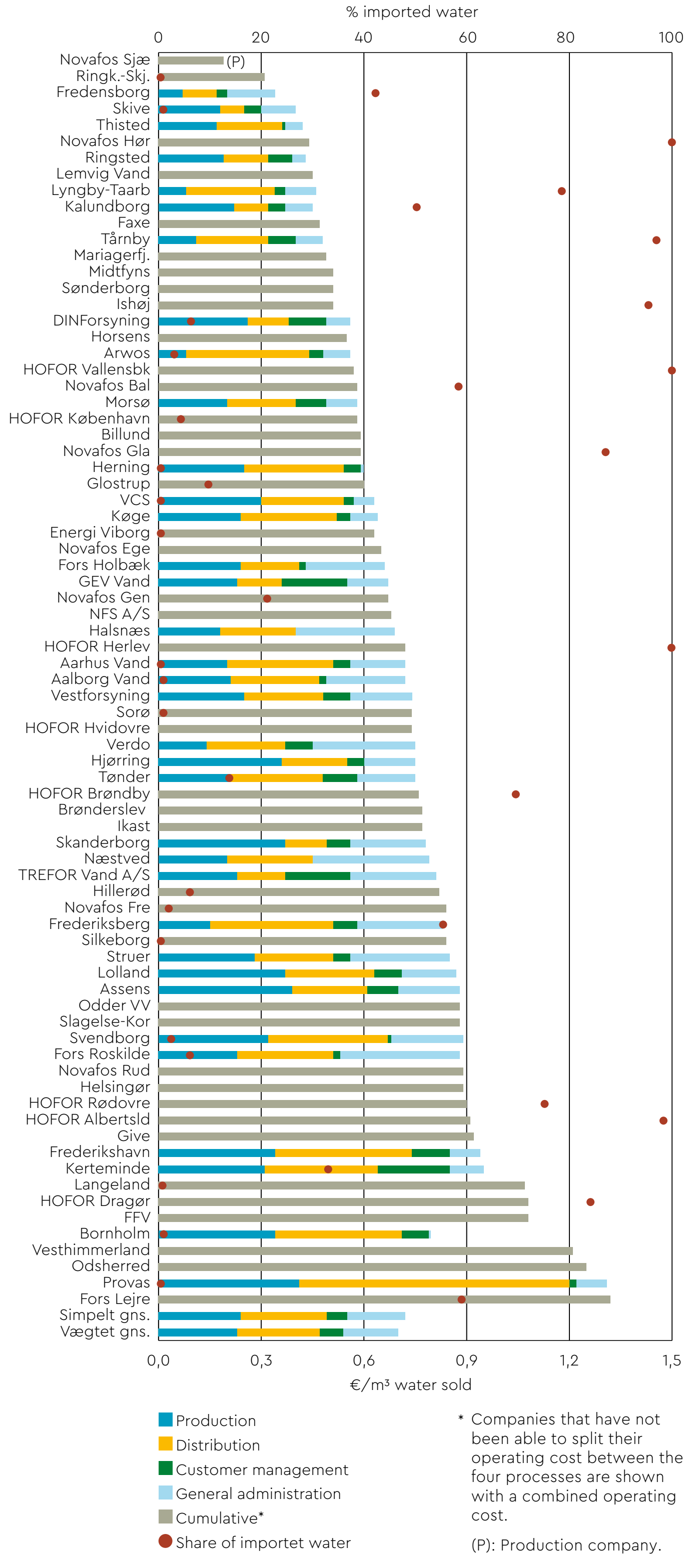
Investments are divided in the following way: 67 % are invested in the distribution network and 30 % in drilling and waterworks. The remaining 3 % are invested in other things.

Udsvingene i investeringerne kan skyldes, at investeringer i nye vandværker betyder meget for den samlede sum, hvorimod investeringer i distributionsnettet er mere ens. ■

Wide variation in actual **operating costs**

The average actual operating costs for the production and distribution of 1 m³ of water sold is € 0.65, but, as can be seen from the graph, there is a very significant spread between the lowest and the highest of the operating expenses. The reason for this is the difference in framework conditions under which the companies operate. These include geological conditions, access to groundwater, extent of groundwater protection and the necessary processing steps before the water is pumped into the pipeline network, all of which affects production costs. Insofar as distribution is concerned, it is factors such as population density, the size of the mains network and its proximity to the customers, its condition and age that have an impact on costs.

DRINKING WATER ACTUAL OPERATING COSTS, 2021



Water loss in Denmark is low

Danish drinking water companies are characterised by keeping good track of their water losses, which are generally maintained at a very low level compared with the surrounding world.

Two measures have had a major impact on the Danish water industry, making Denmark one of the countries with the lowest water loss: In 1996, a general requirement for the installation of water meters was introduced for all water consumers. In 1993, a penalty tax was introduced for companies with more than 10 % water loss, measured as the ratio between the water that is pumped out and the volume of water that is sold.

The work of water companies to reduce water loss is driven by an ongoing assessment of when it can pay off to further reduce water loss in relation to the cost of the lost water. The general attitude is that if the water loss is around 8 %, the company is in a good position. It does not take much to have to pay penalties for your water loss, and the company "saves" on costs, since the costs per each percentage of reduction grow materially higher, the cheaper it gets. The companies' water loss strategy should always be based on a balance between access to the water source and the costs of renovation of the distribution network.

It can be cheaper to pump up the water, treat it and then perhaps "lose" it again in the distribution network by letting it seep back into the groundwater than to hunt for minor "expensive" leaks in the distribution network.

The 50–52 drinking water companies that have participated in DANVA Benchmarking in the past 11 years have witnessed a steady decline in water loss from 2011 to 2021, with a simple average at 7.22 %. The sole exception was a rise in 2018, which can be attributed to the record temperatures of the summer of that year, resulting in the ground being extremely dry with "shrinkage" in the pipe network and many more burst pipes.

The work of the companies to continuously reduce water loss is an achievement that is further emphasised by the fact that a decline in water consumption over the same period by about 7 % among the population means a percentage increase in water loss. This underlines the considerable efforts made by the companies, which continue to get better and better at tracing leaks and repairing and maintaining the pipe network.

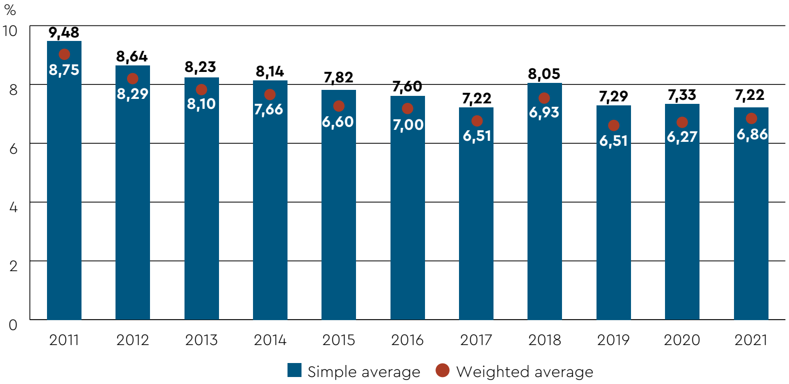
Reducing water loss

There are many different methods that can assist water companies reduce water loss, such as segmentation of the pipe network, which, if flow measurement is installed in the sections, provides significantly better data for leak detection, for example by analysing night-time flow measurements. The change to online remote metering can also provide very detailed and valuable data sets that can be used to detect water loss and generate an "alert" in the event of sudden unexpected water consumption. There are also various "listening" techniques that can indicate leaks. The companies can also improve their monitoring and the speed of repairs, as well as incorporate asset management into their renovation planning.

Different calculation methods

Water loss can be measured in several different ways: as a percentage of water loss per km of supply pipe, or in more detail as an infrastructure leak index. Water loss as a percentage or in m³ per km of pipe is calculated as the difference between the volume of water pumped into a company's own distribution network and the volume of water sold to its consumers. This calculation also includes volumes of water used for flushing in connection with pipe renovation work, fire-fighting and similar purposes, which cannot be regarded as a direct loss. The Infrastructure Leakage Index goes rather deeper and compares the actual water loss into the ground to the water loss that is "unavoidable", which is calculated on the basis of the size of the plant and water pressure. ■

NON-REVENUE WATER (WATER LOSS), 2011 - 2021



Average (%) based on 50–52 drinking water companies which have participated in DANVA benchmarking over the past 11 years.

The utility company Provas marked the start of the Tour de France in Denmark by dressing a water tower in the mountain jersey's iconic red dots. Photo: Provas

Drinking water companies use sonic equipment in pursuit of leaks. Photo: EWII

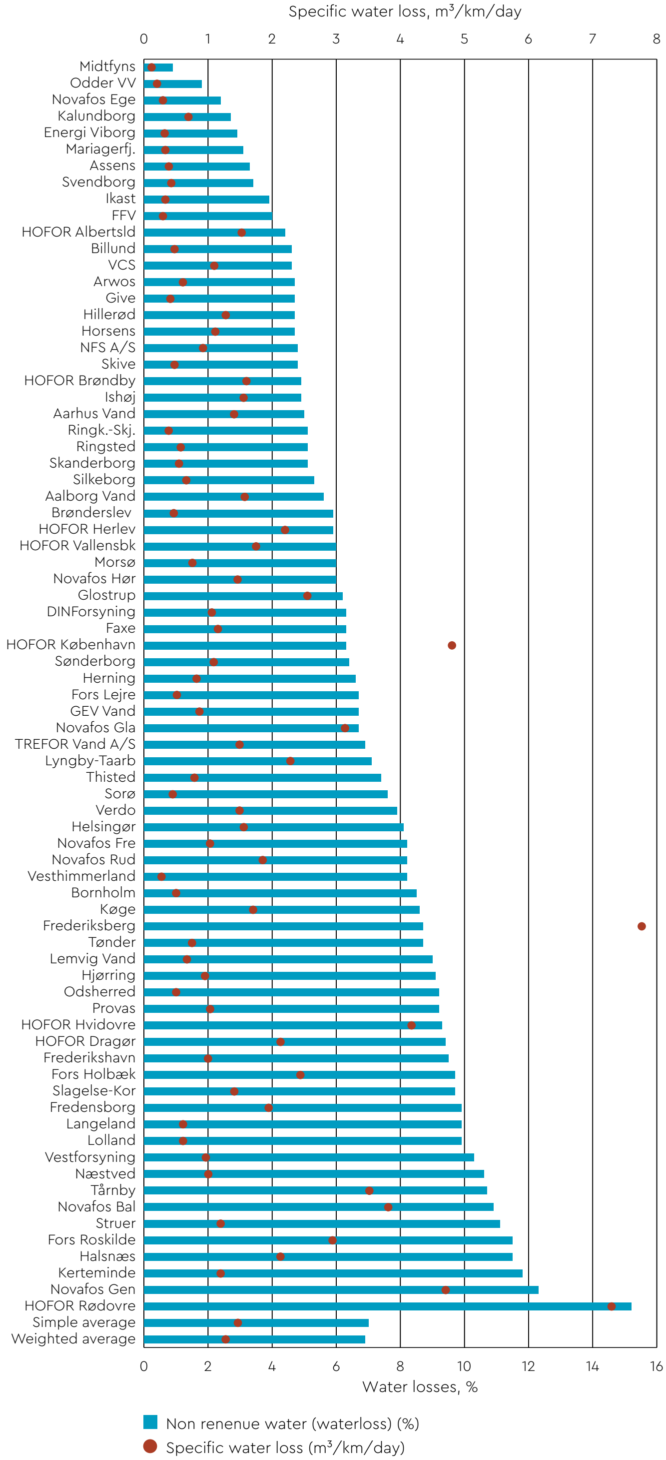
Water loss of drinking water companies

Drinking water companies' calculation of water loss, also known as "non-registered consumption", shows significant differences between companies. Companies can compare with one another using two methods of calculation, expressed either as a percentage or as specific water loss, expressed in m³ per km per day. Companies with a large pipe network but lower water consumption have better results when it comes to specific water losses, whereas companies with higher water consumption from a smaller pipe network are ranked better when a percentage comparison is used.

The actual calculation used for the companies may have minor fluctuations from year to year without any direct explanations being found. However, fluctuations can occur compared with the previous year especially when replacing consumption meters or pumping meters at the waterworks. Some companies also experience major pipe bursts that can affect the water loss balance by several percentage points before the burst is found and repaired.

The statement for this year shows a simple average water loss of 7.0 % among the 76 drinking water companies participating in the benchmarking. 10 companies must pay a penalty tax, because their water loss exceeds 10 %. ■

NON-REVENUE WATER (WATER LOSS), 2021



Note: No subsequent corrections to the water loss have been taken into account, e.g. water volumes used to flush the pipes in connection with contaminants. An exemption is required to be able to subtract these volumes of water from the water loss calculation.

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Large volumes of drinking water are lost across Europe

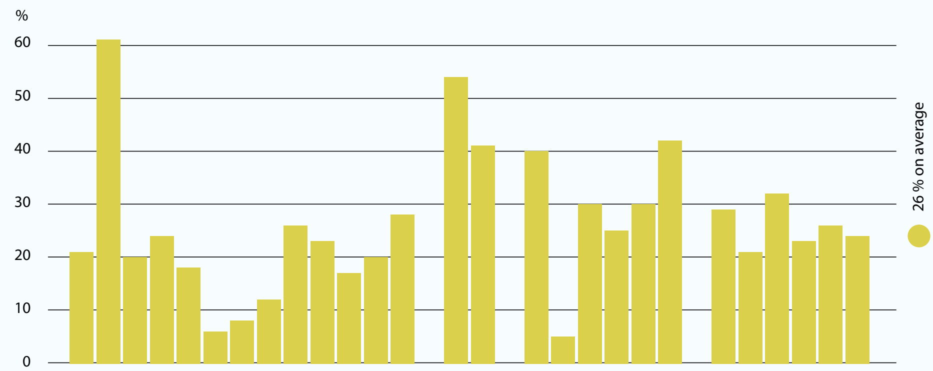
Sustainable drinking water management requires a change of attitude and a great deal of work.

Leaky pipes and valves, ageing systems, faults in meters as well as theft. There are many reasons why a large portion of the drinking water abstracted in Europe is lost. And this raises energy consumption and puts pressure on resources, says Markos Sklivaniotis, special advisor to the European Federation of National Associations of Water Services, EurEau.

"Good-quality natural water resources are precious to society. They should be utilised wisely to safeguard sustainability. And minimising water loss is the most important factor in minimising abstraction of water for drinking water," says Markos Sklivaniotis, who has been working with water loss for a long time.

He also calls attention to other consequences of high water loss. If the distribution system experiences problems with burst pipes and poor assemblies, this may lead to low water pressure that can cause drinking water contamination. Therefore, this will require more energy to maintain the water pressure, while simultaneously raising the use of chemicals needed to keep the water clean in those countries that disinfect drinking water.

WATER LOSS IN EU MEMBER STATES



Individual countries are anonymised, as it is the variation in water loss that is in focus.
Source: EurEau Water in figures 2021

The problem needs to be taken seriously

It is not uncommon to see a water loss in excess of 30 % and, in individual cases, all the way up to 50 %. Markos Sklivaniotis believes that it requires an enormous amount of work as well as a change in attitude in order to get rid of this tremendous water loss.

"The first and fundamental step is to begin to take the problem seriously. Bearing this in mind, it is important to measure water loss repeatedly adopting a scientific approach. This sounds simple, but it is certainly not. It requires good organisation and a great deal of work both in the field and in the office," he says.

There is a great deal of discussion in the sector as to what should be defined as an appropriate water loss limit. Markos Sklivaniotis does not want to commit himself to a certain limit. His opinion is that we should instead focus on constantly improving the level in relation to the starting point.

The lost water is also referred to as non-revenue water and, as indicated by the name, water companies are not paid for this water. In other words, there is also a financial incentive to reduce water loss.

Reporting requirements

Water loss is not merely water loss. Markos Sklivaniotis distinguishes between what he refers to as actual water loss and water loss. Let us start with the simple part, namely actual water loss. This item covers all water that is pumped out of the waterworks but does not reach the customers. Thus, actual water loss comprises all water that is lost from the distribution network into the soil.

On the other hand, water loss covers actual water loss plus any water that is not registered at the customers for one reason or another. Such reasons can include authorised non-metered use of water, theft, meter failure as well as billing errors.

"There are variations from one country to another and even from one region or city to another within the same country. There are areas with actual water loss in excess of 30 % and areas where it is below 5 %.

The EU's Drinking Water Directive, which came into force on 12 January 2021, contains, for the first time, requirements to the reporting and assessment of leakage rates with an eye to continual improvements. The requirement applies to water utilities that supply at least 10,000 m^3 of water per day or at least 50,000 persons. Data must be collected and assessed with an eye to establishing an average leakage rate in the Union that Member States must work towards. The indicated method is infrastructure leakage index (ILI) or an equivalent.

All water in Denmark is required to be measured, and water companies are subject to penalties if the water loss exceeds 10 %. ■

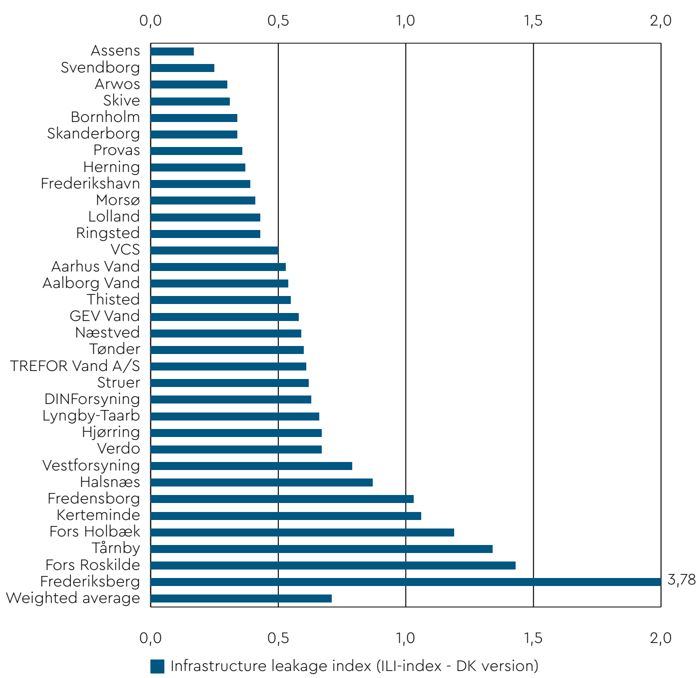
Infrastructure Leakage Index (ILI)

Real water loss can be more accurately calculated and compared through the calculation of the Infrastructure Leak Index (ILI). This is an international water loss performance indicator developed by the International Water Association (IWA). It makes it possible to compare real physical water loss and unavoidable water loss between companies with different framework conditions and across national borders. The statement is based on what is technically feasible from a financially acceptable perspective. Actual physical water loss is calculated as the difference between the amount of water sold and the amount of water pumped, minus authorised non-billed consumption (for example, flushing of the pipe network after repairs, water used for fire-fighting), as well as unauthorised consumption (theft) and meter measurement uncertainties. "Unavoidable water loss" is a calculation based on the size, density and water pressure of the pipe network, assuming that it is a well-run, healthy young pipe network.

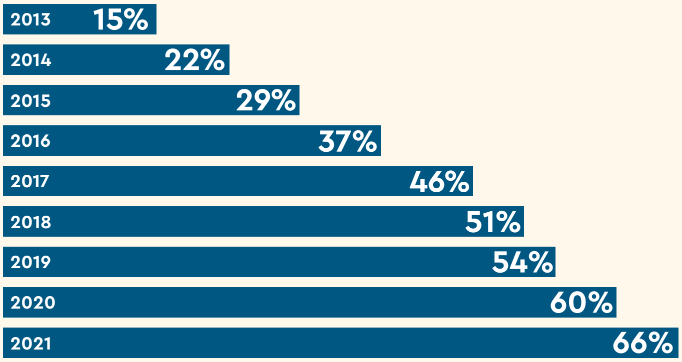
You can read more about the Infrastructure Leakage Index on the website www.leakssuitelibrary.com underneath "Global ILIs".

The Danish ILI calculation is partially based on assumptions, e.g., of the length of private pipes and an "assumed" average pressure in the distribution network. Measuring uncertainty is not factored into the Danish statements, and the "unavoidable water loss" has not been adjusted to accommodate IWA's latest guidelines yet, which is why we refer to it as the "ILI Index — DK Version". ■

INFRASTRUCTURE LEAKAGE INDEX (ILI), 2021



SHARE OF REMOTE METER READING



The share of remote reading meters is steadily increasing

The switch to remote meter reading is gaining ground, and data from 55–75 drinking water companies that jointly have a total of 948,769 meters shows that the proportion of remotely read meters has increased from 15 % in 2013 to 66 % in 2021.

The replacement of manually read water meters with remotely read meters by water companies provides a number of advantages:

- Major administrative relief in connection with the reading of consumption and invoicing.
- A huge, detailed database of usable knowledge in connection with the search for leaks and renovation planning.
- The level of service to residents can also be enhanced by, e.g., allowing them to be able to monitor their own consumption online or be alerted in the event of unexpectedly high water consumption due to, for example, a burst water pipe at their holiday home.

However, the numerous advantages must be evaluated with regard to the fact that the operating expenses of the companies are often inflated somewhat by the introduction of remotely read meters.

The companies usually first replace water meters at the end of their service life, which is when they are 8-12 years old. The definition of remotely read meters extends from the first models, where the reading is taken by driving past the meters on the road outside once a year, thereby recording annual consumption, to the latest smart meters, which can send consumption information to the companies every second. ■

TEXT AND PHOTO: MADS VOLQUARTZ, DANVA

Smart meters warn you when the water loss is high — and save customers millions

Both the water company and the customers in Brønderslev in North Jutland are happy with the security provided by the new, digital water meters. The frequently updated meter data makes it possible to quickly identify any problems in the distribution network. After the digital leak monitoring came into force, 6,500 customers collectively save up to € 270,000 per year on their water and wastewater bills.

Brønderslev has put an end to the leaks in its drinking water system, where water could gush out for days, weeks or months on end before being discovered. Here, Brønderslev Forsyning has installed intelligent water meters both at the customers and in several places in the distribution network in order to receive up-to-date data on current water consumption at all times, thus enabling comparisons with normal consumption. If there turn out to be major irregularities, Brønderslev Forsyning can quickly intervene in order to stop any leak before the water loss grows high. Swift action will also make it possible to reduce any damage to infrastructure and property. The new, smart meters have contributed to a low, stable water loss of around 5 % in the last three years, compared with substantial fluctuations for previous years, and a value of up to 12 % in 2017.

"Until a couple of years ago, we did not know our water loss for the previous year until the month of January the following year. Thus, we could have had a burst for 10 months and not be aware of it. However, this is over now, and we can react immediately if something happens," says managing director Thorkild B. Neergaard

He says that Brønderslev Forsyning's new objective is to reduce water loss to less than 5 %. And data from the 6,500 intelligent meters will help safeguard this, while simultaneously raising the quality of the data.

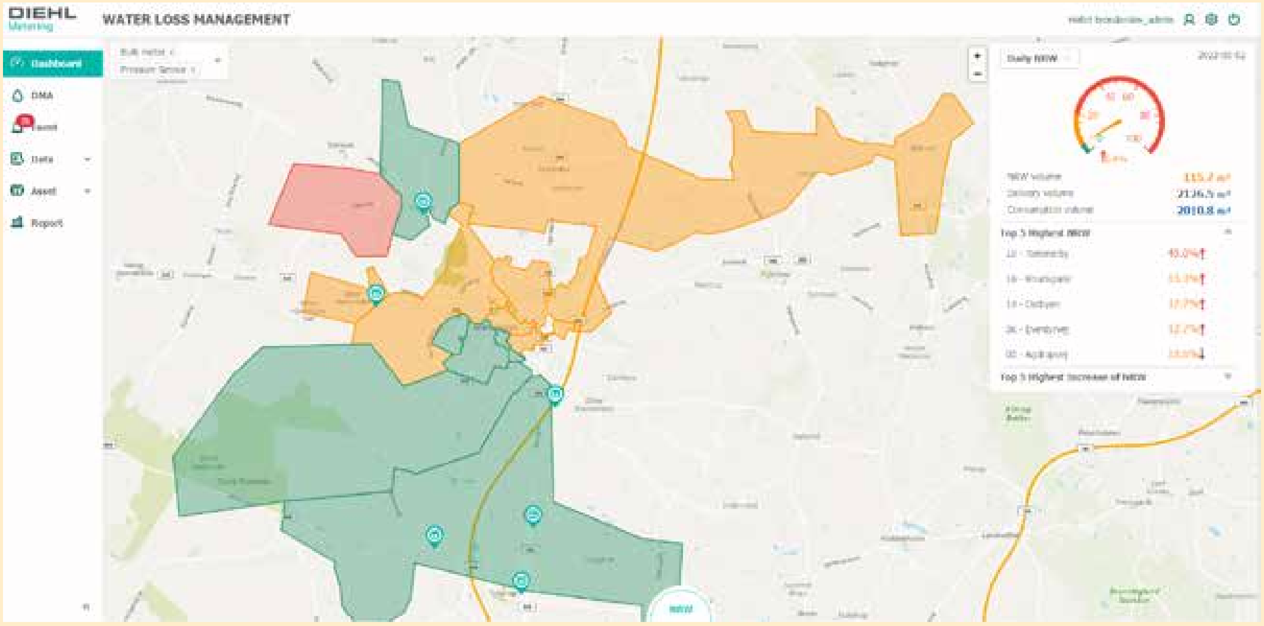
Smart water meters should help keep the water loss below 5 % in Brønderslev Forsyning, according to managing director Thorkild B. Neergaard.

Automatic alarm in connection with high water loss

The entire geographic area that is supplied with drinking water by the company can be observed on a large screen at Brønderslev Forsyning. The area is divided into 22 smaller sections, and an online inlet meter that constantly provides an accurate picture of the pressure, flow and volume of the water that is pumped into the respective section, is installed on the boundary between the sections. By comparing data from the inlet meter with data from individual meters at the customers daily, Brønderslev Forsyning gets an accurate picture of the water loss in the distribution network for the section in question. And more than 99 % of the meters send data to a fixed aerial network daily.

The water loss is calculated automatically, and if it is higher than a value specified by the utility company, the system sounds the alarm, and the section changes colour from green (below 5 %) to yellow (between 5 and 7.5 %) or red (over 7.5 %) on the monitoring panel on the screen.

If the alarm goes off, investigations within the given section, where the water loss is registered, are launched. Customers in this section are contacted. As a rule, once people have been made aware of a possible leak, they find indications of leaks in the form of a soft spot on the lawn or suchlike. However, if the leak is not discovered quickly, Brønderslev Forsyning can send experts with listening equipment to localise the problem.



The green areas in the figure indicate that the water loss in the respective sections is less than 5 %. It is below 7.5 % in the yellow ones, and if the colour changes to red, the water loss exceeds 7.5 %.

Over time, the meters could help find the leak even better, as they can register changes in the temperature of the water in the distribution network that can indicate a leak, using a sensitive temperature sensor. This function is one of the next steps in the digital transformation of Brønderslev Forsyning's leak monitoring.

Calls make customers happy

Brønderslev Forsyning also gets an alarm if one of the individual meters at a customer registers an unusually high water consumption.

"If things look bad, we simply call the customers and alert them to the fact that they are using much more water than usual. The cause can be a leaking toilet, but also a burst pipe in the floor or the hot water heat exchange that would otherwise not be discovered immediately.

Brønderslev Forsyning's calculations indicate that the intelligent meters in private households save the customers between € 200,000 and € 270,000 per year. And this exclusively applies to water losses on "the other side" of the meters that is the sole responsibility of the home owners themselves.

"The customers are extremely happy that we call them. It is, naturally, a sad message we deliver, yet still a message they are happy to hear as it enables them to react. And we have come to know a large number of our customers better. It is quite many of them that get a call over the course of a single year," says Thorkil. B. Neergaard.

Part of a wider digitalisation effort

"If we were cynical, we wouldn't call anyone; it is, after all, we that sell them the water. However, we have a business case, where we operate with two bottom lines. One for the company and another one for the customer. If customers save € 270,000 thanks to an action we take, then it is worth a lot. And considering that we are owned by the municipality and thereby also by the customers, we take just as much care of the customers' bottom line, too," says the managing director.

It is not only the utility company that can keep an eye on consumption. The customers themselves can keep track of their water and heating consumption by using an app on their mobile phone, and they can set up an alarm if it suddenly shoots up.

"Perhaps the garden sprinkler hose has defected. Or the ball float in the toilet cistern is stuck so that it does not close properly, and the toilet is just running. However, our app gives the customers an alert, which permits them to take quick action," says Thorkil B. Neergaard.

As more and more customers install and use the app's functions, our plan is to make manual phone calls unnecessary, as the app will take care of notifications. ■

Brønderslev's water in figures

- 900,000 m^3 of water sold per year
- 6,500 intelligent meters
- 5 % water loss (previously up to 12 %)

Security of supply and availability

When it comes to security of supply, one of the most important goals of drinking water companies is to make sure that there is always water coming out of the tap at the consumers, that it is always clean and that its quality is top notch. The high security of supply can be affected in many ways, for example:

- Companies can ensure that they have sufficient reserve capacity to supply water if one of the company's waterworks fails or becomes affected by contamination. This may be achieved via ring connections and excess capacity between a company's own works or via an "emergency connection" to another company, which can provide additional water in the event of mishap.
- Good pipeline maintenance standards to avoid unnecessary shut-down of the water supply for customers, for example, in case of bursts.
- Segmentation and ring connections in the distribution network so that repairs can result in a shut-down for the smallest number of customers possible.
- Companies can also plan their maintenance works so that the "water supply shut-down time" to consumers is as short as possible. They can also notify the consumers via an SMS notification, or the like, to minimise the inconvenience of not having tap water.

Customer availability

There is no clear definition or calculation method for measuring security of supply, but one way of measuring the impact of the company's work is to measure the availability of water to the customer. Availability is an expression of how large a part of the year for which the customer has tap water. If, each time a valve is closed, that shuts down the water supply to one or more customers, the companies register the length of time that it has been closed and how many mailing addresses that have been affected by this, an average number of interruption minutes per mailing address can be calculated. The records can be divided into two types:

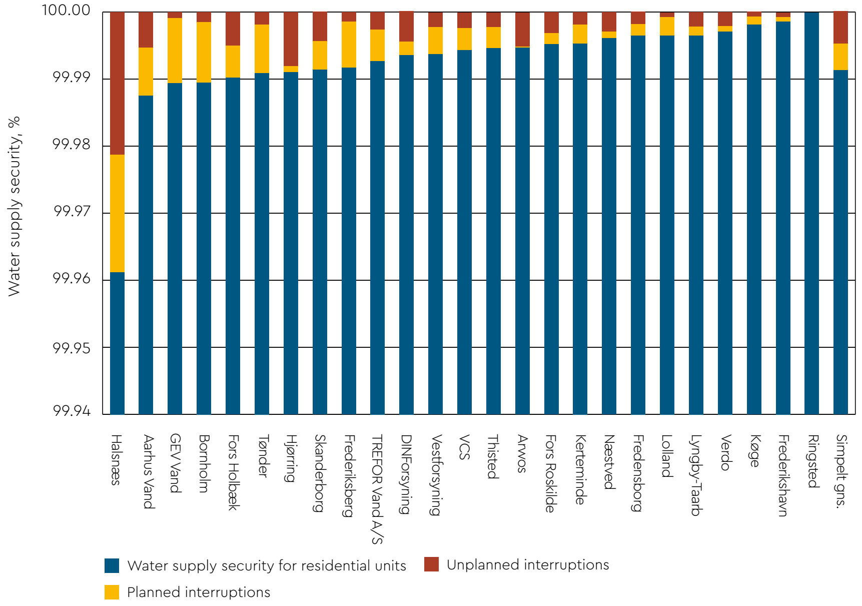
- Planned interruptions, where the company has informed the customers in advance that the water will be shut down in connection with planned renovation of the pipelines, replacement of valves etc. As a rule, planned works are works that the company has known for more than 48 hours in advance; usually several weeks/months in advance.
- Unplanned interruptions are defined as interruptions to the water supply for one or more customers where the company has not notified the customer 48 hours in advance that they would be carrying out the work.

Customer availability can be calculated by taking the total number of minutes in one year and deduct the average number of minutes per mailing address where there have been unplanned interruptions or scheduled shutdowns.

The average availability for the 24 companies participating in this calculation in DANVA Benchmarking is 99.9912 %, which means that customers only had to be without water for 46 minutes on average a year.

The method of calculation is new and must be taken with reservations, as it places huge demands on the continuous registration of shutdowns, periods and scopes, the degree of detail of their management registration databases as well as the instruction of employees involved. ■

WATER SUPPLY SECURITY, 2021



Bursts in the distribution network

Bursts may occur over the entire pipe network from the waterworks to the customer's water meter. Most of the pipe network that belongs to the water company is referred to as mains and supply pipes and communication pipes. The last few metres from the property boundary to the water meter, which are referred to as the property supply pipe, belong to the landowner. Bursts are divided into two categories:

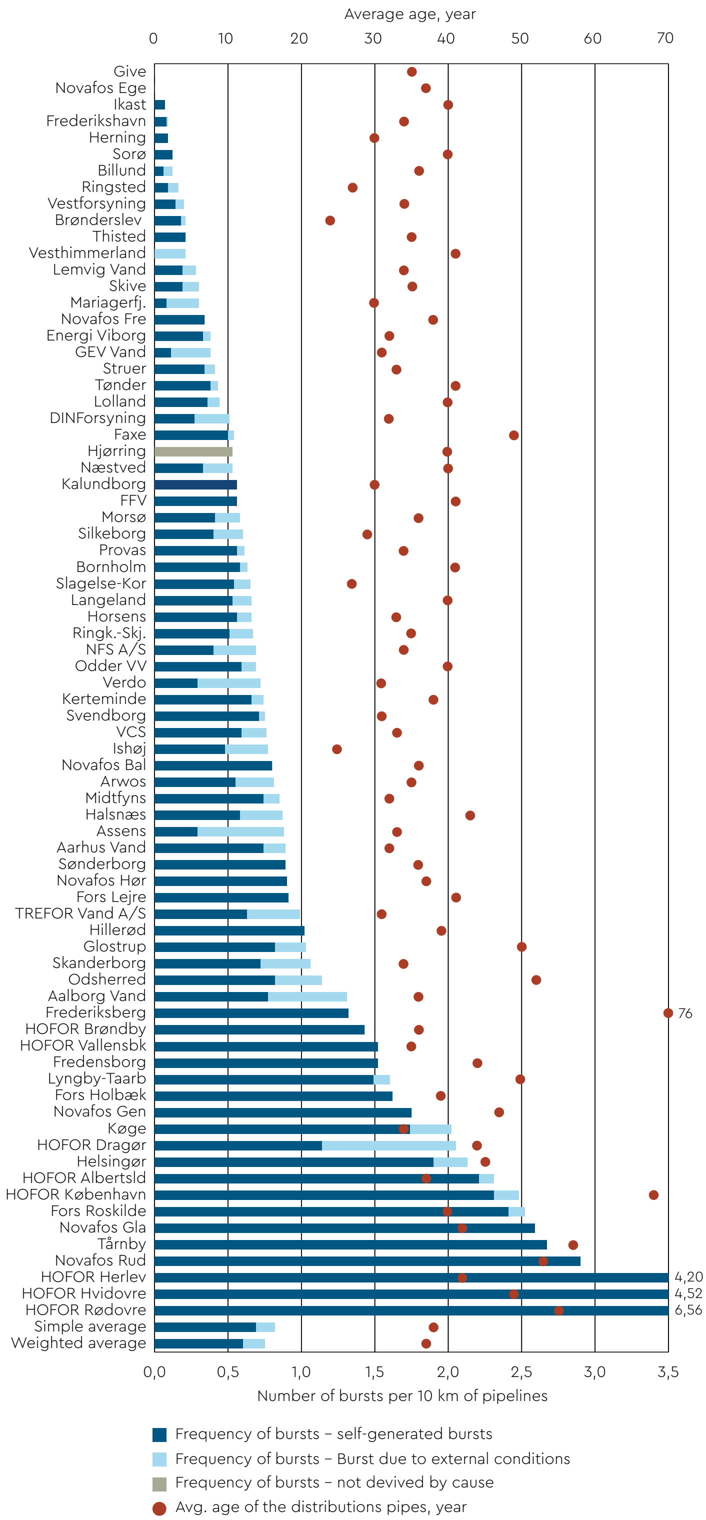
- Self-arising ruptures in the pipeline network or house/building connections, where the pipeline's age, pipe material, drilling saddles, geology and the quality of work performed are often the cause of the rupture.
- Ruptures due to external conditions, where the rupture is often due to excavation damage caused by a contractor in connection with excavation work.

The 77 companies participating in DANVA Benchmarking and Statistics had a total of 2,801 bursts in their pipe networks in 2021. This is an average of 36.9 bursts per company, which is 5 more compared to 2020. 18 % of the bursts are owing to external circumstances, while 46 % of them can be attributed to the building connections.

As regards private property supply pipes, 17 companies recorded 832 bursts of their own pipes and were made aware of 196 bursts of private property supply pipes. The majority of up to 79 % of these bursts are classified as self-arising bursts. The number of bursts could be significantly higher, as companies are usually only aware of bursts when the landowner is not able to find the stopcock during repairs or anticipates the water company repairing the burst in the property supply pipe. ■

New rainwater pipes are being laid in the ground at the water company Novafos. Photo: Jesper Blæsild for Novafos

BURST FREQUENCY ON DISTRIBUTIONS PIPES, 2021



Moving pipes is costly

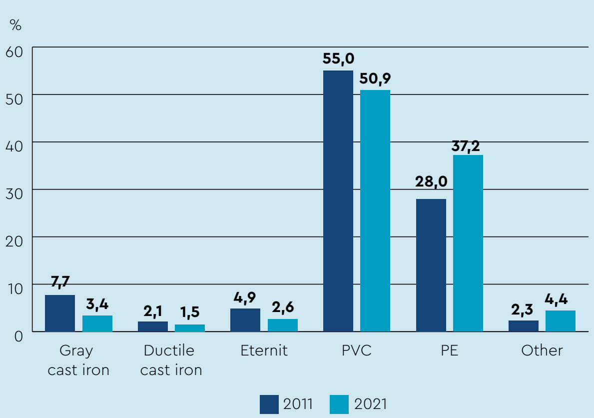
Water companies rerouted pipes for more than € 340 mio. 2020, as indicated by a survey conducted by DANVA. The water sector wants the Danish Planning Act to take into account the placement of the companies' pipes by means of better long-term planning, as this will reduce the unnecessary cost of moving the pipes.

Renewal of the pipe network

The pipe network's renewal rate shows what percentage of the pipe network was replaced/renovated in the last year compared with the average per year for the past 10 years. There are many factors, such as materials, geological conditions, surface load and age, that have a bearing on when the pipe network should be renewed. Other important factors are that many infrastructure and construction projects often require water companies to relocate or extend their water pipes even if they are not at the end of their service life. Another cause can be the advantages in connection with joint excavation, e.g., if a road is dug up to renovate a sewer pipe or the district heating network, the water pipe is renovated/replaced to the same extent in order to avoid having to dig the road up again at a later date. There are 30 companies that have reported an average age for the 120 km of pipes that have been dug up. The weighted average stood at 55.4 years compared to an expected service life of 75 years. ■

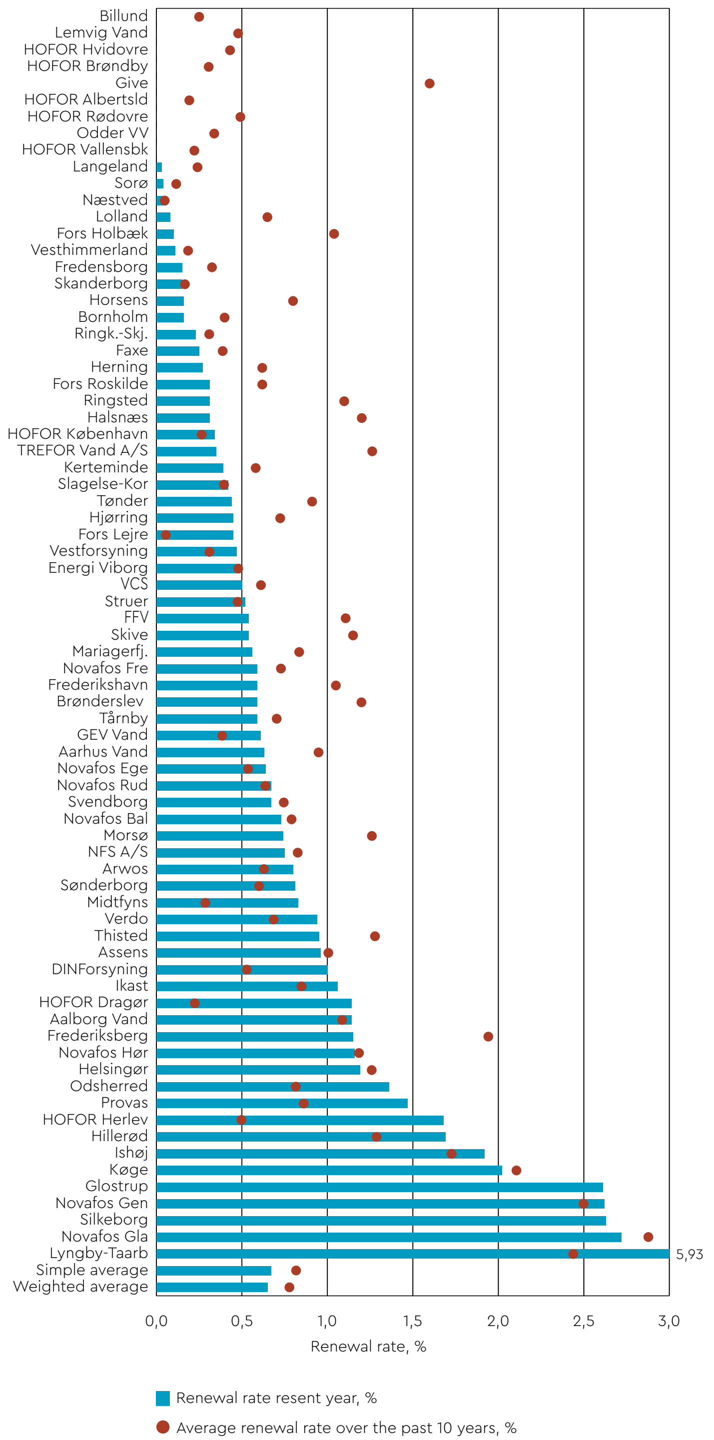
The pipe network is made of different materials

Various materials have been used for drinking water pipes throughout the ages. Overall, there has been a change from cast iron to PVC and then to PE, which is expected to become the dominant choice of material in the future.



Distribution of pipe materials for 26 drinking water companies that jointly have 15,337 km of pipes with an average age of 39 years.

RATE OF RENEWAL OF DISTRIBUTIONS PIPES, 2021



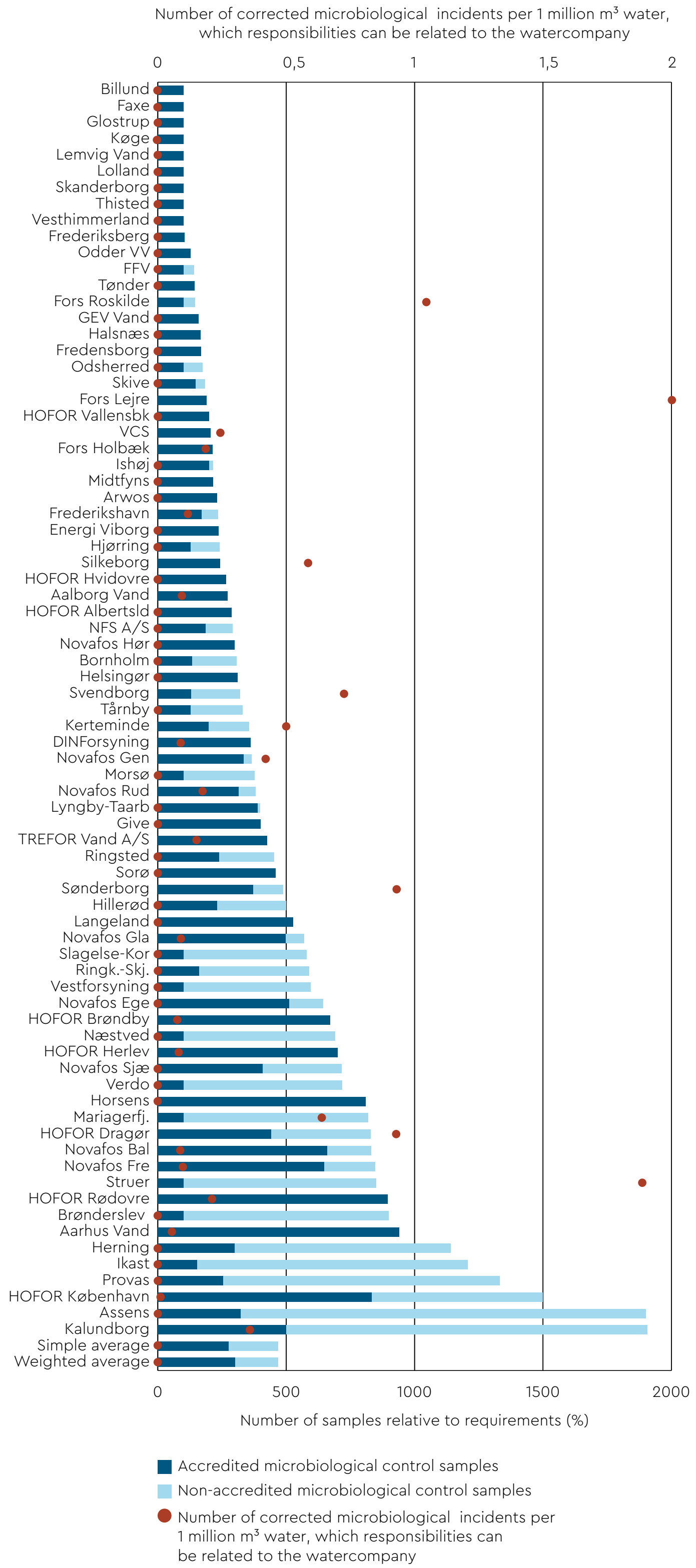
Tests to determine drinking water quality

Making sure that the water quality is good is one of the drinking water companies' most important tasks. Large-scale preventive control work based on Documented Drinking Water Safety, or DDS, is continuously under way. The tests consist of analyses for selected chemical parameters, such as iron and manganese, but also for microbiological parameters, such as E. coli and bacteria counts. In conjunction with the supervisory authority, a decision is made as to the number of statutory control samples that must be analysed at an accredited laboratory and carried out over the course of the year. This decision will be based on the size of the drinking water company. In addition, the individual water company must stipulate any additional control samples if it would like more frequent sampling than is required by the supervisory authority. Such sampling may include more of the same type of samples called for under statutory requirements or other non-accredited control samples which the company can take itself, for example, various quick tests. There is a particular focus on microbiological contaminants such as E. coli, as it could have material health consequences, such as diarrhoea.

The 77 participating companies have jointly performed 14,030 accredited microbiological analyses, of which 99.4 % met all requirements. If just one analytical parameter on a water sample exceeds the quality requirements, it is recorded as an "incident". This is not synonymous with the water being hazardous to health, but it means that there are circumstances that need to be investigated in greater detail. In 2021, companies found that 178 samples exceeded one or more microbiological parameters, 84 of which could be attributed to the companies. The remaining non-conformances were found to be down to conditions pertaining to the private consumers' installations upstream of the tap.

In 2021, 6 companies had to issue a boil-water advisory to their customers due to exceedances of the microbiological parameters. Together, they have impacted a total of 11,405 addresses. ■

MICROBIOLOGICAL WATER QUALITY ANALYSES, 2021



The drinking water companies' **energy statements**

Most of the energy used by the drinking water companies consists of power that is used to pump water up out of boreholes, across the waterworks and then out to the users. The water companies' options for producing energy from normal water production are limited, but they can produce solar power. In certain cases, power from turbines in the water pipes and the drinking water can be used to produce heating via heat pumps for internal heating, district heating operators or to large-scale private heat consumers.

Energy consumption in 2021

There is a big difference in how much electricity and energy is consumed by the Danish drinking water companies in supplying 1 m^3 of clean water to the customers. The average weighted gross energy consumption (power and heating) for drinking water is 0.44 kWh per m^3 of water sold, while the weighted net energy consumption stands at 0.43 kWh per m^3 of water sold. Since only a small portion of the companies have in-house energy production, the gross and net energy consumption is similar for most drinking water companies. However, one exception is Morsø Vand A/S, which has a heat pump in one of the company's water towers and therefore can produce and sell more energy than it consumes.

Electricity consumption (purchased electricity) averages 0.44 kWh/m^3 sold, and the companies themselves produce and sell electricity equivalent to about 0.39 % of what they consume. The companies' electricity self-supply rate is 0.5 %.

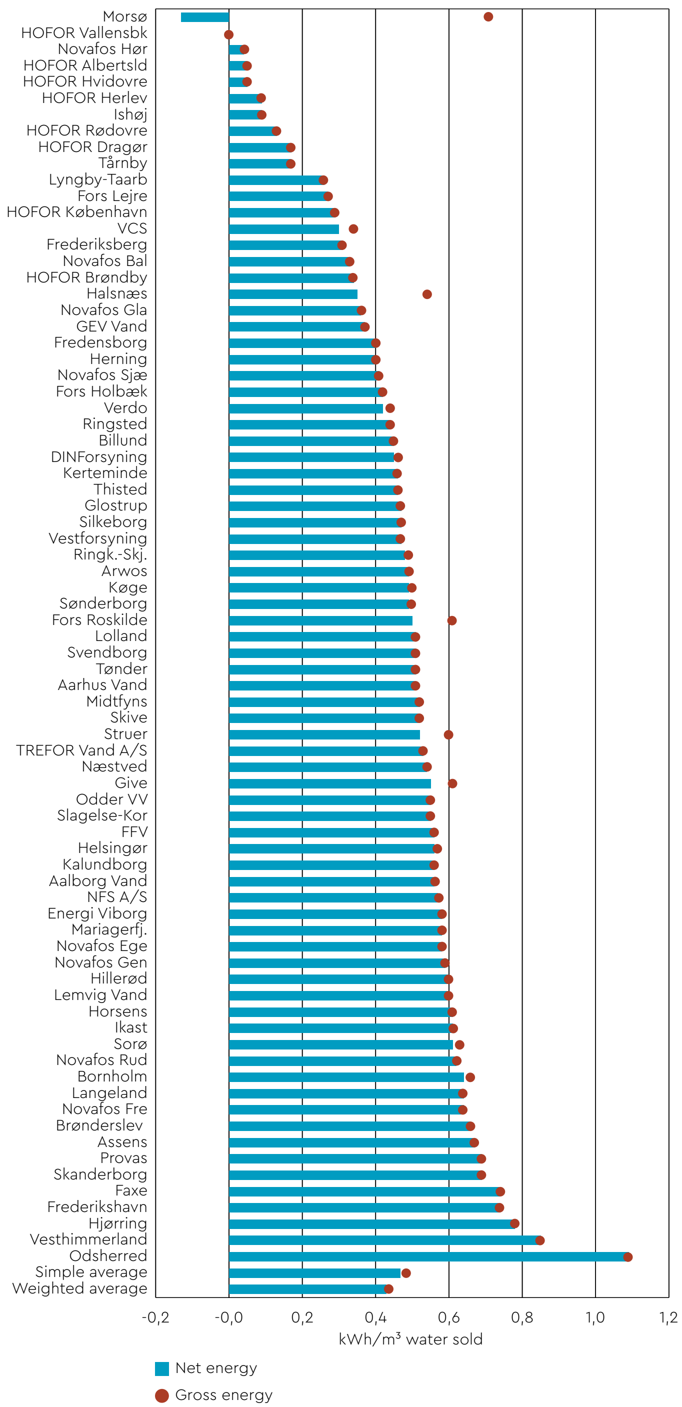
The way ahead to energy-positive drinking water companies:

There is still a very long way to go before the drinking water companies become energy-positive. Below follows a summary of energy purchases, energy production and energy sale for the 77 drinking water companies that participate in DANVA's reports.

See definitions of key figures in the graph and the net self-supply ratio on page 37. ■

Drinking water companies	Electricity	Heating/ power	Sum total
Purchased energy, kWh	100,537,957	3,420,132	103,958,089
Self-produced energy used internally, kWh	854,150	28,735	882,885
Sold energy, kWh	336,311	410,500	746,811
Net self-supply ratio, %	0.3	12.0	0.7
Total self-supply ratio, %	1.2	12.7	1.6

NET- AND GROSS ENERGY FOR WATER COMPANIES, 2021



Because Denmark's drinking water supply is based solely on groundwater, this places high demands for water protection against pesticides and other environmentally hazardous substances. Photo: Jesper Blæsild

TEXT: KATRINE RINGGAARD JØRGENSEN, DANVA / **GRAPHICS:** JTO

New study:

THE SUSTAINABLE DEVELOPMENT GOALS have brought changes to Danish water companies

According to a new survey, the UN Sustainable Development Goals have really moved in to the engine room at Danish water companies. Eighty-five per cent of the companies work with the Goals, and for the vast majority of these, employee involvement is prioritized as a pathway to successful implementation.

The task of integrating the Sustainable Development Goals into the water companies' work began for real in 2018, when DANVA published, in collaboration with a number of water companies, an Inspiration Catalogue that was supposed to facilitate translation of the Goals into the everyday life of a Danish water utility company. Just one year later, a study found that not fewer than 31 % of the water companies had stated that the Sustainable Development Goals had been incorporated into their strategies. And now DANVA finds in a recently completed survey of water companies that the majority of Danish water companies (85 %) state that they are working with the Sustainable Development Goals. See the selected results in the current figures.

According to Miriam Feilberg, Climate Change Manager at DANVA, the Sustainable Development Goals are managed separately from the rest of the activities of the companies. In order to make a difference, they must be integrated into the strategy and operations and be visible to employees, customers and surroundings.

It is exciting to see that the work of many water companies today is dedicated to the Sustainable Development Goals. The Goals are an agenda for change that must be implemented by in the entire world. We will only implement the goals if we create change in our own organisations and are in dialogue with our surroundings. This is the message that has been adopted by water companies.

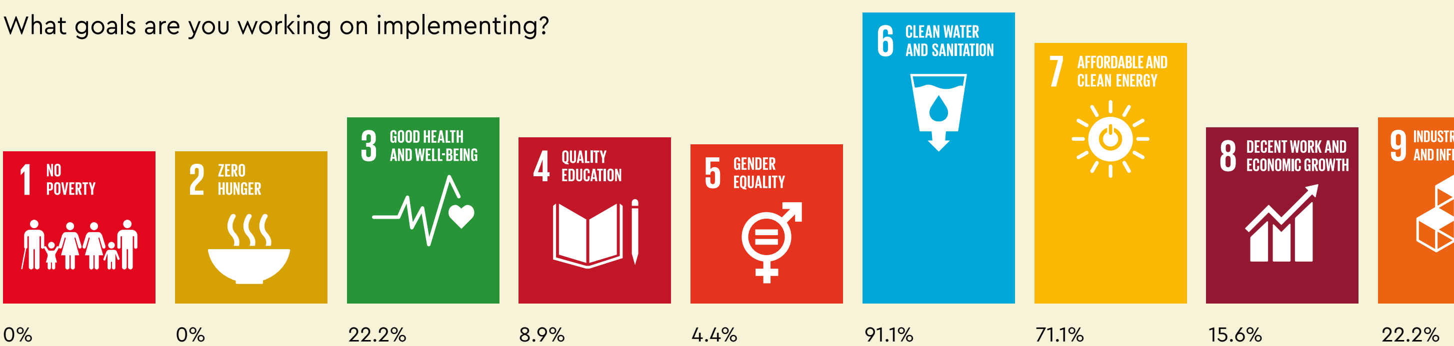
Employees take centre stage

In accordance with the survey, by far the majority of companies prioritise 3 to 6 goals that they concentrate their actual efforts on. If we take a look at the specific implementation, there is a great deal of variance in the answers. Among other things, 6 % are certified in the SDGs, whereas 39 % include them in their business management systems. Seventy-two per cent have incorporated the SDGs as a strategic focal point, and 53 % use them as a guidence for choosing specific projects. Finally, the involvement of employees is crucial for the implementation of the SDGs. An amazing 80% of water companies do so.

"Employees are crucial for change. It is

Do you work with the Sustainable Development Goals?

What goals are you working on implementing?



not just the Executive Board, but also project managers that must make sustainable choices daily, e.g., in tenders and requirements to subcontractors. As many as 80 % of people state that they involve employees in the implementation of the SDGs, while several point out without hesitation that there has been a change in the organisation and greater employee satisfaction," says Miriam Feilberg.

Based on the survey, DANVA has asked two participating water companies to specify their replies, and both of them consider the SDGs to be crucial for their strategic efforts. At Guldborgsund Forsyning, the SDGs are the focal point of the business strategy, and the company is one of just under 72 % of respondents that are in the process of integrating the goals centrally into the business strategy. According to Niels Rasmussen, Chief Executive Office of Guldborgsund Forsyning, the SDGs can help strengthen cooperation with the company owner.

"We are currently working on our strategic plan, which will take effect from 2023, and here the SDGs occupy a vital place. We aspire to define two to three SDGs that the employees can identify as crucial for their work and where we are certain we can deliver tangible results. In addition to the manifest environmental benefits, I have the clear expectation that the selected SDGs will give us far better prerequisites for supporting our owner and creating a common strategic vision. We have created a clearer correlation between the company's and the owner's strategy plan, when the SDGs recur in both documents, and we devise a common language when goals are converted into action plans." says Niels Rasmussen.

New demands changing the market

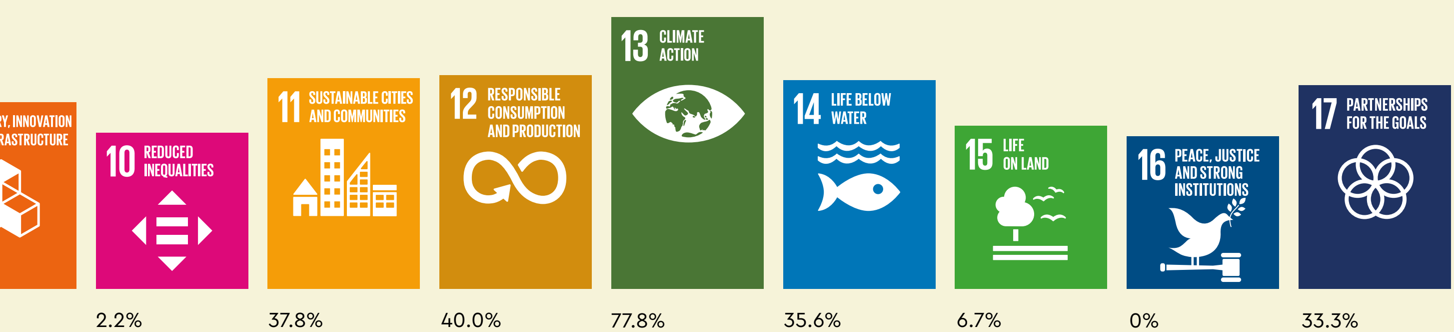
Further to the North, at Greater Copenhagen Utility (HOFOR), The Sustainable Development Goals feature prominently in the company's Group Strategy 2020-25. According to Susanne Lykke Jakobsen, Program Manager for Efficient Resource Utilisation and a Carbon Neutral Footprint by 2040, each of the company's five group targets is directly linked to five SDGs. Now HOFOR has had a few years of experience, which has been translated into concrete projects. The incentives for working with SDGs are found both in the natural responsibility associated with being a major multi-purpose utility and due to the greater focus from the surrounding world — in particular, the owners.

"I very much consider the work with the Sustainable Development Goals as a lever that generates an even greater focus on the work we are already under way with as part of the green transition. Moreover, the SDGs have resulted in clearer communications. But there are also areas where we are only now ready to present actual action plans," says Susanne Lykke Jakobsen.

Another element in the work with the SDGs is also the natural question about the cost of choosing alternatives that are better for the environment. For example, HOFOR has considered quite specifically what it would mean to buy concrete that is more CO^2-friendly.

"We have discussed the extent of the demands we can make. You see, the challenge is that the market usually only changes once we begin establishing the demands. We can perhaps also risk getting a CO_2-friendly alternative that is not as durable as, for example, 'classic' concrete. And moreover, what a CO_2-saving must cost when we simultaneously seek to maintain the price of our services as low as possible may turn into a political issue," concludes Susanne Lykke Jakobsen.

DANVA continues its work on supporting the implementation of the SDGs by water companies, e.g., via webinars and conferences, and will launch a network in the autumn to help define new activities and projects. ■



Energy and climate neutrality of the water sector by 2030

It was a historic moment in 2015 when the UN's 195 member states signed the Paris Agreement, thereby undertaking to limit emissions of greenhouse gases and counter global warming. Under the agreement, each country made a legal commitment to submitting a plan for how it would work to reduce pollution of the environment. Denmark has set a climate target of a 70 % reduction in CO_2 by 2030.

The Climate Action Plan from June 2020 stipulates that the Danish water sector is to lead the way in becoming energy and climate-neutral. Based on the results of the "Paris Agreement for the Water Sector", it has been decided that the water sector's goal is to achieve energy and climate neutrality by 2030. The study asked companies to make a guess about their expectations for the developments in energy consumption and production, treated volumes of water and selected emission sources in the next 15 years.

The goal, which applies to the companies' operations, is an overall, not an individual target for drinking water and wastewater companies, as prerequisites for each individual company differ widely. Opportunities for making a positive contribution with regard to energy savings and energy production at waterworks are materially greater, whereas drinking water companies and sewers/transport can contribute with energy savings, but much less so with energy production.

Since new requirements and numerous climate mitigation measures will also raise, for example, power consumption, it may also prove difficult to achieve both goals. ■

Based on the results of the Danish Environmental Agency's very own "Paris model"- for water companies, the goal we set is for the Danish water sector to become energy and climate neutral by 2030.

Lea Wermelin, Minister for the Environment- published at DANVA's annual meeting in May 2021

Calculating carbon footprint

Operating a drinking water and wastewater company naturally has a big carbon footprint. Carbon footprint can be divided into an operations footprint and a construction footprint (investments).

The companies' operations footprint originates in the day-to-day activities from source sites, waterworks and the distribution network in order to bring drinking water out to the consumers as well as the day-to-day activities in transporting the wastewater across the sewer network and clean it at the wastewater treatment plants.

The most important parameters of the climate footprint of drinking water companies consist of power consumption and heat, methane degassing at waterworks and, on the positive side, reforestation for groundwater protection.

The most important parameters of the climate footprint of wastewater companies consist of emissions of two potent greenhouse gases, nitrous oxide and methane, power and heating consumption, impact on recipients in connection with the discharge of water with a low nitrogen content, emissions from sludge, chemical consumption and transportation during operations. On the positive side, there is production of CO_2-neutral power and heating, biogas to replace natural gas or use it in the transport sector, reprocessing of sludge and recycling of, e.g., phosphorus.

Efforts continue to develop an overall model for describing and measuring the companies' operating discharges. At the same time, many companies are looking at the carbon imprint of their buildings and installations, with a focus on sustainability and the right materials. ■

50 % reduction in nitrous oxide emissions

The political agreement from June 2020 lays down a target of a 50 % reduction in nitrous oxide emissions from waste water treatment plants over 30,000 PE from 2025. To be able to support this target, the Danish Environmental Agency is in the process of preparing the documentation and method of computation.

Methane from biogas plants has to be reduced

A large study on the emissions of methane from Denmark's biogas plants indicated in 2021 that methane loss stood at approx. 7.7 % of the volume of methane gas produced. In summer 2022, new strict requirements were introduced for biogas plants' loss of methane from leaks, the gas engine and evaporation from digested sludge, as well as a requirement for annual control and the introduction of a self-control system. The requirements aim to reduce the loss of methane to 1 %.

A wastewater treatment plant's energy flows. Drinking water and the pipe network share the same figure, however, without the 2 lowermost biomass arrows.

Calculation of **energy consumption**

The aim is for the Danish water sector to be energy-neutral or, even better, energy-positive, which means that the water sector delivers more energy for the benefit of society than it purchases measured as net energy consumption. Energy is the sum total of electricity, power and other forms of energy such as biogas.

Danish drinking water and wastewater companies have had a major focus on cutting energy consumption for more than 20 years. An overall conservation model was implemented in 2017 in the mandatory performance benchmarking carried out by the Danish Environmental Protection Agency that covers all water companies subject to the Danish Water Sector Reform Act. The model was prepared in collaboration between the Danish Environmental Protection Agency and DANVA, and the method of calculation produces a net and gross energy consumption calculated for drinking water companies along with the sewerage networks and treatment plants of wastewater companies, respectively.

The calculation method is based on three main streams: Energy in (purchased), self-produced energy used internally, and energy out (sold). The energy designation covers electricity, heating as well as other energy forms such as biogas, where all forms of energy are converted to kWh.

Calculation for 2021:

The Water Sector	Drinking water	Transport	Treatment	Sum total
Purchased energy, kWh	103,958,089	92,404,059	309,655,066	506,017,214
Self-produced energy used internally, kWh	882,885	96,707	89,177,105	90,156,697
Sold energy, kWh	746,811	87,277	249,151,796	240,069,176
Net self-supply ratio, %	0.7	0.1	77.3	47.4
Total self-supply ratio, %	1.6	0.2	82.3	55.4

Data for 77 drinking water companies, 88 wastewater companies transport and 77 companies with wastewater treatment plants

This method of calculation makes it possible to compute an overall comparable key ratio reflecting how much energy is used by the drinking water company and the wastewater company when a customer purchases one m³ of water.

- Net energy consumption: The difference between energy purchased and energy sold, kWh/m³
- Gross energy consumption: The sum total of energy purchased and self-produced energy used internally, kWh/m³

There remains some way to go until the climate neutrality objective is achieved, but it is clear that it will be wastewater that will have to be pulling the load, since it is best positioned with regard to energy production potential. The objective is reached when the self-supply ratio of companies exceeds 100 %. 2 different degrees of self supply are calculated:

- Net self-supply ratio: Percentage of energy sold in relation to energy purchased, %
- Total self-supply ratio: Share of sold energy and self-generated energy used internally in relation to purchased energy and self-generated energy used internally, % ■

Wastewater companies **in DANVA Benchmarking and Statistics**

In 2022, 91 wastewater companies reported data to DANVA Benchmarking and Statistics. The reported figures are for 2021. Together, the companies provide services to approximately 5.39 million people and operate 449 treatment plants, which purify more than 629 million m³ of wastewater with a load of 7.6 million population equivalents. The companies have between them more than 84,920 km of sewer pipes with 2.35 million communication pipes. In total, the sewer system area accounts for about 460,000 hectares. Total investments and renovations amounted to approximately € 781 mio., and actual operating costs were just over € 409 mio. (see the participants' overall key figures at the end of this publication).

Wastewater companies' operating costs slightly reduced

The statement of the actual operating costs of wastewater companies indicates that they used on average € 1.53 per m³ of water sold, which is a slight reduction compared to the previous year. Actual operating costs are governed by the Danish Water Sector Reform Act's requirements for efficiency improvements, and they form the basis for comparing the companies' efficiency in the OPEX calculation. Actual operating costs exclude VAT and other taxes, non-controllable costs and any selected associated activities that are kept outside the statement of operating expenses. Since 2016, there has been a change in the calculation of actual operating costs, which in comparison to the old method, now includes operating costs for environmental and service objectives, part of the previous 1:1 costs, plus any selected associated activities.

Wastewater companies spend, on average, 34 % of their actual operating expenses on the transport network, 46 % on wastewater treatment, 5 % on customer service and 15 % on general administration.

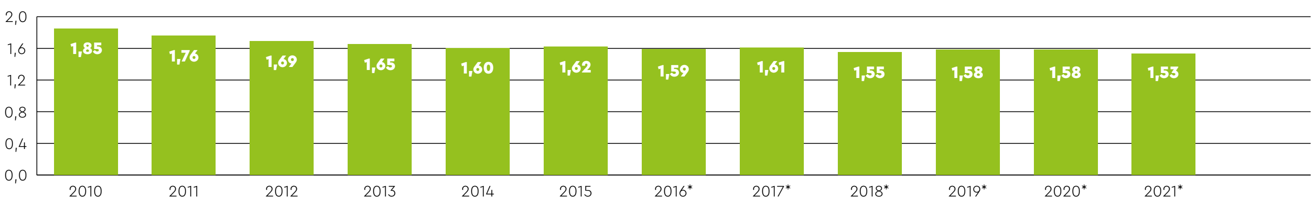
Investments increase a bit

The statement of investments made by wastewater companies in 2021 indicates a modest increase in the level of investments of companies in relation to 2020. Recent years have witnessed material fluctuations in the level of the investment drive and opportunities for companies. In 2021, the companies invested € 2.85 per m³ of water sold, which is € 0.04 more compared with 2020. On the other hand, the companies expect the level of investment in the coming years to be some 36-43 % higher.

Wastewater companies use on average 82 % of the carried out investments and renovations for improvements and extensions of the distribution network, whereas 16 % are used on wastewater treatment plants. The remaining 2 % are used for other investments. ■

OPERATING COSTS, 2010 - 2021

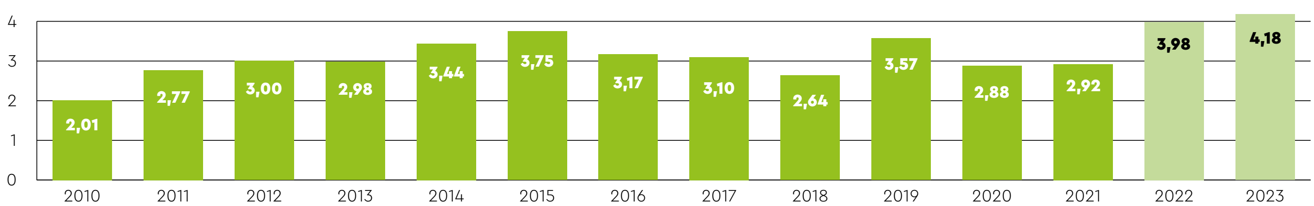
€/M³ SOLD WATER (2021 PRICES)



2010–2020: Actual operating costs (62–89 companies) *: New calculation of actual operating costs (FADO)

INVESTMENTS, 2010 - 2023

€/M³ SOLD WATER (2021 PRICES)



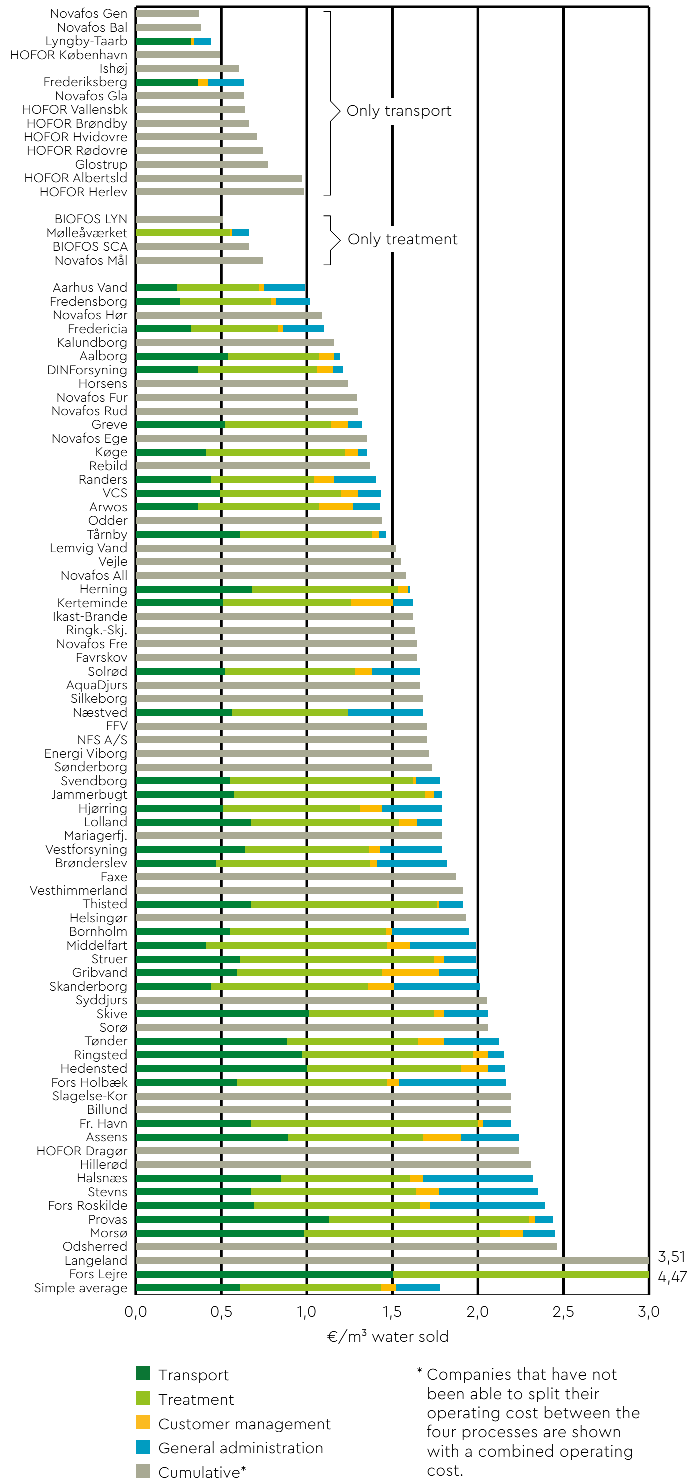
2010–2020: Implemented investments (66–89 companies – Investments and renovations)
2021–2022: Planned investments (89 companies – Investments and renovations)

High variation in actual operating costs

It costs an average of € 1.53 to transport and treat 1 m³ of water sold. The variation between expenses per m³ of individual companies is relatively substantial and reflects the very different framework conditions under which the companies operate. These may, for example, include topographic differences, differences in population density, the relationship between residential areas and large industries and companies' need for climate adaptation. The treatment and disposal of sludge also affects operating costs.

Pump wells like this are used to pump wastewater on into the sewer system on the way to the treatment plant.
Photo: Fredericia Spildevand og Energi

WASTEWATER:
ACTUAL OPERATING COSTS, 2021



Companies' **sewer network**

The sewer network guides wastewater from the citizens to the wastewater treatment plant. Historically, sewer networks were built with only one line, where wastewater and rainwater flowed through the same pipe. Later, the design changed to separate sewer systems, which has been the preferred design for all new housing and building developments over the last 20 to 30 years. The purpose of having separate sewer systems is to split wastewater and stormwater in order to ensure that the wastewater can be in the sewer network and then on to the wastewater treatment plant, thus preventing overflows of water containing wastewater in connection with heavy downpours. Stormwater can either be carried in its own pipe to the aquatic environment, or citizens can be asked to handle the stormwater on their own land, or the local stormwater drainage. Most wastewater companies opt to separate the sewer systems when renovating the older sewer system. However, this involves extensive excavations in all road areas, and also requires citizens to separate wastewater and stormwater on their own land, which entails a direct additional expense for the citizens. Building separate sewers in older, densely-built areas, e.g., city centres can be difficult and costly. The solution here will often be to upgrade the existing sewer pipes and build large wastewater ponds that can collect and retain the water that contains wastewater until there is room again at the treatment plant.

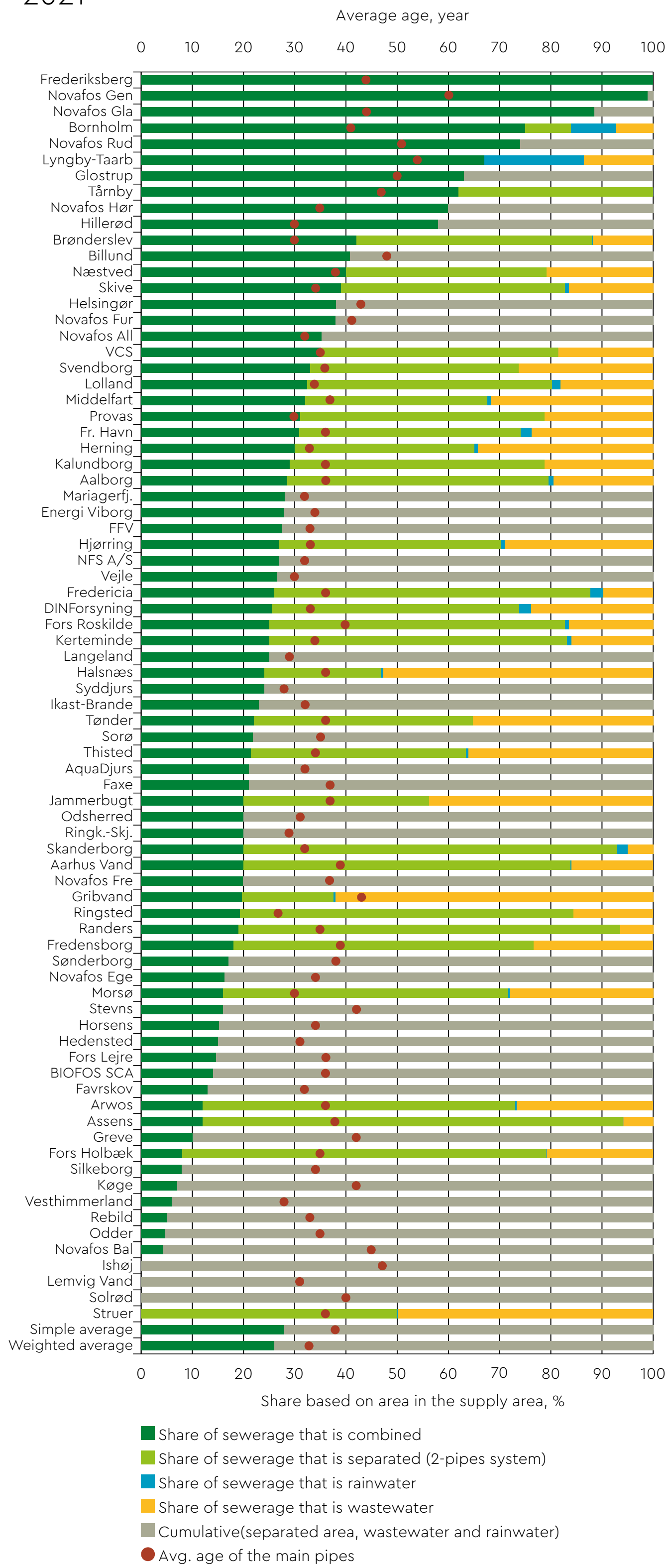
Extraneous water

Extraneous water is found to varied degrees at different wastewater companies, and since it generates a number of undesired and unnecessary expenses, the companies continuously work to minimise the amount of extraneous water.

Conditions such as the sewer network's origin, groundwater level, soil conditions, rainfall and the state of the sewer network are parameters which affect the amount of extraneous water directed to the treatment plants. Extraneous water includes, among other things:

- Seeping groundwater in areas where the sewer pipes are below or close to the groundwater level. Because of the rising groundwater level, the problem has deteriorated.
- Faulty connections in rainwater pipes and road drainage into wastewater systems.
- Drainage water connected to wastewater systems.
- Previous drainage pipes and piped streams which have eventually become sewer systems over time without the streams being disconnected. ■

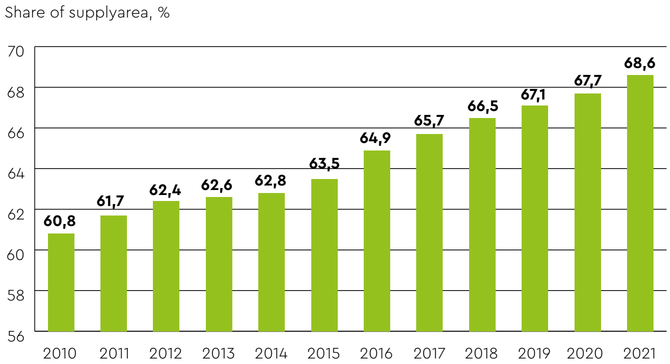
COMBINED AND SEPARATE SEWAGE SYSTEM, 2021



Development towards separate sewage systems

There is a very substantial difference in the extent of separate sewer systems among the benchmarked wastewater companies. Some companies have almost exclusively combined wastewater sewer systems, while others have generally divided up wastewater and rainwater into separate sewer systems. The majority of the companies tend to raise the degree of separation of the sewer systems, but this is a slow and expensive process that often takes several years and will burden the citizens with additional costs and roadworks for a long time. As indicated by the graph, the development from combined to separate sewers is slow. ■

SHARE OF SEPARATE SEWARAGE

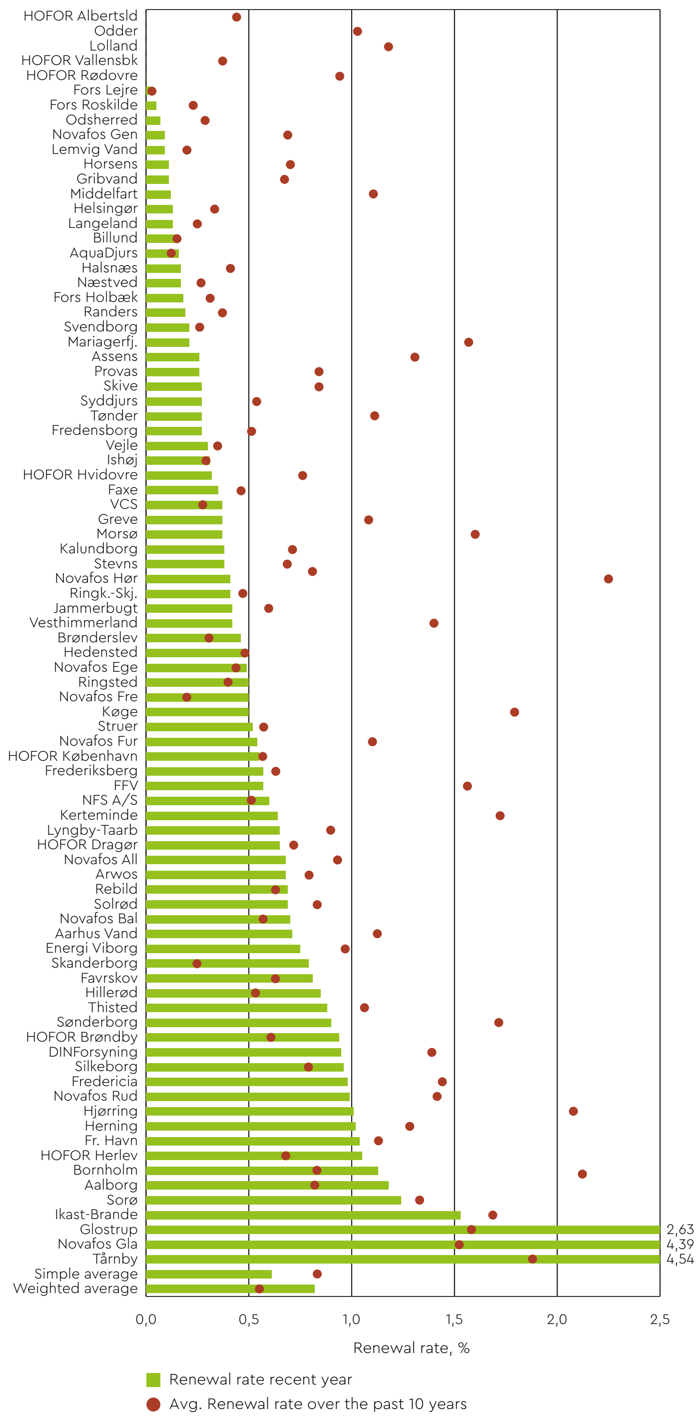


Simple average based on 38 companies development in area with separated sewerage from 2010 to 2021.

Rate of renewal of the transport network

The rate of renewal of the sewer network shows how much of the pipe network (as a percentage) was replaced last year, compared with the average per year for the past 10 years. Benchmarking in recent years has shown that more and more companies have a rate of renewal above 1%, which is fully in line with the major investments in sewer networks of recent years. Factors such as materials used, pipe dimensions, leaks and failures, geological conditions, surface load and age, have a bearing on when the sewer network should be renewed. Another important factor is that large infrastructure and construction projects often require wastewater companies to move their sewer pipes even if they have not reached the end of their useful life. There are 36 companies that have reported an average age for the 202 km of pipes that have been dug up. The weighted average stood at 51.3 years compared to an expected service life of 75 years. ■

RATE OF RENEWAL OF SEWER PIPES, 2021



Wastewater companies' **discharges to the aquatic environment**

The overriding task of wastewater companies is to guide the wastewater away from consumers across the sewer network and into the wastewater treatment plant, where the water is purified until it discharges into a stream, lake or the sea. There are six general types of discharge in this process, where nutrients are discharged into the aquatic environment.

Discharge of treated wastewater from the treatment plants

Approximately 600–800 million m^3 of wastewater flow into Denmarks about 700 treatment plants during the course of a year. Approximately 90 % of the nitrogen and phosphorus are removed here, before the water is returned to the natural environment. Wastewater companies' own ambitions to minimise pollution of aquatic environment have caused Danish treatment plants to generally treat wastewater far better than the discharge requirements set by the authorities. Overall, the treatment plants discharge less than half of the phosphorus and less than 70 % of the nitrogen they are permitted to release in their discharge permits.

Outflows of rainwater

In sewer systems where wastewater is kept separate from rainwater, the latter is conducted from roofs, courtyards and roads into its own stormwater pipe and discharged into the aquatic environment. Before the water is discharged into a creek or lake, it is usually required to establish a stormwater basin, the purpose of which is to regulate the flow and retain particles and oil. Stormwater also contains a small amount of nutrients. Often, the rainwater reservoirs provide a recreational element to local communities.

Overflow of water containing wastewater from combined sewer systems

The sewer network is designed to carry wastewater from consumers to the wastewater treatment plant, and in the past it used to be built as one sewer line that both received wastewater and stormwater which was led to the water treatment plant. During heavy downpours, water volumes can become too great to be managed in a combined sewer system. For this reason, they are designed with overflow structures (safety valves) that can discharge the water into the aquatic en-

Gudenåen, Denmark's longest river, at Brestenbro. Photo: Colourbox.dk / Mic

vironment preventing the water from being pushed back up into residents' basements or toilets. Once the heavy rain starts, the "first flush", which is the water that contains the most wastewater, flows down to the treatment plants. Subsequently, there is room for the rainwater in the combined sewer, and if it cannot remain there, it will eventually be discharged via the overflow structures. Here, the water flows through a grate which holds back paper and other large solids. Overflow water is often described as mechanically treated diluted wastewater, and the mean concentration of nitrogen is a little less than 30 % of the mean concentration of nitrogen in domestic wastewater, while the phosphorus content corresponds to approx. 15 % in relation to domestic wastewater.

Emergency overflow from pumping stations

Many pumping stations are built with an emergency overflow that allows water to run off if the pump breaks down. However, this happens rarely.

Relief/bypass arrangements upstream of treatment plants

Treatment plants are designed for a maximum water flow through the plant. This flow must not be exceeded, as otherwise there is a possibility of the active biological sludge being washed out of the aeration tanks, through the final sedimentation tanks, and out into the aquatic environment. To prevent this, treatment plants may have an overflow structure positioned just upstream of the plant or a bypass within, e.g., the aeration tanks or after the mechanical filter and sand/grease trap. This water is often referred to as "relief of biologically untreated wastewater". The nutrient levels are lower than with normal wastewater, as it has been mixed with large quantities of rainwater.

Scheduled temporary discharges

When conducting short-term renovations of central pipe pumping stations, wastewater companies may be forced to apply for a temporary permit to discharge wastewater directly into the aquatic environment, but only after initial mechanical treatment. As a rule, the solution is usually selected as a last resort, and the number of planned discharges has been very limited in recent years. ■

Calculation of discharges to the **aquatic environment**

It is the Danish Environmental Protection Agency that is responsible for the calculation of the discharges of nutrients from wastewater treatment plants to the aquatic environment via discharges from treated wastewater, overflows from combined sewers and stormwater.

The calculation is carried out in the PULS database, which in recent years has gone through extensive work to ensure and improve the quality of the data that is reported to PULS. A new and better database with new user-friendly functionalities and a better “engine room” was introduced in February 2020. Every year, the Danish Enviromental protection agency prepares a report titled “Point Sources”, which calculates the discharge nutrients from, among other things, wastewater companies. The report can be found on the website of the Danish Environmental Protection Agency.

Discharges from treatment plants

Initiated by the Action Plan for the Aquatic Environment I in 1987, a major upgrade and conversion of wastewater treatment plants in Denmark was launched to improve the treatment of nitrogen and phosphorus prior to discharge into rivers, lakes, fjords and the sea. This led to a major upgrade of wastewater treatment capacity in Denmark at the end of the 1980s. The result was clearly shown in the reduction of nutrients discharged from treatment plants over the following 10 years. From 1989 to 1998, organic matter was reduced by 90%, nitrogen by 71% and phosphorus by 87%.

The following table of the number of wastewater treatment plants and discharged nutrients indicates that the number of wastewater treatment plants has dropped, due to the centralisation of treatment plants as well as the fact that there is a correlation between the discharged volume of water that is dependent on rain and the discharged amount of nutrients.

Treatment plant size in 2020 based on actual load in PE:

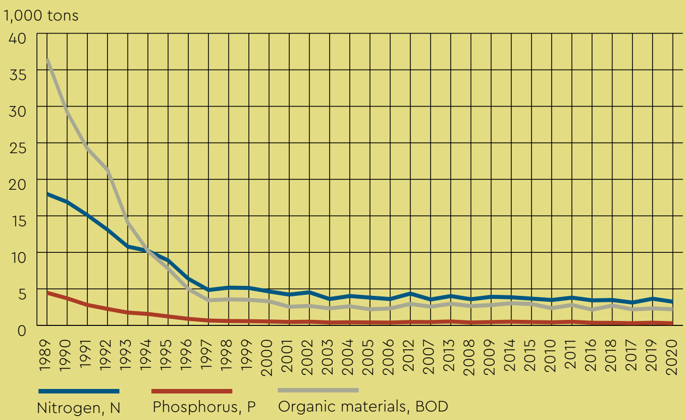
- Treatment plants greater than 100,000 PE: 13 plants
- Treatment plants between 75,000 and 100,000 PE: 12 plants
- Treatment plants between 50,000 and 75,000 PE: 6 plants
- Treatment plants between 25,000 and 50,000 PE: 31 plants
- Treatment plants between 10,000 and 25,000 PE: 68 plants
- The rest are below 10,000 PE

Discharged treated wastewater from wastewater treatment plants

Year	Treat-ment plant	Nitrogen	Phospho-rus	Org. Sub-stance, BI5	Water amount
	Number	tonnes	tonnes	tonnes	1,000 m^3
2017	773	3,482	348	2,712	714,169
2018	746	3,127	297	2,200	614,460
2019	725	3,655	372	2,328	721,052
2020	701	3,245	292	2,214	682,758

Source: MST Point Source reports

NUTRIENTS IN OUTLET FROM WASTEWATER TREATMENT PLANTS



Source: Point sources 2020, Ministry of Enviroment and Food.

Vejle wastewater treatment plant is close to the town and the fjord.
Photo: Vejle Spildevand

Climate adaptation made by Aarhus Vand along the street Risvangen. Photo: Ole Hartmann

Discharges from rainwater outlets

Discharges from the companies' sewage network via overflows from combined sewers and discharges of rainwater from areas with separate sewerage are referred to as stormwater outlets. Every time it rains, stormwater is discharged. However, it is only in the event of strong rain and where the sewage system cannot contain the stormwater that water can be discharged via the safety valves of the combined sewer (overflow structures).

The tables on the right indicate that the number of discharge sites from the combined sewer has been decreasing in the last couple of years and the number of stormwater discharges has risen, which matches the companies expansion of separate sewerage areas, which is designed to extract stormwater from the shared sewer. ■

Overflow Combined Sewer (water containing sewage)

Year	Dis-charge points	Nitro-gen	Phos-phorus	Org. Sub-stance, BI5	Water amount	Avg. rainfall
	Number	tonnes	tonnes	tonnes	1,000 m^3	etc.
2017	4,601	833	190	2,591	110,479	848
2018	4,478	348	59	1,029	33,403	595
2019	4,364	550	100	1,540	41,850	905
2020	4,222	404	71	1,116	33,618	770

Separate sewer (discharged stormwater)

Year	Dis-charge points	Nitro-gen	Phos-phorus	Org. Sub-stance, BI5	Water amount	Avg. rainfall
	Number	tonnes	tonnes	tonnes	1,000 m^3	etc.
2017	15,052	527	124	1,860	275,623	848
2018	15,176	367	55	1,132	194,757	595
2019	15,647	580	80	1,930	311,150	905
2020	16,219	510	70	1,500	278,429	770

Source: MST Point Source reports

TEXT: REGNER HANSEN, JOURNALIST / **PHOTO:** JESPER BLÆSILD

Holistic climate adaptation provides better solutions at a lower cost

These are the experiences from Denmark's largest cloudburst mitigation partnership so far. The decisive challenge is to find a simple and equitable financial model for the cross-cutting approach.

Water runs down. When there is a cloudburst, a lot of water falls, and it takes up a lot of room. In such a situation, it makes no sense to insist that it is the municipalities that must live up to their responsibilities by handling each individual water mass separately. In the worst-case scenario, this can cause a municipality to establish solutions that pose a definite disadvantage to neighbouring municipalities upstream or downstream.

There is more sense for the municipalities in a watercourse area to work together with other municipalities and the utilities on finding a solution. This is better suited to the challenges that can be brought by lots of rainfall in a short time — a phenomenon that can be expected to intensify.

This health-oriented approach to climate adaptation is gaining ground in Denmark these years. The model of cooperation is used, among other things, in connection with Harrestrup Å, which is the primary waterway to large parts of Greater Copenhagen. Ten municipalities and four wastewater companies have partnered on the largest Danish cross-cutting cloudburst project.

Brian Hansen is chief planner at HOFOR and chair of the steering group of the committee.

"The best place to intervene is above the cloudburst water, where there is most room to part the water, and preferably upstream. This delays the amount of water in the stream in the event of heavy, continuous rain, and this is to the advantage of all municipalities along the stretch," says Brian Hansen.

The Harrestrup Å project is a so-called capacity plan and consists of 40 sub-projects that need to be carried out in four stages over the next 20 years.

Illustrative of the way of thinking

The first completed Harrestrup Å project is called Haraldsminde, and it is very illustrative of the thinking in joint climate adaptation. The project is upstream in the Ballerup Municipality and is carried out by Novafos.

In the event of a downpour, a new lock in Harrestrup Å makes it possible to guide extra water into an oblong stormwater pond that is also newly established. This makes it possible to withhold the water until it can be received by the creek downstream. If the cloudburst is unusually violent, a bog and an additional low-lying area near the stormwater pond can also be flooded.

At the same time, climate adaptation has given Haraldsminde a boost to its recreational activities and improved its nature conditions. Wide footbridges are built over the water, there are flower beds of wild flowers, and the path network is extended.

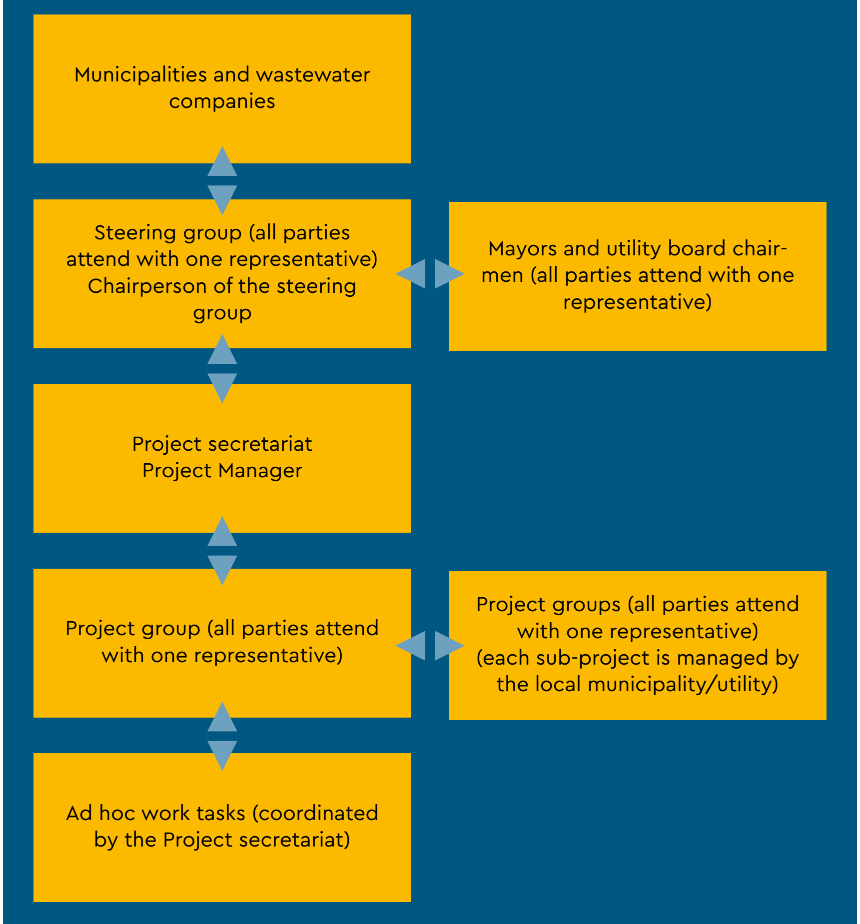
Perhaps the cloudburst mitigation partnership does not have an enormous effect in Ballerup Municipality, but the natural benefit of the cooperation model is greatly appreciated by the municipality and the citizens.

The Harrestrup Å sub-projects range from delaying storms in green areas to the creation of cloudburst basins plus faster diversion of water into the creek and watercourse extensions to remove bottlenecks in the stream system.

One of the upcoming sub-projects will be held in Vigerslevparken in the Copenhagen

The Haraldsminde Stormwater Pond is designed by water company Novafos and is one out of a total of 40 sub-projects that jointly constitute the climate adaptation project for Harrestrup Å. In 2021, the project was awarded DANVA's Climate Award for the holistic approach and ambitious cooperation between 10 municipalities and four water companies.

THE COOPERATION MODEL FROM THE HARRESTRUP Å PROJECT



Municipality. The creek will follow its natural meanders along this section of Harrestrup Å daily, whereas the water capacity will be extended in connection with downpours. A river delta will be created inside the park, which will make it more inviting to animal and plant life. Moreover, several areas next to the stream must be prepared for storage of water.

The Copenhagen Municipality declares that cloudburst mitigation in a continuous water system calls for a joint solution, while the investment simultaneously intensifies citizens' intimacy with nature.

Sixty per cent cheaper

Not only does the holistic climate approach make more sense in relation to the task — the partnership also makes cloudburst mitigation cheaper, as is established by Brian Hansen, chair of the steering group. The goal is to be ready for an event that would take place once in a 100 years.

"It is extremely costly to apply traditional solutions such as sewer systems and basins in order to prevent such an extreme event. It costs less when you are given the chance to establish stormwater ponds and basins for the benefit of the entire river system," says Brian Hansen.

He refers to a calculation that indicates that if the 10 municipalities should prepare for a 1-in-a-100-year event individually, they should be able to handle double the volume of water, compared to joining their forces together.

"On a rough estimate, the capacity plan accomplishes the same at approximately 60 % of the total price of the municipality-by-municipality solutions," adds Brian Hansen.

The capacity plan, which mayors and utility company chairmen agreed upon after several years of attempts, describes the management of the Harrestrup Å, sub-projects and finances.

According to the agreed distribution of the work, wastewater companies are in charge of infrastructure, whereas the municipalities in some places supplement with recreational aspects and payment for them.

Brian Hansen states that the cooperation partners accepted, without major objections, a financial distribution key that is based on the drainage areas in each municipality.

Brian Hansen further states that the partners have found the order of the sub-projects to be quite obvious.

Current setup inadequate

The government has launched the work on drawing up a national climate adaptation plan. The main stakeholders recommend a holistic approach. A holistic approach is distinguished by crossing administrative boundaries. Moreover, such an approach takes into account, among other things, CO_2 footprint, development of sustainable cities, biodiversity and options for local seepage of stormwater.

Financing of climate adaptation is often the biggest challenge.

"Preferably it should be a model that is just and simple to administer," says Miriam Feilberg, Climate Change Manager at DANVA.

"It should also be a model that handles expenses in the entire catchment area and covers all sources of flooding, whether from cloudbursts, the ocean or high groundwater," continues Miriam Feilberg.

There are also expenses that are difficult to cover for each individual municipality.

"Therefore, on some occasions, national financing may be appropriate," explains the Climate Change Manager at DANVA. She emphasises that DANVA, KL and DI have proposed a national climate fund for this purpose.

Holistic aquatic environment management is not only regarded as appropriate from the Danish side. In accordance with the EU's Water Framework Directive, Denmark is obliged to ensure the good ecological condition of all water areas by 2027 at the latest, which, according to Miriam Feilberg, requires a look at the overall picture, including, in particular, water catchments.

"Holistic orientation impedes overflows and flooding and reduces damage to the environment," concludes Miriam Feilberg from DANVA. ■

Wastewater companies' energy statements

The energy consumption of wastewater companies is split into gross and net energy consumption on the transport network and the company's total number of wastewater treatment plants. The reason for this is to produce appropriate comparable key figures such as kWh/m³ of water sold in the catchment area of the sewer system and the sewage treatment plant. The key figures reflect the amount of energy needed when a customer has purchased one m³ of water and discharged it into the sewer.

Currently the wastewater companies use a lot of electricity for the pumping stations that pump water through the sewers and down to the treatment plants. At the treatment plants, the items that consume the most power are the aeration tanks, but internal pump operation and sludge treatment also use a lot of electricity. On the other hand, the treatment plants offer a great potential for producing energy in the form of electricity and heat for use in the district heating network. The heat comes from the gas engine that converts biogas into electricity or heat pumps on the treated water at the outflow from the treatment plants.

The transport network's energy consumption

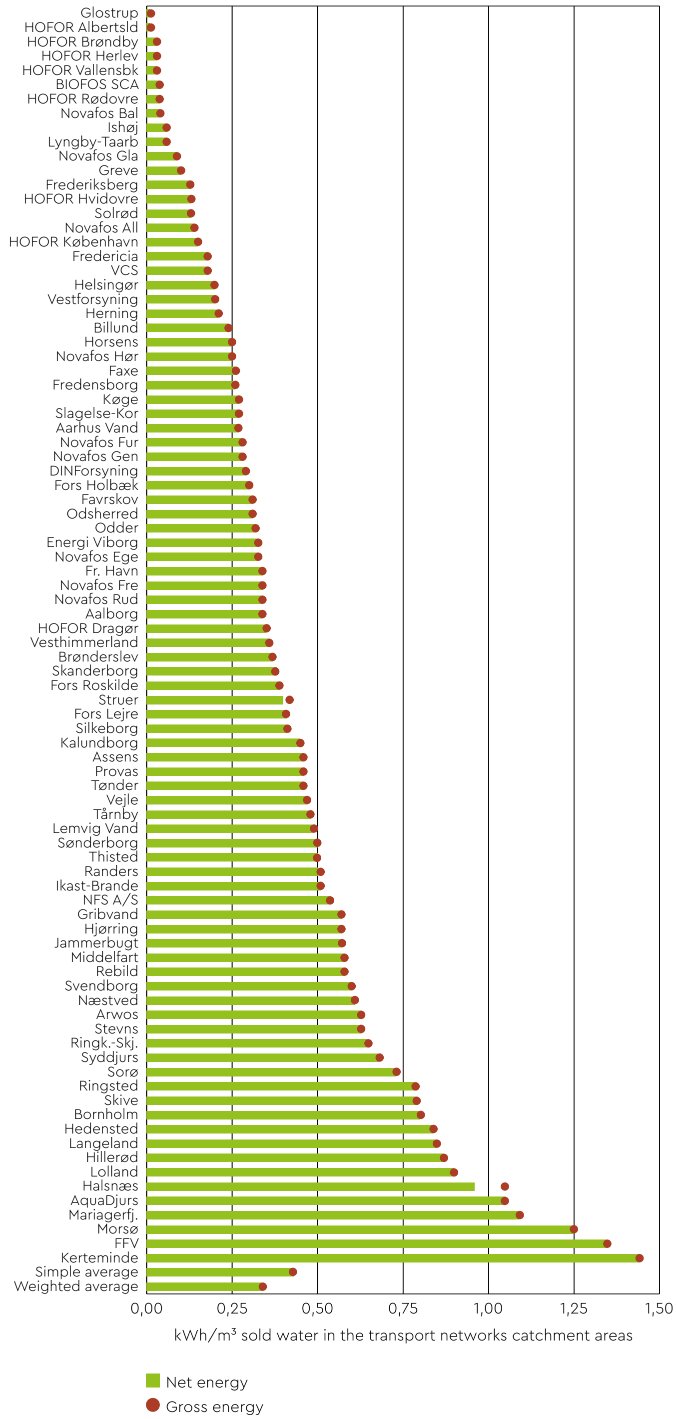
The net and gross energy ratio for the transport network is identical for the majority of companies. However, a small minority of companies are able to produce just a bit of energy, typically using solar cells. The average weighted net energy consumption stands at 0.34 kWh per m³ of water sold, while the weighted gross energy consumption stands at 0.34 kWh per m³ of water sold in the catchment area of the sewage system.

Below is a summary of energy purchases and production for the 88 wastewater companies that participate in DANVA's reports:

Transport	Electricity	Heating/ power	Sum total
Purchased energy, kWh	90,804,083	1,599,976	92,404,059
Self-produced energy used internally, kWh	96,707	-	96,707
Sold energy, kWh	87,277	-	87,277
Net self-supply ratio, %	0.1	0.0	0.1
Total self-supply ratio, %	0.2	0.0	0.2

See the definition of energy statement and explanation of net self-supply ratio on page 37. ■

NET- AND GROSS ENERGY FOR TRANSPORTATION, 2021



Electricity consumption for treating waste water

Wastewater companies purchase, on average, electricity equivalent to 1,38 kWh/m³ of water sold to customer, split between 0.34 kWh for transport to the treatment plant and 1.05 kWh for treatment. If the sold electricity produced by the companies themselves is deducted, the net electricity consumption is, on average, 1.12 kWh/m³. The 45 wastewater companies with their own electricity production produce electricity equivalent to about 34.5 % of their own consumption.

Treatment plants' energy consumption

Unlike the transport network, treatment plants have good potential for energy production, since treatment plants above a certain size can usually generate energy using biogas plants, which provide biogas that can be used for electricity and heat production, sludge incineration or using heat pumps, which extract large amounts of heat from the lukewarm treated sewage. Some companies have chosen not to include energy production internally within the plant, but instead cooperate with, for example, a biogas plant (external energy production). Some companies do not have the means for biogas energy production, usually because their sludge quantities are insufficient. These companies often have identical net and gross energy consumption.

If the total water industry is to become energy-positive, it is expected that it will be the big treatment plants that must produce sufficient amounts of energy to match the energy consumed by the transport part and drinking water companies.

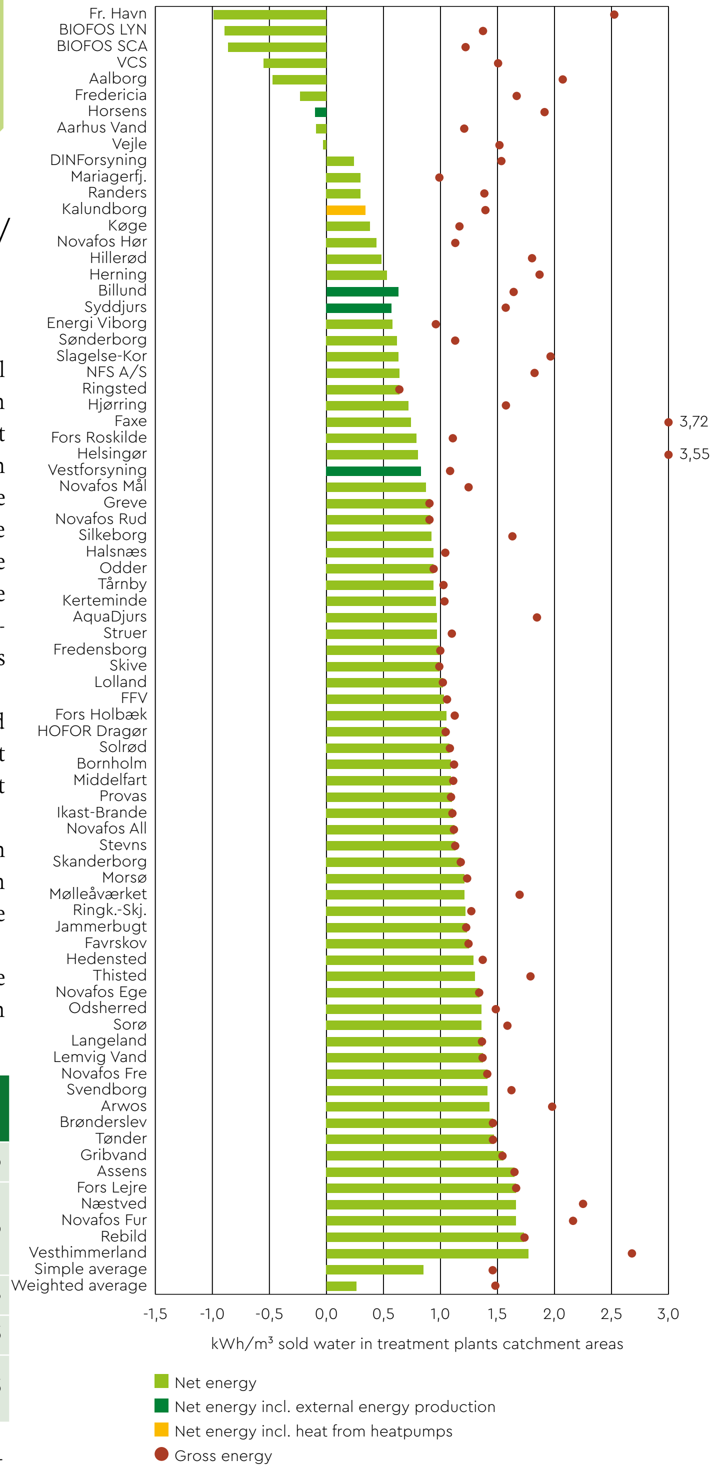
The average weighted net energy consumption stands at 0.26 kWh per m³ of water sold, while the weighted gross energy consumption stands at 1.49 kWh per m³ of water sold in the catchment area of the sewage system.

Below is a summary of energy purchases and production for the 77 wastewater companies with treatment plants that participate in DANVA's reports:

Treatment	Electricity	Heating/ power	Sum total
Purchased energy, kWh	279,320,774	30,334,292	309,655,066
Self-produced energy used internally, kWh	2,986,421	86,190,684	89,177,105
Sold energy, kWh	70,592,269	168,642,819	239,235,088
Net self-supply ratio, %	25.3	555.9	77.3
Total self-supply ratio, %	26.1	218.7	82.3

See the definition of energy statement and explanation of net self-supply ratio on page 37. ■

NET- AND GROSS ENERGY FOR TREATMENT, 2021



Treatment plants have widely divergent loads

Inflow factor

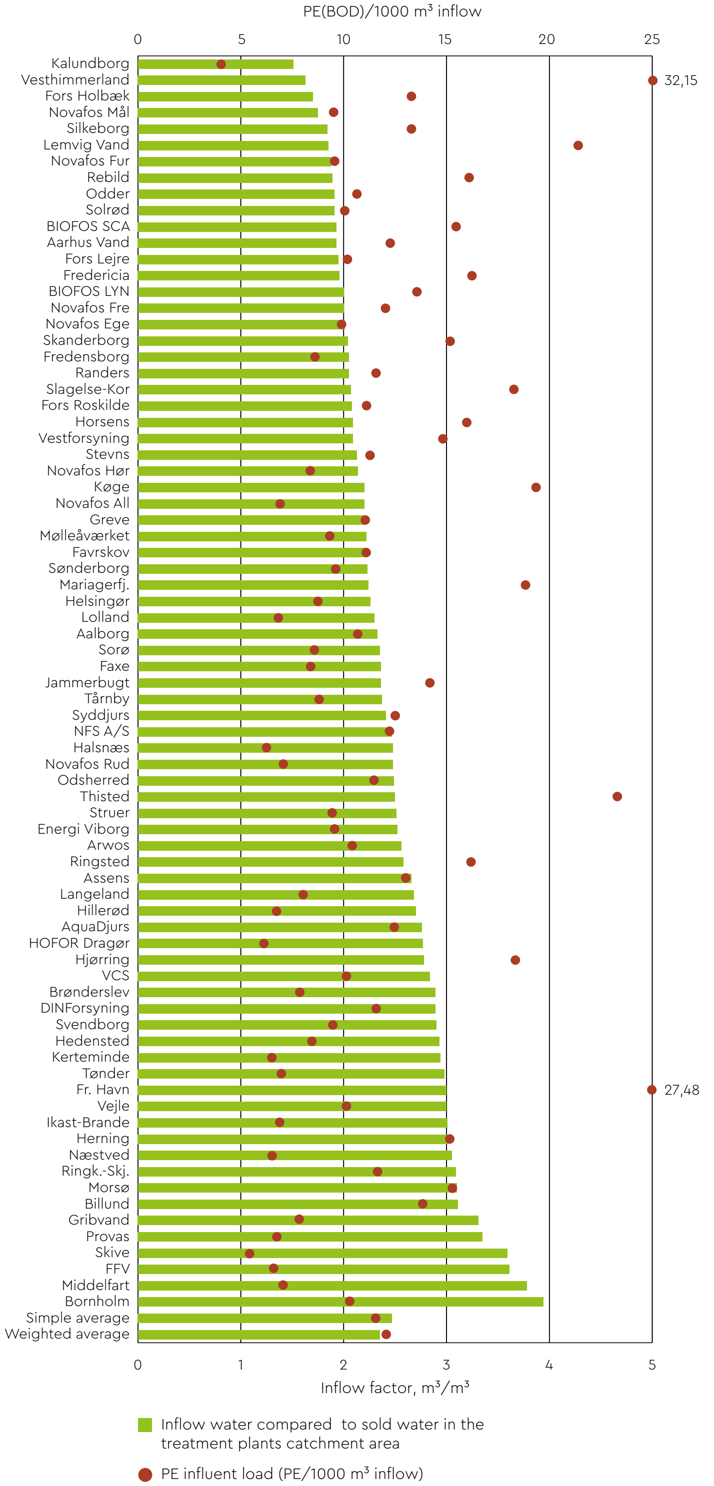
Inflow factor at a treatment plant is an expression of how much water enters the treatment plant in relation to the volume of water that is sold to the customers in the catchment area. An inflow factor of 3 means that when you sell 1 m^3 to a consumer, 3 m^3 flow into the treatment plant. The “extra” water is a mixture of stormwater and extraneous water, such as, for example, drain water and seeping of groundwater.

The graph indicates that the inlet volume to the treatment plants varies widely and that the inflow factor is between 1.5 and 4. A high inflow factor will produce a very varied water flow and will certainly need to be saddled with extra costs for dimensioning and pumping as well as higher wastewater tariff in connection with the discharge of more nutrients.

Loads at the treatment plants

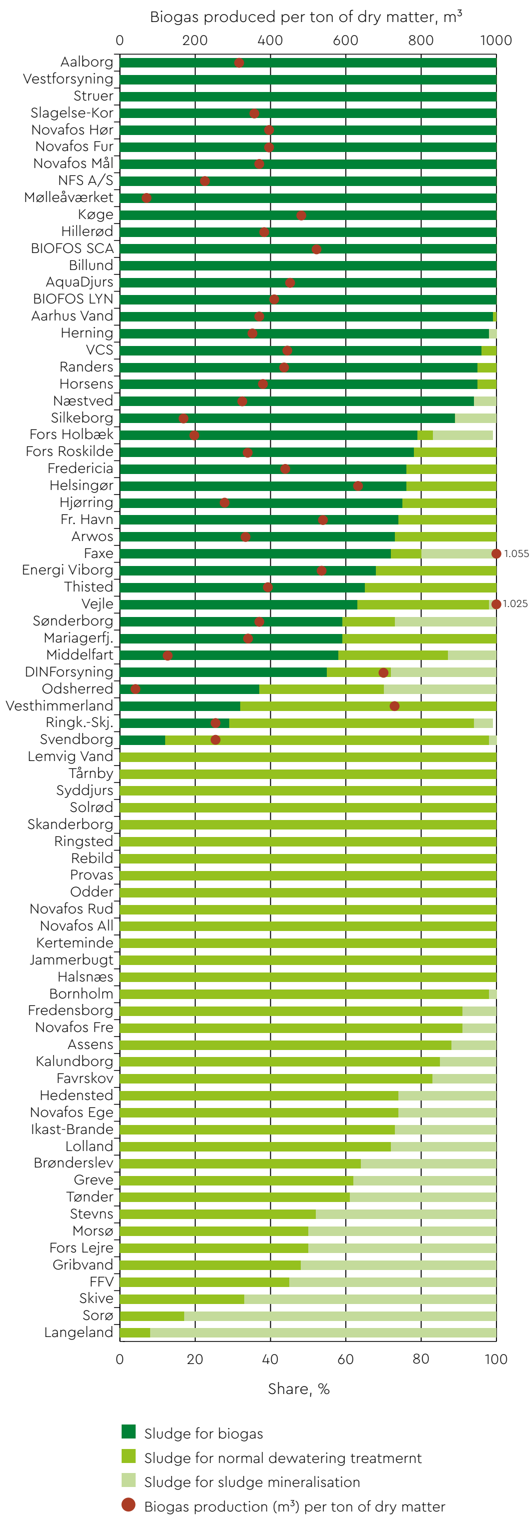
There is a very large variation in the wastewater piped to treatment plants. Companies such as slaughterhouses or breweries emit large quantities of organic matter, and wastewater treatment plants having this kind of industry within their catchment areas have "thick" wastewater. If the treatment plant mainly receives wastewater from residential areas, it is defined as "thin” wastewater. The wastewater load is calculated in person equivalents referred to as PE and is not dependent on the inflow water volume, but on the quantity of nutrients. One person equivalent is defined as the amount one adult contributes in the way of organic biodegradable material (BI5), nitrogen and phosphorus per day. 1 PE corresponds to 60 g of BI5/day, 12 g N/day and 2.7 g P/day. ■

INFLOW FACTOR AND INFLUENT LOAD TO THE TREATMENT PLANTS, 2021

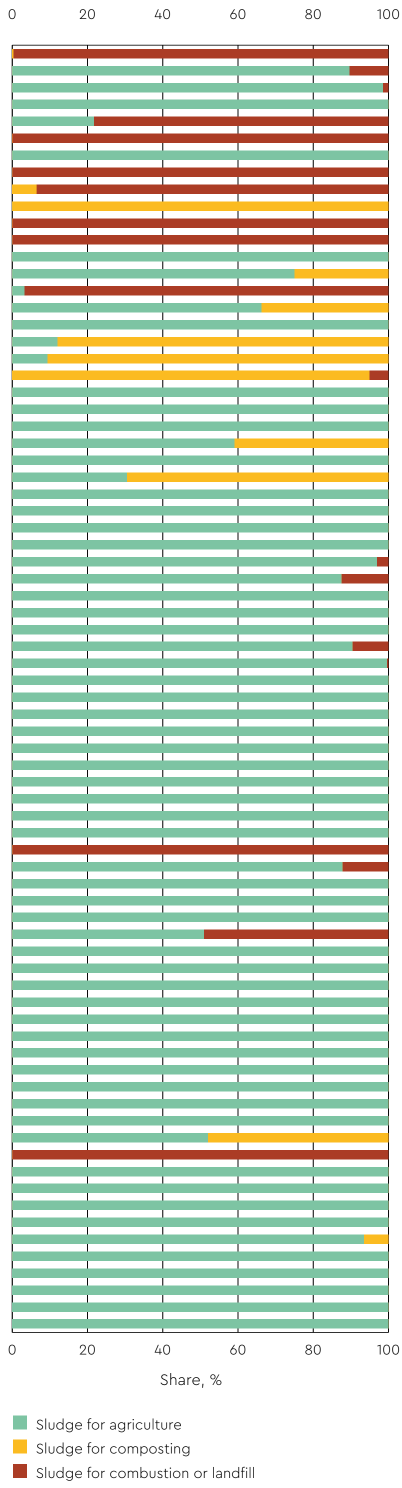


Vandmiljø Randers produces biogas in their decomposition towers.
Photo: Vandmiljø Randers

SLUDGE TREATMENT, 2021



SLUDGE DISPOSAL, 2021



Companies' **sludge treatment**

After wastewater has been treated, the company is left with the biological sludge, which is a surplus product from the treatment.

Internal sludge treatment

The companies' excess sludge can be divided into three groups:

- Sludge that only undergoes ordinary dewatering (normal treatment).
- Sludge that is used for the production of biogas and is subsequently drained.
- Sludge that is driven directly to sludge mineralisation beds that are normally emptied once every ten years.

Sludge disposal

Danish companies dispose of approx. 123,000 tonnes of solid matter (The Utility Secretariat, 2021 Report). As a rule, dewatered sludge is disposed of according to one of three categories:

- Sewage sludge that can be spread on agricultural land (A-sludge).
- Sewage sludge that must be further treated, e.g., by composting before recycling (B-sludge). The reason for this is usually excessive levels of pesticides, which can be reduced by e.g. composting.
- Sewage sludge that is landfilled or incinerated (C-sludge). This may be due, for example, to excessive heavy metals in the sludge.

Expenses

Sludge treatment at treatment plants on average stands at about 25 % of the operating costs of internal sludge treatment and disposal, which is in turn split into 12 % for internal treatment and 13 % for the removal of the sludge. For wastewater companies without biogas plants, the average is around 24 % of operating costs, and for companies with biogas plants, it is 25 % of operating costs ■

Sønderborg Forsyning's new waterworks in Gråsten. Photo: Sønderborg Forsyning

The value of **benchmarking**

Benchmarking is a process where you measure your own performance against equivalent companies.

Benchmarking is defined as a comparison between like-minded in order to find good practice in the area and get an overview of one's performance and, in particular, of how to make selected areas more efficient. The comparison across provides an opportunity to learn from the best people in the class and exchange knowledge in specific areas.

Benchmarking provides:

- A good overview of your own business by means of deeper understanding of internal procedure and working processes. Statements of key figures often provide food for thought about what it looks like and how we do what we do.
- Overview and comparisons with the other participants on service targets and key ratios as well as regulatory parameters that focus on performance and potential for development and efficiency improvement
- It can be the foundation for meaningful dialogues about which changes can move the company in a desired direction.

DANVA Benchmarking

DANVA Benchmarking was launched in 2003, where 8 companies got together, united in their desire to create a common comparison system. This developed into DANVA Benchmarking, which introduced the first reporting platform, BESSY, in 2003.

Nowadays, 2 participant levels are offered — a large "Benchmarking" package with approx. 250 questions and a small "Statistics" package with approx. 75 questions. The number of participants in 2022 includes 77 drinking water companies and 91 wastewater companies.

It has become particularly clear that it has been highly worthwhile for the industry to have benchmarked itself for many years prior to the adoption of the Danish Water Sector Reform Act and the financial benchmarking that would be developed in 2010. There were good grounds to test and evaluate the various proposals for the regulation.

DANVA Benchlearning

DANVA is developing ongoing benchlearning courses for the participants in its benchmarking project. The goal is to go one step deeper and help companies utilise data to identify development potentials and implement measures to realize these. The courses have been held as workshops with typically 6 to 8 companies registered for each. They are based on the individual companies' own figures/performance. This means the lessons from the individual courses can then be used directly in the companies. Another learning angle is naturally the exchange of experience among the participating companies, and courses are designed to focus on this form of knowledge sharing/sparring. Great importance is also attached to dialogue between the companies' finance and technical departments about what results in the best solutions for the companies. This increases understanding between different departments of the companies with a view to optimising procedures. Some of the benchlearning courses DANVA Benchmarking has held include: "Effective investments", "What drives costs for the sewer network and a drinking water company, respectively?" and "What drives the costs for drinking water in the sewers?" ■

NO MORE GUESSING:
Model can calculate the costs of various types of water in the sewers

Thanks to a detailed Excel model, the water company Provas has found out why their benchmarks look so mystic. And at the same time, they have been given an answer if it can pay off to shut down a small treating plant and pump the water into the central sewer treatment plant.

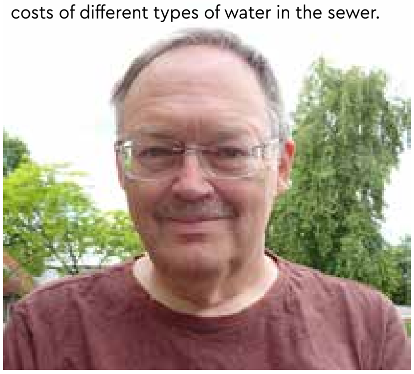
Should we close down a small treatment plant and pump the sludge from a village via new pipes to the central sewer treatment plant in the city? Or is it cheaper to keep the life in the small treatment plant? The answer took Claus Kofoed Pedersen, planning engineer at the Provas utility, by surprise. He had not expected that it could pay off to install new pipes all the way from a remote village and to pump wastewater into Vojens rather than keep the village treatment plant.

"We did not believe that it could pay off to close down the treatment plant, so this was a huge surprise," explains Claus Kofoed Pedersen.

It was no crystal ball that gave him the answer, but rather a detailed spreadsheet with a model of what it costs to handle the various types of water in the sewers. The model has been prepared by DANVA Benchmarking in close cooperation with a number of wastewater companies. And when you have procured data for the costs of operation and depreciation as well as water volumes in the sewer, the spreadsheet can provide an answer about the costs that are associated with different solutions. For example, costs of handling wastewater, stormwater in the shared sewer, stormwater in the separate sewer as well as extraneous water.

"It is quite new to be able to say with big certainty now what the last cubic metre of water in the sewer costs. And we can now calculate how much we save by disconnecting stormwater. We can also see how the price develops if more and more water enters our treatment plant. This is something we have never known before. We only guessed," says Claus Kofoed Pedersen.

Claus Kofoed Pedersen from Provas sees great advantages in the smart model comparing costs of different types of water in the sewer.



Benchmarks looked mystic

A prerequisite for ensuring that the model will give correct answers is the correctness of the data, and this required a bit of clean-up work.

The entire thing kicked off with some genuine puzzlement about the company's benchmarks at Provas — i.e., how the company manages in relation to other companies on a range of different parameters.

"In some places, we were very expensive, and in others, extremely cheap. It looked mystic. And so we had to find out where these inaccuracies originated," says Claus

It turned out that various costs were incorrectly entered.

"For example, a stormwater basin lying at the side of a pumping station was entered in the pumping station. We have found a number of things that would have to be redone," explains Claus Kofoed Pedersen.

Eventually, the company fixed the errors, and the expenses are now entered correctly. This would result in significantly more accurate benchmarks. At the same time, Provas has by far boosted its data quality and exact knowledge of what drives costs, which is a prerequisite for the Excel model giving as accurate calculations as possible. ■

Strong decision-making basis for investments

DANVA Benchmarking has developed an Excel model to calculate the costs associated with the management of the various types of water: wastewater, stormwater in separate sewer, rainwater in shared sewer as well as extraneous water. Both in relation to operating costs and investment costs (depreciation) associated with the management of the four types of water.

The purpose of knowing the costs of handling the four types of water is to enable companies to make investment decisions on an objective basis.

The spreadsheet could also — with minor adaptation of, among other things, fixed/variable costs — be used to give specific inputs for business cases for investment opportunities such as, for example, separation, centralisation of wastewater purification, new treating facilities and suchlike.

DRINKING WATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2022 (DATA FOR 2021)

	BASIC DATA					
	Residents in the utility district	Total quantity of water sold (Utility company definition)	Boreholes (water abstraction)	Waterworks	Hardness of extracted water	Supply pipes
Company	persons	m³/year	number	number	dH	km
Arwos Vand A/S	16,896	1,218,783	12	3	11.5	274
Assens Vandværk A/S	8,400	623,131	11	2	15.0	136
Billund Drikkevand A/S	7,393	585,003	9	1	8.4	159
Bornholms Vand A/S	20,000	1,260,742	28	4	15.0	626
Brønderslev Vand A/S	15,600	893,850	12	3	11.2	339
DIN Forsyning Vand A/S	118,800	8,468,319	74	10	7.4	1,489
Energi Viborg Vand A/S	70,067	2,395,683	12	4	8.0	583
Faxe Vandforsyning A/S	12,040	1,788,192	4	3	17.0	282
FFV Vand A/S	9,191	603,802	8	2	18.0	214
Fors Vand Holbæk A/S	42,505	2,293,801	14	2	15.0	216
Fors Vand Lejre A/S	6,185	235,574	3	1	23.6	88
Fors Vand Roskilde A/S	84,259	3,426,819	14	3	19.0	361
Forsyning Helsingør Vand A/S	59,102	2,740,121	26	4	14.2	427
Fredensborg Vand A/S	40,828	1,827,612	11	2	14.0	282
Frederiksberg Vand A/S	103,608	4,925,812	5	1	28.9	166
Frederikshavn Vand A/S	56,000	4,317,700	105	5	8.0	1,239
GEV vand A/S	11,987	1,166,225	11	2	6.7	263
Give Vandværk A.m.b.a	5,000	295,201	5	1	7.2	94
Glostrup Vand A/S	23,514	1,369,248	14	2	23.0	97
Halsnæs Vand A/S	14,416	711,244	11	2	19.0	103
Herning Vand A/S	44,380	3,277,318	22	3	8.0	737
Hillerød Vand A/S	32,045	1,758,429	12	3	15.8	186
Hjørring Vandselskab A/S	40,000	3,124,289	39	4	12.6	882
HOFOR Vand Albertslund A/S	27,586	1,248,718	3	1		104
HOFOR Vand Brøndby A/S	35,264	1,831,692	12	1		161
HOFOR Vand Dragør A/S	14,235	664,068	3	2		88
HOFOR Vand Herlev A/S	28,675	1,522,493	0	0		119
HOFOR Vand Hvidovre A/S	53,008	3,082,147	1	1		208
HOFOR Vand København A/S	618,722	51,215,365	434	7		1,167
HOFOR Vand Rødovre A/S	39,791	1,813,158	4	2		122
HOFOR Vand Vallensbæk A/S	12,269	459,509	0	0		46
Horsens Vand A/S	72,980	4,155,320	25	4	14.0	500
Ikast Vandforsyning A.m.b.A	16,500	808,175	9	2	8.0	282
Ishøj Vand A/S	23,225	1,143,546	5	1	21.0	104
Kalundborg Vandforsyning A/S	16,650	3,269,860	28	4	15.0	357
Kerteminde Forsyning – Vand A/S	10,200	896,913	17	2	12.0	257
Køge Vand A/S	33,121	1,641,522	14	2	21.0	247
Langeland Vand ApS	8,775	775,930	21	3	21.0	379
Lemvig Vand A/S	16,000	2,004,834	12	2	7.0	794

PROCESS BENCHMARKING (OVERALL KEY FIGURES)						Tariffs 2022 (Level 1)		
Actual operating costs for production, distribution, customer management and general administration in relation to the billed volume of water flow	Operating costs related to production, in relation to pumped self-produced water from own works	Operating costs related to distribution in relation to the amount of water billed from the company's own supply area	Operating costs related to customer management in relation to the number of water meters	Operating costs related to general administration in relation to the amount of water billed	Implemented investments and renovations	Fixed annual charge, incl. VAT	Variable water fee, incl. VAT and other taxes	Charges with a consumption of 100 m³/year
€/m³ sold	€/produces m³	€/m³ sold	€/watermeters	€/m³ sold	€/m³ sold	€	€/m³	€/year
0.55	0.08	0.36	5.57	0.08	0.82	168.01	1.49	317.07
0.87	0.38	0.23	14.41	0.18	1.19	89.89	2.66	356.15
0.59					0.36	102.32	1.85	287.67
1.16	0.31	0.38	9.42	0.37	0.62	167.84	2.22	389.48
0.77					1.51	108.87	2.24	332.66
0.55	0.26	0.12	24.85	0.07	0.44	134.41	1.98	332.66
0.63					1.24	105.01	1.67	272.48
0.47					0.19	19.49	2.79	298.12
1.08					0.73	117.61	2.45	362.37
0.66	0.22	0.21	5.27	0.23	1.18	84.01	1.72	255.91
1.32					1.16	84.01	2.84	368.41
0.89	0.22	0.32	6.43	0.35	0.22	84.01	2.66	350.00
0.89					0.75	92.36	2.85	377.17
0.34	0.12	0.10	4.45	0.14	0.61	34.14	2.35	269.36
0.84	0.31	0.36	73.48	0.25	1.19	49.73	2.89	338.84
0.93	0.30	0.40	17.28	0.09	1.58	75.60	2.21	296.71
0.66	0.21	0.13	46.77	0.12	0.31	28.10	1.93	220.84
0.92					0.98	92.91	1.91	283.90
0.60					2.46	38.00	2.59	296.74
0.76	0.16	0.25	0.25	0.29	1.98	132.75	2.48	380.87
0.60	0.24	0.30	8.09	0.01	0.56	108.66	1.67	276.13
0.82					0.66	89.35	2.46	335.46
0.75	0.33	0.19	8.13	0.15	0.76	164.99	2.06	371.17
0.91					1.95	13.44	3.01	314.52
0.76					0.53	16.80	3.49	366.13
1.08					3.27	59.29	3.27	385.91
0.72					1.13	–	3.06	306.45
0.74					0.96	–	2.63	262.90
0.58					0.78	64.52	2.37	301.75
0.90					0.55	–	2.94	293.68
0.57					0.44	16.80	2.84	300.81
0.55					0.44	129.37	1.91	320.36
0.77					2.51	88.21	2.19	307.02
0.51					5.72	33.33	2.50	283.74
0.46	0,44	0,10	23,62	0,08	0.85	–	3.02	423.35
0.96	0.40	0.36	23.81	0.10	0.97	106.85	2.37	343.41
0.63	0.22	0.28	7.42	0.08	0.66	69.39	2.77	346.14
1.07					0.60	134.76	1.84	318.36
0.45					0.17	126.17	2.25	351.43

DRINKING WATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2022 (DATA FOR 2021)

	BASIC DATA					
	Residents in the utility district	Total quantity of water sold (Utility company definition)	Boreholes (water abstraction)	Waterworks	Hardness of extracted water	Supply pipes
Company	persons	m^3/year	number	number	dH	km
Lolland Vand A/S	23,562	1,596,048	32	4	19.0	768
Lyngby-Taarbæk Vand A/S	56,614	2,865,470	9	2	16.7	261
Mariagerfjord Vand a/s	15,000	1,524,763	10	4	9.0	357
Midtfyns Vandforsyning A.m.b.a.	16,500	1,811,594	13	5	17.0	445
Morsø Vand A/S	9,283	525,723	9	2	12.5	121
NFS A/S	18,815	1,172,569	21	2	18.7	174
NK-Forsyning A/S	46,000	2,142,474	16	2	16.0	687
Novafos Vand Ballerup A/S	49,574	3,117,359	10	4	18.0	275
Novafos Vand Egedal A/S	16,500	673,182	9	1	23.0	156
Novafos Vand Frederikssund A/S	27,000	1,364,092	23	5	17.0	324
Novafos Vand Gentofte A/S	74,217	3,690,650	22	1	21.0	302
Novafos Vand Gladsaxe A/S	69,259	3,542,921	9	2	20.0	224
Novafos Vand Hørsholm A/S	24,761	1,285,329				155
Novafos Vand Rudersdal A/S	34,348	1,593,843	13	3	21.0	210
Novafos Vand Sjælsø A/S	0	8,907,392	43	1	18.0	32
Odder Vandværk a.m.b.a.	16,852	906,739	9		15.0	203
Odsherred Vand A/S	5,375	401,310	11	3	17.0	220
Provas-Haderslev Vand A/S	25,876	1,509,311	14	3	11.6	408
Ringkøbing – Skjern Vand A/S	36,500	3,604,780	28	5	7.6	1.244
Ringsted Vand A/S	27,636	1,818,924	13	4	17.0	455
Silkeborg Vand A/S	58,895	2,655,102	14	3	4.5	602
SK Vand A/S	70,000	3,508,344	46	4	18.0	728
Skanderborg Forsyning A/S	19,925	1,101,225	11	5	13.9	293
Skive Vand A/S	32,745	2,578,326	28	9	10.0	719
Sorø Vand A/S	10,000	510,812	8	1	19.0	253
Struer Energi Vand A/S	15,663	943,128	12	3	6.3	268
Svendborg Vand A/S	42,547	1,948,517	24	5	20.0	463
Sønderborg Vandforsyning A/S	36,555	2,167,107	21	6	15.0	369
Thisted Vand A/S	32,613	3,296,665	34	8	13.0	915
TREFOR Vand A/S	147,000	10,826,751	76	10	14.0	1.466
Tønder Vand A/S	24,310	1,587,509	12	4	11.0	553
TÅRNBYFORSYNING Vand A/S	42,723	2,673,586	10	1	19.0	191
VandCenter Syd as	177,232	9,590,939	41	5	16.0	1.067
Verdo Vand A/S	60,000	2,366,895	22	4	12.5	374
Vestforsyning Vand A/S	44,531	3,459,312	26	5	11.5	1.115
Vesthimmerlands Vand A/S	545	52,852	7	5	7.0	48
Aalborg Vand A/S	133,798	7,012,442	56	12	13.0	717
Aarhus Vand A/S	296,144	14,600,542	87	9	16.0	1.503

PROCESS BENCHMARKING (OVERALL KEY FIGURES)						Tariffs 2022 (Level 1)		
Actual operating costs for production, distribution, customer management and general administration in relation to the billed volume of water flow	Operating costs related to production, in relation to pumped self-produced water from own works	Operating costs related to distribution in relation to the amount of water billed from the company's own supply area	Operating costs related to customer management in relation to the number of water meters	Operating costs related to general administration in relation to the amount of water billed	Implemented investments and renovations	Fixed annual charge, incl. VAT	Variable water fee, incl. VAT and other taxes	Charges with a consumption of 100 m³/year
€/m³ sold	€/produces m³	€/sold m³	€/watermeters	€/m³ sold	€/m³ sold	€	€/m³	€/year
0.86	0.34	0.26	7,62	0.16	1.06	128.53	3.30	458.64
0.50	0.36	0.26	6,40	0.09	6.96	–	3.08	308.33
0.49					0.05	90.98	1.72	262.89
0.51					0.45	107.53	1.83	290.19
0.58	0.19	0.20	11,26	0.09	0.68	105.01	1.87	292.37
0.68					0.49	84.01	2.10	294.35
0.80	0.18	0.25	0,00	0.34	0.68	119.41	2.31	350.06
0.58					0.84	–	2.86	285.62
0.65					1.67	–	3.47	347.45
0.84					2.12	114.25	2.63	377.02
0.67					1.68	–	2.55	254.70
0.59					2.58	–	3.11	311.16
0.44					1.47	–	3.13	312.50
0.89					2.50	–	2.74	274.19
0.19					0.66			
0.88					0.41	134.41	2.41	375.81
1.25					2.49	191.53	1.77	368.41
1.31	0.37	0.79	3,12	0.09	2.12	122.47	2.48	370.58
0.31					0.89	205.14	2.06	411.46
0.44	0.18	0.13	18,74	0.04	1.20	24.94	2.52	276.82
0.84					0.91	105.85	1.91	296.84
0.88					0.43	134.41	2.18	352.55
0.78	0.35	0.12	10,55	0.22	0.88	99.13	2.25	323.72
0.40	0.17	0.07	9,17	0.10	0.75	100.81	2.18	318.68
0.74					2.29	77.97	2.84	361.57
0.84	0.25	0.23	6,78	0.29	0.76	90.89	1.83	273.56
0.88	0.30	0.34	1,02	0.21	0.74	116.26	2.41	357.66
0.51					0.58	74.60	2.31	305.24
0.42	0.15	0.19	2,17	0.05	0.83	105.51	2.14	319.62
0.80	0.21	0.14	38,67	0.25	0.90	168.01	2.39	406.99
0.75	0.22	0.27	16,54	0.17	0.28	146.37	2.54	400.13
0.48	0.43	0.28	22,26	0.08	0.51	36.57	2.65	265.05
0.62	0.29	0.25	5,29	0.06	0.26	80.65	2.33	313.71
0.75	0.13	0.23	14,47	0.30	1.07	93.25	1.81	274.56
0.74	0.22	0.23	15,15	0.18	0.57	128.70	2.07	335.82
1.21					0.25	85.69	2.11	296.84
0.72	0.20	0.26	7,04	0.23	0.70	180.61	2.22	402.25
0.72	0.19	0.31	10,65	0.16	0.85	92.41	2.58	350.47

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2022 (DATA FOR 2021)

	BASIC DATA					
	Residents in the utility district	Sewer pipes (wastewater and stormwater)	Billed amount of water (Utility company definition)	Treatment plant over 30 PE	Volume of intake water to treatment plant	Total organic load
Company	persons	km	m³/year	number	m³/year	PE, person equivalents
AquaDjurs A/S (Spildevand)	36,279	1,156	2,019,660	2	4,641,008	57,688
Arwos Spildevand A/S	53,000	1,579	2,553,876	7	6,544,896	67,907
Assens Spildevand A/S	35,075	1,478	1,759,545	8	4,685,305	60,910
Billund Spildevand A/S	22,323	501	1,589,445	5	4,937,063	68,299
BIOFOS Lynettefællesskabet A/S		0	44,775,841	2	89,526,296	1,213,759
BIOFOS Spildevandscenter Avedøre A/S	261,000	57	13,062,889	1	25,173,755	389,724
Bornholms Spildevand A/S	30,000	859	1,783,183	7	7,027,765	72,392
Brønderslev Spildevand A/S	29,000	633	1,287,566	4	3,715,232	29,149
DIN Forsyning Spildevand A/S	169,628	2,760	8,912,719	15	25,734,339	299,462
Energi Viborg Spildevand A/S	83,600	2,081	4,016,075	12	10,109,713	97,172
Favrskov Forsyning A/S	43,100	1,123	1,830,155	6	3,833,315	42,632
Faxe Spildevand A/S	31,385	682	2,154,096	5	5,019,888	41,913
FFV Spildevand A/S	51,683	1,287	2,372,058	8	8,561,283	56,612
Fors Spildevand Holbæk A/S	71,913	1,263	3,134,320	8	5,318,259	70,920
Fors Spildevand Lejre A/S	28,173	623	1,102,391	7	2,147,390	21,811
Fors Spildevand Roskilde A/S	88,897	1,113	3,991,329	4	8,294,952	92,321
Forsyning Helsingør Spildevand A/S	60,500	679	2,912,841	3	7,015,816	61,033
Fredensborg Spildevand A/S	39,566	663	1,840,331	3	3,021,138	26,093
Fredericia Spildevand og Energi A/S	51,500	1,057	4,699,000	1	9,224,064	149,945
Frederiksberg Spildevand A/S	103,608	187	4,818,970		0	0
Frederikshavn Spildevand A/S	56,848	1,144	3,683,857	9	10,903,327	299,638
Glostrup Spildevand A/S	23,513	199	1,423,016		0	0
Greve Spildevand A/S	50,630	762	2,276,291	1	5,037,035	56,065
Gribvand Spildevand A/S	48,534	1,047	1,988,182	8	6,577,296	51,172
Halsnæs Spildevand A/S	29,717	614	1,378,880	2	3,424,823	31,163
Hedensted Spildevand A/S	34,380	1,144	1,897,950	5	5,562,604	47,300
Herning Vand A/S	81,420	1,586	4,135,624	11	12,473,218	188,782
Hillerød Spildevand A/S	51,307	681	2,653,107	6	7,145,665	48,157
Hjørring Vandselskab A/S	52,000	1,451	3,133,745	9	8,713,611	159,827
HOFOR Spildevand Albertslund A/S	27,728	392	1,240,215		0	0
HOFOR Spildevand Brøndby A/S	35,264	253	1,813,061		0	0
HOFOR Spildevand Dragør A/S	14,235	178	643,947	1	1,790,530	11,035
HOFOR Spildevand Herlev A/S	28,675	200	1,625,614		0	0
HOFOR Spildevand Hvidovre A/S	53,267	384	2,994,281		0	0
HOFOR Spildevand København A/S	618,797	1,353	30,277,139		0	0
HOFOR Spildevand Rødovre A/S	39,791	215	1,771,200		0	0
HOFOR Spildevand Vallensbæk A/S	16,596	167	642,987		0	0

PROCESS BENCHMARKING (OVERALL KEY FIGURES)						TARIFFS 2022 (Level 1)		
Actual operating costs for transport, treatment and customer management in terms of volume of water billed	Operating costs related to transport in relation to the amount of water billed in the sewer system's catchment area	Operating expenses related to purification treatment in relation to the amount of water charged in the purification treatment plant's catchment area	Operating costs related to customer management in relation to the number of water meters	Operating costs related to general administration in relation to the amount of water billed	Implemented investments and renovations	Fixed annual charge, incl. VAT	Variable charge, incl. VAT and taxes	Charges with a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water meter	€/m³ sold	€/m³ sold	€	€/m³	€/year
1.66					3.66	108.66	4.37	545.48
1.43	0.36	0.71	21.88	0.16	4.81	102.49	7.64	866.06
2.23	0.93	0.79	22.65	0.34	2.62	107.53	8.40	947.58
2.19					1.73	108.53	6.38	746.98
0.51					0.11			
0.66					0.35			
1.95	0.55	0.91	3.73	0.45	2.37	94.09	5.44	637.77
1.82	0.47	0.90	4.60	0.41	2.29	0.00	6.11	610.89
1.22	0.37	0.70	15.03	0.06	3.13	108.53	4.51	560.01
1.71					4.66	0.00	6.05	604.84
1.64					3.56	84.01	5.58	641.80
1.87					1.79	85.36	7.58	843.56
1.70					3.68	87.37	6.62	749.33
2.16	0.59	0.88	9.92	0.62	0.86	105.34	5.36	641.50
4.47	1.73	1.74	10.57	0.90	0.35	105.34	7.00	805.61
2.39	0.69	0.97	10.58	0.67	0.57	105.36	4.94	599.17
1.93					1.00	108.66	4.87	595.49
1.02	0.26	0.66	4.19	0.20	0.71	0.00	5.47	546.91
1.11	0.32	0.51	8.76	0.24	1.48	58.80	4.91	550.20
0.63	0.36		56.84	0.21	0.45	0.00	2.96	296.37
2.20	0.68	1.35	5.15	0.16	3.37	108.70	6.71	779.94
0.77					7.54	0.00	4.47	446.91
1.33	0.52	0.62	16.26	0.08	4.39	0.00	4.20	420.03
2.00	0.59	0.85	22.62	0.23	5.10	108.66	7.22	830.97
2.33	0.85	0.75	8.60	0.64	3.22	105.74	6.64	769.45
2.16	1.00	0.90	16.37	0.10	8.35	108.70	6.55	763.94
1.61	0.68	0.85	7.04	0.01	3.52	108.66	5.54	663.10
2.31					1.21	0.00	7.49	749.33
1.79	0.52	0.80	15.22	0.35	2.43	108.70	6.63	771.47
0.97					1.30	0.00	5.40	540.19
0.66					4.50	0.00	6.06	606.18
2.24					1.30	0.00	5.13	512.90
0.98					0.86	0.00	4.63	463.04
0.71					1.49	0.00	5.60	560.35
0.49					0.62	0.00	2.82	282.12
0.74					0.66	0.00	3.77	377.42
0.64					2.13	0.00	6.28	627.69

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2022 (DATA FOR 2021)

	BASIC DATA					
	Residents in the utility district	Sewer pipes (wastewater and stormwater)	Billed amount of water (Utility company definition)	Treatment plant over 30 PE	Volume of intake water to treatment plant	Total organic load
Company	persons	km	m³/year	number	m³/year	PE, person equivalents
Horsens Vand A/S	94,286	1,681	5,090,305	3	10,584,472	169,216
Ikast-Brande Spildevand A/S	36,000	864	1,862,587	3	5,603,924	38,465
Ishøj Spildevand A/S	23,131	234	1,117,119		0	0
Jammerbugt Forsyning A/S	46,210	1,025	1,802,776	4	4,248,313	60,141
Kalundborg Rens og Spildevand	48,445	981	5,989,206	8	9,060,948	36,227
Kerteminde Forsyning – Spildevand A/S	21,195	587	1,085,977	4	2,542,076	16,529
Køge Afløb A/S	59,073	940	2,614,304	3	5,759,245	111,496
Langeland Spildevand ApS	9,377	533	586,993	8	1,574,500	12,670
Lemvig Vand A/S	19,000	625	1,344,845	3	2,485,595	53,234
Lolland Spildevand A/S	19,318	1,147	2,641,780	30	6,071,192	41,445
Lyngby-Taarbæk Spildevand A/S	56,672	452	2,841,715		0	0
Mariagerfjord Spildevand A/S	30,000	1,165	2,198,527	1	4,906,364	92,438
Middelfart Spildevand A/S	39,603	847	1,608,680	6	6,073,584	43,105
Morsø Spildevand A/S	16,381	700	848,476	3	2,629,881	40,128
Mølleåværket A/S		7	5,277,236	1	11,700,949	109,134
NFS A/S	36,755	715	1,848,966	3	4,532,852	55,496
NK-Forsyning A/S	80,000	1,488	3,171,469	12	9,675,477	63,506
Novafos Måløv Rens A/S		0	2,121,321	1	3,716,067	35,541
Novafos Spildevand Allerød A/S	25,531	366	1,189,392	3	2,575,165	17,792
Novafos Spildevand Ballerup A/S	49,215	458	2,696,511		3,716,067	36,765
Novafos Spildevand Egedal A/S	42,296	688	1,631,944	3	2,351,696	23,273
Novafos Spildevand Frederikssund A/S	43,979	810	2,000,793	6	4,000,821	48,160
Novafos Spildevand Furesø A/S	40,806	436	1,709,236	1	1,597,323	15,210
Novafos Spildevand Gentofte A/S	74,335	493	3,682,061		0	0
Novafos Spildevand Gladsaxe A/S	69,198	379	3,489,108		0	0
Novafos Spildevand Hørsholm A/S	24,739	234	1,827,410	1	3,797,090	32,043
Novafos Spildevand Rudersdal A/S	56,574	519	2,646,500	3	4,043,574	28,787
Odder Spildevand A/S	8,571	522	991,063	2	1,804,300	19,293
Odsherred Spildevand A/S	26,766	821	1,212,389	9	3,022,600	34,697
Provas-Haderslev Spildevand A/S	50,616	1,257	2,366,552	11	7,921,742	53,977
Rebild Vand & Spildevand A/S	24,031	787	1,185,661	11	523,005	8,425
Ringkøbing – Skjern Spildevand A/S	41,000	1,524	2,562,222	10	7,908,303	92,121
Ringsted Spildevand A/S	26,927	793	2,080,617	3	5,227,288	84,896
Silkeborg Spildevand A/S	95,488	1,742	3,983,801	10	7,345,819	97,757
SK Spildevand A/S		1,396	3,439,247	22	7,125,419	130,153
Skanderborg Forsyning A/S	58,698	1,249	2,593,493	5	5,159,787	78,449
Skive Vand A/S	37,717	1,100	1,848,100	5	6,464,177	35,064

PROCESS BENCHMARKING (OVERALL KEY FIGURES)						TARIFFS 2022 (Level 1)		
Actual operating costs for transport, treatment and customer management in terms of volume of water billed	Operating costs related to transport in relation to the amount of water billed in the sewer system's catchment area	Operating expenses related to purification treatment in relation to the amount of water charged in the purification treatment plant's catchment area	Operating costs related to customer management in relation to the number of water meters	Operating costs related to general administration in relation to the amount of water billed	Implemented investments and renovations	Fixed annual charge, incl. VAT	Variable charge, incl. VAT and taxes	Charges with a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water meter	€/m³ sold	€/m³ sold	€	€/m³	€/year
1.24					1.34	108.70	4.61	569.59
1.62					2.60	108.66	5.76	685.00
0.60					1.88	0.00	4.40	440.05
1.78	0.57	1.12	3.53	0.05	2.53	108.60	3.97	505.11
1.16			22.71	0.14	1.07	0.00	7.48	747.72
1.61	0.51	0.93	23.72	0.12	9.17	108.60	5.34	642.88
1.35	0.41	0.81	12.38	0.05	3.92	0.00	6.05	604.84
3.51					1.50	108.66	6.77	785.94
1.52					1.75	110.67	4.86	596.83
1.79	1.10	0.87	13.73	0.15	3.03	108.66	8.67	975.60
0.41	0.32		3.74	0.10	10.56	0.00	4.44	443.95
1.79					5.66	90.98	5.92	682.51
1.99	0.41	1.06	11.25	0.39	2.66	60.48	7.03	763.58
2.46	0.98	1.15	13.40	0.19	2.31	108.66	7.06	814.31
0.68		0.55	7.684.11	0.10	0.93			
1.70					2.43	84.01	6.17	701.48
1.68	0.56	0.68	0.00	0.44	4.17	126.01	7.09	834.74
0.74					0.16			
1.58					2.46	0.00	6.30	629.70
0.38					1.92	0.00	4.64	463.71
1.35					3.67	0.00	5.74	573.92
1.64					2.47	100.13	6.54	754.03
1.29					1.25	0.00	6.06	606.18
0.37					11.74	0.00	5.65	565.19
0.63					9.88	0.00	4.06	405.91
1.09					1.60	0.00	5.70	569.89
1.30					1.33	0.00	4.57	456.99
1.44					1.29	108.70	4.84	592.57
2.46					12.52	104.17	6.59	762.77
2.44	1.13	1.17	3.62	0.11	2.58	108.66	7.04	813.10
1.37					5.42	108.66	6.47	755.84
1.63					4.40	108.20	6.37	745.03
2.15	1.42	1.02	19.17	0.09	4.98	0.00	7.95	794.62
1.68					3.46	105.85	4.87	593.08
2.19					1.44	102.99	6.05	707.83
2.02	0.46	0.94	18.47	0.50	5.83	92.41	5.80	672.11
2.05	1.03	0.75	7.77	0.26	5.43	100.81	5.68	668.68

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2022 (DATA FOR 2021)

	BASIC DATA					
	Residents in the utility district	Sewer pipes (wastewater and stormwater)	Billed amount of water (Utility company definition)	Treatment plant over 30 PE	Volume of intake water to treatment plant	Total organic load
Company	persons	km	m^3/year	number	m^3/year	PE, person equivalents
Solrød Spildevand A/S	23,566	364	967,767	1	1,849,044	18,582
Sorø Spildevand A/S	21,000	416	1,041,804	5	2,521,545	21,699
Stevns Spildevand A/S	20,914	565	889,944	4	1,894,892	21,368
Struer Energi Spildevand A/S	19,080	506	863,042	3	2,167,291	20,482
Svendborg Spildevand A/S	58,325	1,073	2,687,356	6	7,785,673	73,808
Syddjurs Spildevand A/S	36,000	1,030	1,665,739	10	3,078,131	38,490
Sønderborg Spildevandsforsyning A/S	73,806	1,647	3,302,464	5	7,365,888	70,554
Thisted Vand A/S	58,303	1,030	2,575,959	5	6,427,245	149,895
Tønder Spildevand A/S	29,304	1,072	1,847,619	17	5,185,155	36,002
TÅRNBYFORSYNING Spildevand A/S	42,723	266	1,993,533	1	4,857,999	43,007
VandCenter Syd as	234,169	2,874	11,243,355	7	31,906,225	324,614
Vandmiljø Randers A/S	92,664	1,930	4,549,860	4	9,307,625	107,646
Vejle Spildevand A/S	104,313	2,278	5,347,363	8	16,043,318	162,246
Vestforsyning Spildevand A/S		1,334	3,626,039	6	7,572,750	111,969
Vesthimmerlands Vand A/S	29,838	1,069	2,017,831	3	3,228,615	103,800
Aalborg Kloak A/S	214,087	2,624	11,034,807	2	24,747,655	264,722
Aarhus Vand A/S	346,734	3,722	15,921,698	4	30,772,824	377,968

Wastewater treatment plant at the Fors company. Photo: Fors

PROCESS BENCHMARKING (OVERALL KEY FIGURES)						TARIFFS 2022 (Level 1)		
Actual operating costs for transport, treatment and customer management in terms of volume of water billed	Operating costs related to transport in relation to the amount of water billed in the sewer system's catchment area	Operating expenses related to purification treatment in relation to the amount of water charged in the purification treatment plant's catchment area	Operating costs related to customer management in relation to the number of water meters	Operating costs related to general administration in relation to the amount of water billed	Implemented investments and renovations	Fixed annual charge, incl. VAT	Variable charge, incl. VAT and taxes	Charges with a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water meter	€/m³ sold	€/m³ sold	€	€/m³	€/year
1.66	0.52	0.76	12.93	0.28	1.65	0.00	5.38	537.63
2.06					1.76	89.10	7.10	799.45
2.35	0.67	0.97	12.24	0.58	5.12	101.31	7.58	859.11
2.00	0.61	1.13	5.70	0.19	3.79	0.00	5.71	571.24
1.78	0.55	1.07	2.92	0.14	1.04	54.44	5.78	632.39
2.05					3.51	108.67	7.60	868.48
1.73					3.55	0.00	6.65	665.32
1.91	0.67	1.09	1.49	0.14	2.90	108.66	5.83	691.32
2.12	0.93	0.82	13.33	0.32	3.17	86.29	6.45	731.45
1.46	0.59	0.75	7.47	0.04	1.83	0.00	4.07	407.12
1.43	0.49	0.71	13.44	0.13	2.66	0.00	4.83	483.06
1.40	0.48	0.60	16.05	0.24	5.64	100.17	5.12	612.00
1.55					3.36	109.56	5.38	647.19
1.79	0.64	0.72	11.90	0.36	3.14	107.99	5.26	633.66
1.91					2.65	104.50	6.68	772.24
1.19	0.62	0.55	17.41	0.03	2.22	108.62	4.03	511.85
1.00	0.24	0.48	5.75	0.24	2.21	84.01	3.92	476.34

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DANVA

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KEY FIGURES, 2021

- ½ litre of water costs 0,5 cent.
- The average consumption of water in Danish households is 105 litres per person/per day.
- The actual operating expenses of the drinking water companies are on average € 0.65 per m³ sold, and the investments implemented amount to € 0.95 per m³ sold.
- The actual operating expenses of the wastewater companies are on average € 1.53 per m³ sold, and the investments implemented amount to € 2.92 per m³ sold.
- Electricity consumption (purchased electricity) for 1,000 litres of water pumped from the ground, delivered to the consumer and drawn from the tap amounts to an average of 0.41 kWh. Transport, purification/treatment and drainage of water to the recipient use an average of 1.39 kWh. Collectively, this results in purchased consumption of electricity of 1.80 kWh. If the number is offset by the electricity that the companies produce themselves, the net consumption of electricity amounts to 1.53 kWh per 1,000 l.
- An average family of 2.12 people annually uses 81.34 m³ of water, the net cost of which is 1.53 kWh/m³ in electricity consumed by the drinking water company and the wastewater company. This means that a family's annual "greenhouse gas" emissions based on the amount of electricity used to cover its water consumption is equivalent to 14.7 kg of CO_2.