DANVA

WATER IN FIGURES

2019

TEXT: CARL-EMIL LARSEN/ PHOTO: DANVA

Wastewater heat pumps take heat production to a new level

Water companies act efficiently and create value for households and industry. This document shows the water sector's key figures compiled by DANVA in "Water in figures 2019". We will also review relevant topics including how water companies are starting to use water as hydroelectric power plants to generate CO_2-neutral energy, which benefit consumers and the Danish climate change plan.

For example, Kalundborg Forsyning's new heat pumps pull heat out of the wastewater, giving a net energy gain of just under 8 kWh per m³ of water sold through consumers. Morsø Forsyning has installed a heat pump on their water tower that produces heat for the district heating network while drinking water is cooled 3-4 degrees before it is delivered to consumers.

The use of wastewater and drinking water has been turbocharged to create electricity, gas and heat in the Danish water sector. There is tremendous potential in the methods the Danish water companies are using, which can not only help meet Denmark's ambitious target of reducing greenhouse gas emissions by 70% by 2030, but can also create a market-leading asset in the export market.

The Danish water companies act on their own accord to reach ambitious goals and provide their core services at stable prices, which means that a household's water costs represent only 1.4% of an average household's annual expenses. The total annual cost of drinking water and wastewater is € 771 for an average family. The average water price has increased by only 0.94% from € 9.23 to € 9.32. It is less than the general net price trend for society as a whole, which from 2017 to 2018 increased by more than 1%.

Moreover, the small change in the price trend has to be seen in the context of the implementation of the "Three-Step Tariffs Model", which led to cheaper wastewater prices for large consumers, and was during 2018 fully phased in. As a consequence of the discount scheme for major consuming industries, the average water price for the ordinary citizen in 2018 was 4.7% higher than if the Three-Step Tariffs Model had not been introduced.

Another anomaly in the year's key figures is that for the first time in many years, Danes used more water than the previous year. As is widely known, Denmark was hit by massive drought in the summer of 2018. High evaporation rates meant that the Danes filled their swimming pools and watered their gardens more than usual. On the other hand, in 2017 Danes broke the water conservation record, using only 103 litres on average a day; in 2018 that figure increased to 105 litres.

Denmark is the world leader in low water loss. 7.22% of drinking water did not reach customers in 2017. That figure had increased to 8.05% in 2018. This increase can also be related to last year's hot summer in Denmark, when the water companies experienced more ruptures than usual as a result of the soil being affected by the heat and creating more stress around the water pipes that caused several ruptures and resulted in water loss.

The key figures also show that Danes have access to tap water almost 24 hours a day, 365 days of the year. Danes, on average, are without access to water for only 35 minutes out of the 525,600 minutes in the year, which means they have access to water 99.99% of the time.

In other words, the water companies act optimally and exactly as dictated by the policy coming down from Christiansborg, the Danish Parliament. Therefore, it would be logical to prioritize the easing of the bureaucratic burden on the water sector, which devotes considerable resources to comply with documentation from authorities. If the tariffs are reasonable, the targets are met, and water customers are satisfied, politicians should work to create a less zealous, resource-dependent bureaucratic system, which, after all, results in nothing but higher costs and higher water prices.

Water and wastewater are one of the most important foundations of our societal structure. This responsibility will not decrease in the future. DANVA's benchmarking shows that the water companies, with their targeted, efficient management, fully meet the expectations of customers, authorities and regulators. ■

DANVA and DANVA Benchmarking

DANVA, the Danish Water and Wastewater Association, is an industry organisation for drinking water 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 DANVA Statistics form the basis for the preparation of this publication. In total, 157 drinking water and wastewater companies have participated in the reporting to "Water in figures 2019", with data from 2018. The participating drinking water companies collectively supply water to 60% of the Danish population. Collectively, the participating wastewater companies receive and process water from 80% of the Danish population.

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

Last summer's **drought affected water consumption**

Since the introduction of the Environmental Plan for Water I in 1987, average water consumption in households has been constantly decreasing, though at a slightly lower rate in recent years. However, last summer's record heat resulted in slightly higher water consumption per person per day in Danish households. In 2017, the average consumption was 103 l/person/day, but due to last year's higher temperatures, consumption increased to 105 l/person/day. It was clear that more citizens chose to water the garden more than usual and that pools were used frequently. 2018 was also a record year for wildfires, which also affected water consumption for fire extinguishing purposes.

The total water consumption in 2018 measured in households, holiday homes, businesses, institutions and water losses was on average 62.88 m^3 per person/per year. Households accounted for 66% of the total volume of water sold. An individual uses an average of 38.46 m^3 per year, corresponding to 105 litres per day. The calculation is based on 64 drinking water companies, which together serve 3.27 million inhabitants.

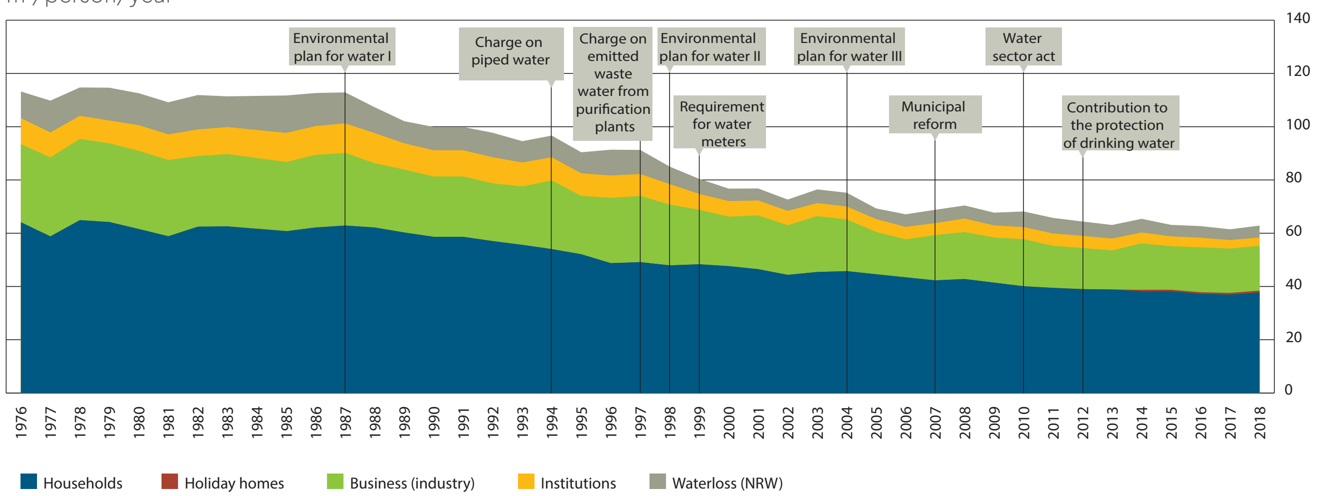
The graph lists some of the laws and regulations which are believed to have influenced the decrease in water consumption and price trends. At first glance, it appears that it is the Environmental Plan for Water I which, with increased environmental awareness among consumers combined with an increase in wastewater rates, has led to the decrease in water consumption. The introduction of a drinking water tax on tap water, which was initially called the green 70 cents, meant that in the period from 1994 to 1998 14 cents was added to the tariff each year. During the same period, water consumption in the household decreased by 10.5%. Water consumption in households has decreased by 38% over the 31 years since the implementation of Environmental Plan for Water I.

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

- 1987: Environmental Plan for Water I — the plan was intended to protect the aquatic environment, both groundwater and surface water. The Environmental Plan for Water 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 tax for drinking water companies with a water loss of over 10% – Act No. 492 of 30/06/1993 (Ministry of Taxation).
- 1996: Tax for wastewater — Act No. 490 of 12/06/1996 (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: Environmental Plan for Water II — the plan was mainly intended to reduce nitrogen emissions.
- 2004: Environmental Plan for Water III — further reduction of nitrogen and phosphorus emissions.
- 2007: Municipal reform — reduced the number of municipalities from 271 to 98, resulting in a merger of many water utilities.
- 2009: The Danish Water Sector Act — the separation of municipal water and wastewater supply activities to municipally owned public limited companies (water companies) and the introduction of price caps and efficiency requirements — Act No. 469 of 12/06/2009 (Danish Ministry of Climate, Energy and Utilities).
- 2011: Introduction of drinking water contributions of 67 cents per square meter^3 — Act No. 1384 of 28/12/2011 (Ministry of Taxation).

CONSUMPTION OF DRINKING WATER, 1976-2018

m^3/person/year



Since 2014, a new category "Holiday homes" has been introduced, which is included in household consumption figures.
Data Source: 1976–1998: Master project: Modelling water demand by Nana Sofie Aarøe — data for 14–30 companies.
1999–2018: Data from DANVA's calculations for Water in figures — data from 33–116 companies.

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 the water cost what it costs?”. These are two good questions which DANVA is often asked and they are not quite so easy to answer.

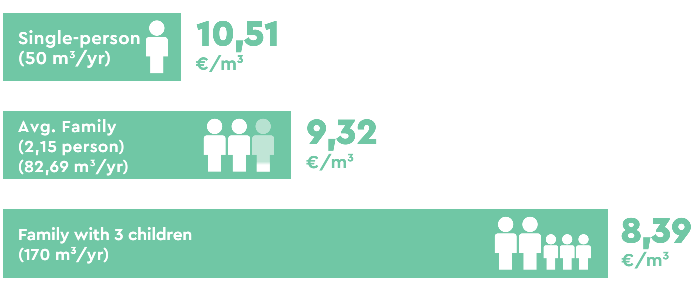
Some companies charge a fixed annual base fee on water and/or wastewater and an amount per cubic metre consumed. Other companies charge solely on the basis of water consumption. As the fixed annual base fee is paid per household (and not per person, for example), it is most accurate and fair to calculate the average price as the price paid by an average household. In this way, we can compare the price across companies regardless of the pricing scheme each company uses.

The average price for water in Denmark in 2018 was € 9.32 per m^3, based on an average household size of 2.15 people with an average household water consumption of 105 litres per person per day. This means that an average Danish household pays € 771 a year for water. For a single person, the average price of one cubic meter of water is slightly higher, namely € 10.51 per m^3 at a consumption of 50 m^3, since the fixed fee increases the average price more at low consumption. The average price per m^3 for a family with three children is somewhat lower, namely € 8.39 per m^3, based on an annual consumption of 170 m^3. The average water price has increased 0.94% compared to last year's price of € 9.23/m^3. The increase for the year is lower than the overall trend in the net price index.

The price of drinking water covers the cost of groundwater protection, abstraction, treatment and distribution of drinking water from the water stations to customers. The cost of wastewater covers the operation and maintenance, renovation and extension of the sewerage system, climate protection, operation and maintenance of treatment plants, as well as checks to ensure compliance with discharge requirements before being discharged to the recipient.

AVERAGE PRICE OF WATER BASED ON CONSUMPTION, 2018

€/m^3



Simple average, based on 218 drinking water companies and 98 wastewater companies. The price includes VAT and taxes. The average water price for 2019, based on the same water consumption as in 2018, is expected to be € 9.49/m^3 for an average family, € 10.63/m^3 for a single person and € 8.54/m^3 for a family of children.

Find your water price on the Denmark Map

On DANVA's website, you will find an interactive map “Water prices on the Denmark Map”, which shows the water price for the 200 largest water companies and about 100 wastewater companies who are subject to the Danish Water Sector Act. The map shows the m^3 prices for drinking water and wastewater and the cost for households with average consumption of 50 m^3, approximately 83 m^3 and 170 m^3. The map is available at: www.danva.dk/vandprispaadanmarkskort.

Half a litre of drinking water from the tap costs under

0.47 cents

Information about **water prices**

How much does water cost?

The price of water depends on which water company you are affiliated with. Contact your local water company to get your water prices. On average, a litre of water costs 0.93 cents.

What does the water price consist of?

The water price consists of a total of five elements:

- Fixed fee for drinking water (if any)
- Cubic metre price for drinking water consumed
- Fixed price for wastewater (if any)
- Cubic metre price of wastewater removed
- VAT and other charges/taxes.

Why does the price of water vary?

There is a spread between the lowest and the highest prices among the water companies. In general, the difference in total prices can be attributed to several factors:

- It can be relatively less expensive to supply water-consuming industries than small-sized customers, such as holiday homes.
- Geological conditions can make it more expensive to extract water from the underground.
- In some places, groundwater pollution and scarcity of water resources may mean investing in new water catchment sites.
- Some drinking water companies spend more than others on groundwater protection. Other companies are "born" lucky, as their water catchment sites are already in protected natural areas.
- The treatment requirements for wastewater depend, in particular, on where in the natural environment the treated water is discharged. Requirements are often higher for discharge to vulnerable recipients in freshwater areas than for discharge to the sea.
- Decentralised wastewater treatment in smaller plants is usually more expensive than central wastewater treatment at larger plants.

- Environmental conditions requiring additional measures.
- There is a significant difference in the level of investment from company to company. Currently, many companies invest in new sewer systems in order to respond to the challenges of climate change. 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.

Water distribution in the household

Danes consume an average of 105 litres of water per day in the household, but where is the water used when it is delivered to the house? Unfortunately, there are no recent Danish studies on the distribution of water consumption, but the Dutch company Vewin has been conducting a very detailed study every three years since 1995. Because Denmark and the Netherlands are similar in many social parameters, it is possible to transfer the percent distribution of Dutch water consumption to represent Danish homes even though the Dutch use a little bit more water in the household than an average Dane.

DISTRIBUTION OF WATER CONSUMPTION IN A DUTCH HOUSEHOLD, 2016

Personal Hygiene	47.2%	Bath	1.6%
		Shower	41.2%
		Washing	4.4%
Toilet flush	29.0%	Water consumption for flushing toilet	29.0%
Laundry	12.9%	Laundry by hand	1.1%
		Laundry, machine	11.8%
Washing dishes	5.0%	Washing by hand	2.9%
		Washing machine	2.1%
Food/drink	2.1%	Cooking	1.0%
		Coffee, tea & drinking water	1.1%
Other	3.8%	Other water consumption	3.8%

Source: Drinkwaterstatistieken 2017, Vewin, dec. 2017.
The example covers an average Dutch person with a daily water consumption of 119.3 litres per person per day

PHOTO: HERNING VAND

Water price **composition**

The water price can be divided into the drinking water company's share, which covers the treatment and supply of pure drinking water, respectively, and the wastewater company's share, which covers the collection, treatment and subsequent discharge of treated wastewater. In addition, a share has to be paid to the State in the form of taxes and VAT. Of the total average water price, 17.7% goes to the drinking water company, 52.3% to the wastewater company, while 30% goes to the State in the form of VAT and taxes.

If you look at the price, including the distribution of taxes between drinking water and wastewater, the distribution is as follows:

- The treatment and supply of clean drinking water includes groundwater protection, treatment and supply of drinking water. Together, this amounts to € 3.14, of which € 1.48 goes for VAT and taxes. The share of drinking water corresponds to 33.7% of the total average water price. 30% of the income the drinking water companies receive from the sale of water comes from the fixed fee and another 70% comes from the variable consumption. 94% of the water companies use a fixed fee.
- The collection of wastewater in sewers, treatment and discharge amounts to € 6.19, of which €1.31 is VAT and taxes. The wastewater share corresponds to 66.3% of the total water price. 12% of the income for wastewater companies comes from the fixed fee and another 88% comes from variable fees. 62% of the wastewater companies use a fixed fee.

SHARE OF WATER PRICES BY CATEGORY, 2018

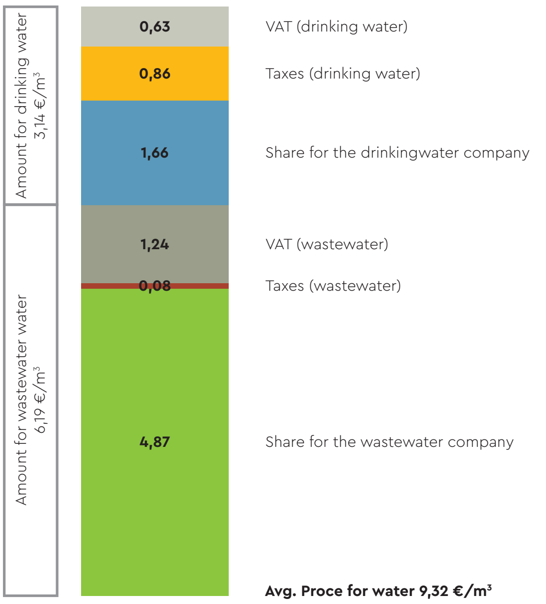
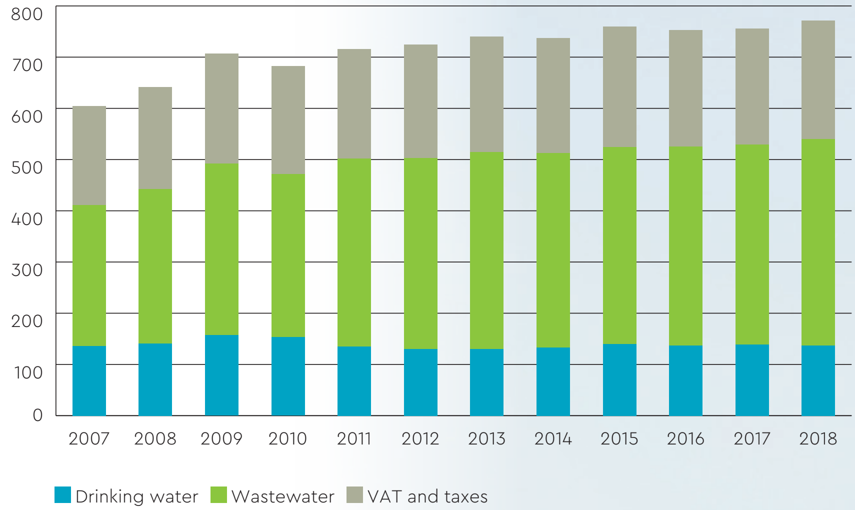


PHOTO: COLOURBOX

AVERAGE HOUSEHOLD COSTS FOR WATER, 2007 - 2018

€/m^3 (2018 price)



The estimate is for an average family of 2.15 people with an average consumption per person of 38.46 m^3/year.

Household water costs are stable

An average Danish family of 2.15 people who uses 82.69 m^3 in one year must pay € 771 per year to get fresh, clean, controlled drinking water and to remove the wastewater that is properly treated before being discharged into the natural environment. In addition, the price of water also covers groundwater protection and climate adaptation, as well as taxes and VAT. Costs paid by an average family has been fairly consistent over the last few years.

The share of water costs represents 1.4% of an average family's annual consumption. The source is StatistikBanken.dk/FU51. Assuming a family with 2 adults and an annual consumption of € 55,428. (data from 2016). Similarly, family expenditure on telephones and equipment amounted to 1.6%, electricity 2.3%, district heating 2.4% and insurance 5.2% of the family's annual expenses.

The United Nations Development Programme (UNDP) has set a figure of 3% of household income as an expression of affordable water and wastewater prices. Thus, the cost of water and wastewater paid by Danish families is less than half of the maximum cost recommended by the UN.

Debt in the water sector

Water companies (drinking and wastewater companies) have to take loans more often when investing in new plants, pipelines and other assets than if it is up to the authorities. It is also evident from the graph below that the debt of water companies with KommuneKredit has been steadily increasing since 2007.

The price will be paid by the next generations

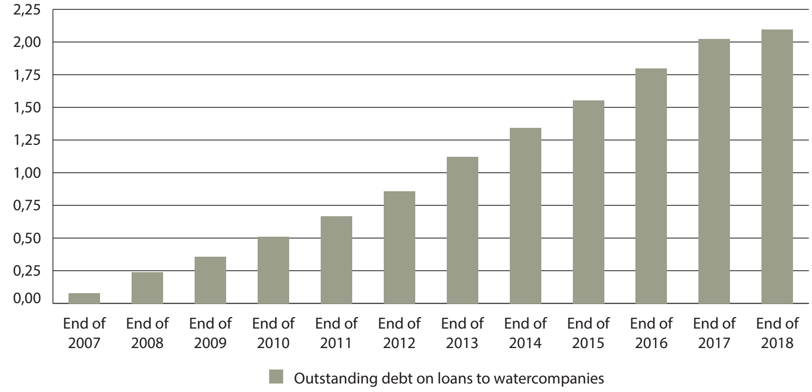
Increased loans rather than cash (by tariffs) financed investments will reduce the price in the short term and give water consumers cheaper prices in the first few years. However, this will also mean that the price, which includes compound interest, is passed on to the next generation. The State authorities and some politicians would like to see increased loans by water companies. The consequence of this would be that prices would go down in the short term, but the price would be passed on to the next generation. The problem with financing through loans is that tariffs will rise even more over the longer term.

The lifetime regulation is far from reality

Water companies are struggling with the fact that the lifetime estimates used in economic regulation are based on a technical service life. For example, pipelines must last for 75 years. The problem is that the actual service life of many assets is significantly shorter. DANVA's analyses show that the service life of sewage systems and wells is 46 years on average, not 75 years as the authorities are proposing using the technical service life. The reason for the lower actual service life is due, for example, to climate adaptation and the replacement of wastewater pipes for district heating, paved roads renovation and the like, where water pipelines are also replaced. Since, in reality, a service life of 75 years is rarely achieved at the plant, the consequence is that water companies - and hence customers - will have to pay for assets that have long since been removed from the ground. There is therefore a risk that we will be paying for both the infrastructure that no longer exists and the new infrastructure put in the ground.

OUTSTANDING DEBT ON LOANS TO WATER COMPANIES

BILLIONS €



Less expensive wastewater tariffs for major consumersmaj

After a phasing-in period of 5 years, the discount scheme for major water consumers called the “Three-Step Tariffs Model” has been fully phased in. The Three-Step Tariffs Model was introduced on the basis of a growth plan from April 2013, where a policy decision was made to ease the wastewater payment for major water consuming companies by € 94 millions by 2018. The discount is to be based on a so-called Three-Step Tariffs Model, which is based on 3 levels. Level 1 is the wastewater companies’ regular tariffs for the removal and treatment of wastewater from households and businesses. Level 2 provides a discount on the regular tariff to consumers who use between 500 m^3 and 20,000 m^3. Level 3 provides a further discount on water consumption over 20,000 m^3 of water. Initially, it was expected that the discount would be financed by increasing level 1, i.e. the tariff that the private consumer pays, but in the long run, the discount would have to be offset by efficiency improvements at the wastewater companies.

The Three-Step Tariffs Model has been particularly important for the wastewater compa-

	LEVEL 2 Water consumption: 500 m³-20,000 m³ The cubic metre tariff is	LEVEL 3 Water consumption: Over 20,000 m³ The cubic metre tariff is
2014	4% lower than level 1	12% lower than level 1
2015	8% lower than level 1	24% lower than level 1
2016	12% lower than level 1	36% lower than level 1
2017	16% lower than level 1	48% lower than level 1
2018	20% lower than level 1	60% lower than level 1

nies that have a greater proportion of major business customers and have therefore had to give discounts on a large part of their income base. An analysis of the tariff trends from 2013 to 2018, when the discount scheme was fully implemented, shows that:

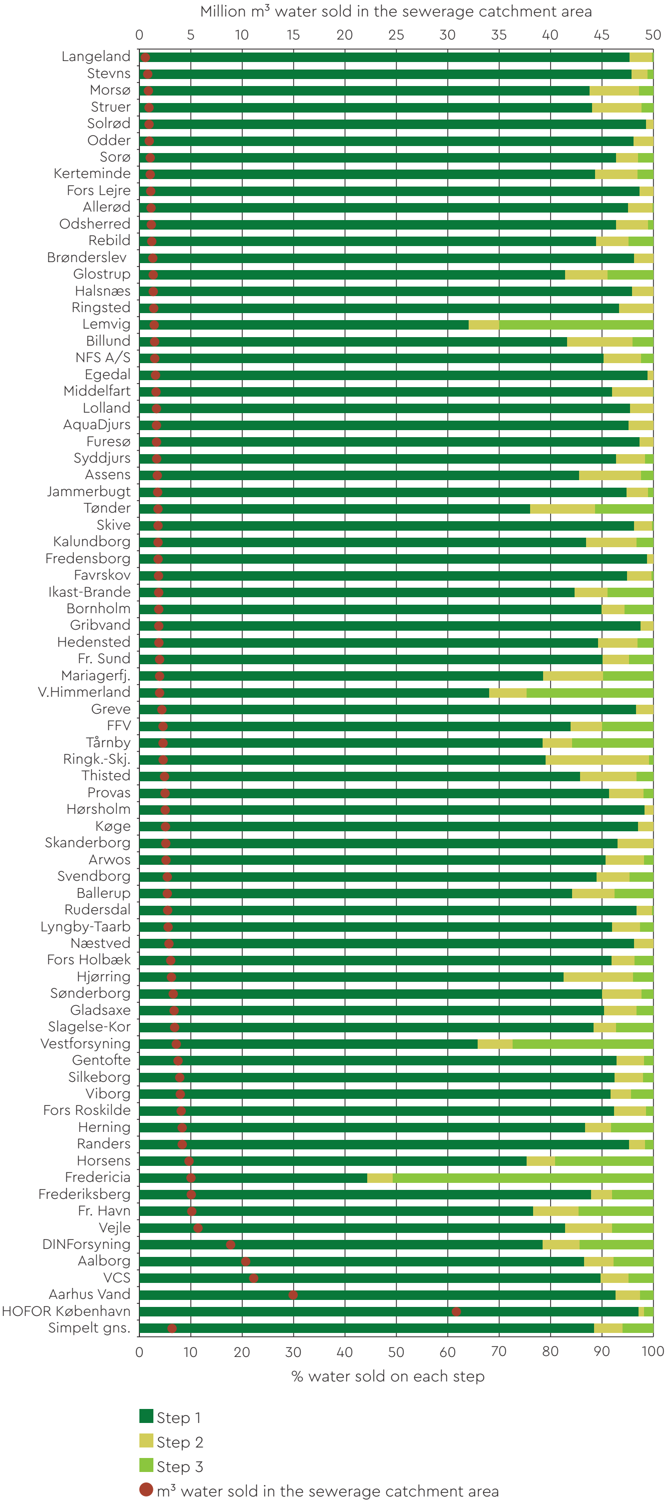
- Companies selling more than 20% of their water in levels 2 and 3 have had an increase in the level 1 tariff of 24.9%, equivalent to 5.0% per year in current prices.
- Companies selling between 10% and 20% of their water in levels 2 and 3 have had an increase in the level 1 tariff of 15.4%, equivalent to 3.1% per year in current prices.
- Companies selling less than 10% of their water in levels 2 and 3 have had an increase in the level 1 tariff of 7.3%, equivalent to 1.5% per year in current prices.

During the same period for July (M7), the net price index of Statistics Denmark increased by 5.18%, corresponding to 1.03% per year.

For the wastewater sector in Denmark as a whole, it can be calculated that as a consequence of the implementation of a discount scheme for large-consuming industries, the average rate paid by the ordinary citizen (level 1) was 4.7% higher in 2018 than what would have been the case if the Three-Step Tariffs Model had not been introduced.

The analysis includes 78 wastewater companies, which together have 241 million m^3 debited in their catchment area, with 88% being sold in level 1, 6% in level 2 and the remaining 6% in level 3. The analysis only covers tariff trends and water sold at each level and does not take into account any other parameters that may have had an impact on the tariff during the same period. ■

THREE-STEP TARIFFS MODEL, 2018



TEXT: JESPER WITH, JOURNALIST/ **PHOTO:** COLOURBOX

After the court case on taxation of water and wastewater companies:

More than € 134 millions is on its way back to the water and wastewater companies

After a nearly 10-year fight, DANVA and the water and wastewater companies won a principal case in the Supreme Court in November 2018, which means that 273 companies will avoid additional taxes over the coming years of up to € 6.43 billions. More than € 134 millions in taxes that have already been paid must be returned to the companies.

With the judges voting 7-0, the November 2018 ruling in the Supreme Court went in favour of Hjørring Vandselskab A/S and Hvidovre Vand A/S - the two companies that had brought the principal case forward. The Danish Ministry of Taxation must therefore return the tax that has already been paid to a number of water and wastewater companies, and even better: Water and wastewater companies will not be obliged to pay up to € 6.43 billions in tax in the future, and should instead be taxed according to the policy intentions of the 2009 Water Sector Act. "The money must be returned to the Danes," said several politicians after the Supreme Court ruling. After the ruling, the parties to the agreement (all parties except the Alternative) then made, in Jens Joel's (S) words: "An adjustment to the regulation of the sector so that it can finance its capital costs and make the necessary investments, so that the quality is top-notch and there is the opportunity for innovation and to create new solutions that can contribute to efficiency improvements, increasing exports and more jobs." So. The fight was over and the water and wastewater companies could cheer on behalf of the customers. Water abd wastewater companies can now organise their operations, maintenance and investment policies based on what makes the most sense in relation to their tasks: To provide clean drinking water, to treat wastewater and to counteract flooding.

A brief review of the tax case

In 2017, the main hearings began at the Eastern High Court in Copenhagen. The ruling came on 16 January 2018, when four out of five judges ruled in favour of the Ministry of Taxation.

- The Ministry of Taxation was of the opinion that the water and wastewater companies' total incoming value at the time of separation amounted to € 29.26 billions. DANVA's claim, on the other hand, was that values amounted to € 7.38 billions at the time of separation. At a corporate tax rate of 22%, this represents a tax difference of up to € 6.43 billions. The amount was highlighted by the Ministry of Taxation in an analysis for the Danish Parliament.
- The tax case represented the principal case for the valuation of Hvidovre Vand A/S and Hjørring Vandselskab A/S.
- The case was appealed to the Supreme Court, and on 8 November 2018, 7 judges unanimously ruled that the Ministry of Taxation had not upheld the policy intentions contained in the basis of the Water Sector Act (vandsektor-loven).

Fair taxation

"The judgement in the Supreme Court on the valuation of water companies is largely identical to the view DANVA had of the policy intentions of the Danish Water Sector Act in 2009, so we were of course extremely satisfied with the decisive ruling," says Carl-Emil Larsen, Director of DANVA. The purpose of the case was to achieve fair taxation for the water and wastewater companies in line with the policy intentions of the Danish Water Sector Act at the lowest possible tariffs for Danish residents. The explanatory notes to the Act indicated that, over the long term, the tax payments by water and wastewater companies should be in the order of € 13.42 millions annually. From the outset, that amount was exceeded year after year. The problem was that the Danish Water Sector Act was never properly aligned with tax legislation, as the parties to the agreement otherwise wished. Therefore, the Ministry og Taxation treated the companies as classic limited companies, which are taxed according to normal rules and are valued according to a market price. In connection with the transition to tax liability, the Ministry of Taxation established a tax input variable of the water and wastewater companies' assets - buildings, treatment facilities and distribution networks, etc. This value has an impact on the ability of companies to make depreciations and therefore on the amount of tax they are required to pay. But since the water wastewater companies are break-even companies, in principle they do not generate profits, nor have they ever been traded. The consequence of the Ministry of Taxation's approach was that water and wastewater companies received low deductions and thus excessive tax payments.

Next step: Guide for resumption circular

Following the decision, DANVA has prepared a guide for members on how to behave going forward. At the end of September, a so-called resumption circular from the Ministry of Taxation was issued.

"We now move on to part two, getting the math done. We have just received a resumption circular notice from the Ministry of Taxation, which must be available when there are changes in practice. Based on this, individual companies can recalculate their opening balance sheets. It should become a relatively simple matter for many of the companies to settle their cases," says Carl-Emil Larsen.

DANVA is in constant dialogue with the Ministry of Taxation regarding practical issues arising from the tax case. However, all companies are not in the same situation. Some already have an agreement with the Ministry of Taxation, but as the Ministry of Taxation changes practices on the basis of the judgement, they have the right to ask that the case should be re-examined by appealing to the assessment authorities. Some will likely choose do that, others will refrain, says judge Carl-Emil Larsen.

'We assume that approximately half of the cases can be settled directly on the basis of the judgement. The other half, which cannot be settled immediately, for example due to disagreements other than the valuation of the assets, may be appealed. So it's not so straightforward for everyone," says Carl-Emil Larsen.

He expects that it will lead to a limited tax payment in the future.

"This case proves to me that the money and knowledge we invest in working together in the water and wastewater companies comes back to us as profit," says Carl-Emil Larsen. ■

" The judgement of the Supreme Court is largely identical to the view DANVA held regarding the policy intentions of the Danish Water Sector Act.

PHOTO: TREFOR VAND

The Danish water sector

All drinking water in Denmark comes exclusively from groundwater, with the exception of a small desalination plant on Christiansø. In 2016, the total pumped water volume for public waterworks was 373 million m^3/year [1]), with DANVA members accounting for 60% of the water volume. The Danish drinking water sector is highly decentralised and consists of approximately 2,600 public waterworks. There are approximately 87 municipally owned drinking water companies, which in total comprise of approximately 340 waterworks. The rest of the waterworks are private, either as individual waterworks or assembled into smaller utilities with several works. These are most often owned by consumers. In addition, there are approximately 50,000 small works, primarily in the category "local water supply for single-family households" [1]).

Wastewater treatment takes place primarily at approximately 110 municipally owned wastewater companies. In Denmark, 773 wastewater treatment plants over 30 PE were registered in 2017, with a total load of 7.8 million PE. The wastewater treatment plant capacity has been estimated at 11.7 million PE. Altogether, they discharged approximately 768 million m^3 of treated waste water, with DANVA members accounting for 80% of the total volume. 94% of the wastewater discharged was treated at tertiary treatment plants, which is the most advanced type of wastewater treatment plant (MBND and MBNDK) [2]).

The Danish Water Sector Act, which covers all drinking water and wastewater companies selling more than 200,000 m^3 of water annually, sets requirements on the establishment of an economic framework for each company. At the same time, the act sets out a general efficiency requirement and, if appropriate, an additional individual efficiency requirement for companies selling over 800,000 m^3. The Danish water sector is based on the so-called "break even" principle. This means that there must be a balance in a company's costs and revenues measured over a number of years. Water companies are financed exclusively through tariffs, and all activities, capital investments and operating costs are to be paid by their consumers.

The Danish Water Sector Act covers about 220 drinking water companies, which collectively sold about 272 million m^3 of water in 2018. The companies had a turnover of approximately € 630 millions, operating costs of € 189 million and invested € 213 millions in 2017.

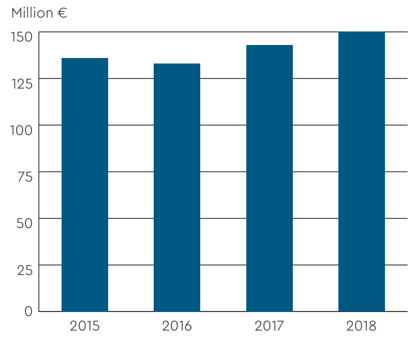
The Danish Water Sector Act also covers approximately 110 wastewater companies, which collectively treated about 279 million m^3 of water sold from their catchment areas in 2018. The companies had a turnover of about € 1,315 millions, invested € 694 millions and had operating costs of € 403 millions. ■

Sources: 1) Groundwater Monitoring 2017, GEUS, 2) Point Sources 2017, Ministry of Environment and Food.

ECONOMIC DEVELOPMENT

The following economic development graphs include all drinking water and wastewater companies covered under the Danish Water Sector Act and which have a charged water volume over 800,000 m³.

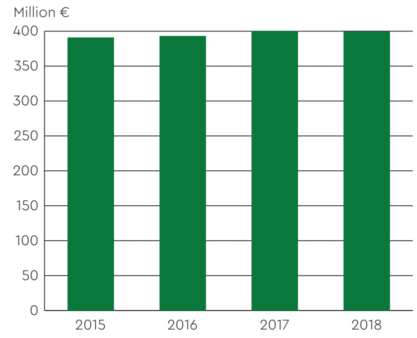
ACTUAL OPERATING COST DRINKING WATER



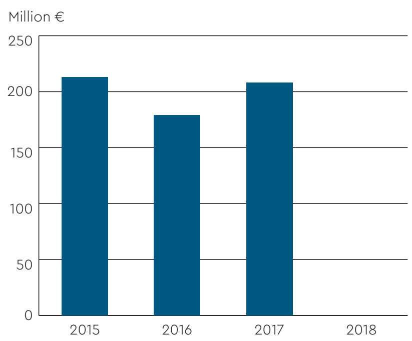
The actual operating costs are the part of the operating costs used in the overall financial benchmarking of the Utility Secretariat.

Actual operating costs are calculated as operating costs from the audited financial statements excluding depreciation on loss on debtors, non-controllable costs, adjustment of provisions included in operating costs, and operating costs from associated activities and the collection scheme, which is included in the general accounts. The definition of actual operating costs has been revised as of 2016, so that it is not completely comparable to the previous years.

ACTUAL OPERATING COST WASTEWATER



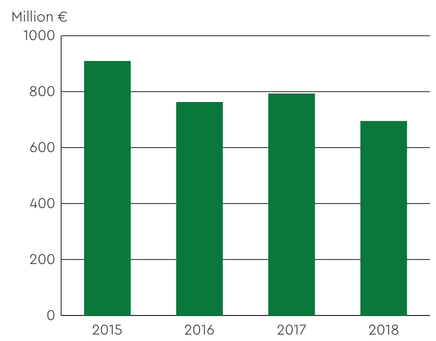
INVESTMENTS DRINKING WATER



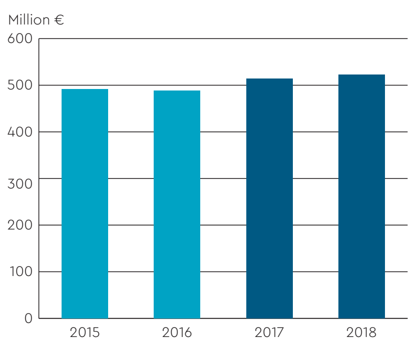
Investments are an expression of the costs borne by companies during the year. This explains the relatively large fluctuations in the years, while depreciation has significantly smaller fluctuations, as investments must be depreciated for up to 75 years.

There is no overall calculation of investments for drinking water companies in 2018, as they will only be benchmarked by the Utilities Secretariat every two years.

INVESTMENTS WASTEWATER



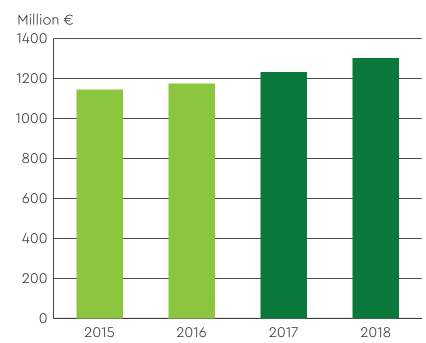
INCOME* DRINKING WATER



The incomes shown in the graphs consist of:

- Income from principal activities in the collection, treatment, transport and supply of water
- Transport, treatment and wastewater discharge
- 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.

INCOME WASTEWATER



The data refer to 74 drinking water companies and 103 wastewater companies, which are covered by the regulatory benchmarking of the Utility Secretariat.
Data in the graphs are presented at current prices excluding VAT.
*The Utility Secretariat changed the definition of income in 2017. Prior to 2017, total income from primary activities was calculated such that connection fees and other items were not included. Since 2017, the definition of income has been changed from: "Total income from primary activities" to "Actual income". One of the major changes is the recognition of connection fees, which is one of the reasons for the significant increase.

DRINKING WATER COMPANIES in DANVA Statistics & Benchmarking

In 2019, 67 drinking water companies reported data to DANVA Statistics & Benchmarking. The figures shown apply to 2018. Together, the companies have more than 1,750 water abstraction wells, comprising 154 catchment areas, 242 waterworks and 31,162 km of supply lines. The participating companies abstracted about 224 million m^3 of drinking water and supplied 3.28 million people. The total investments and costs excluding fees/taxes amounted to approximately € 158 millions and the actual operating costs were just over € 134 millions. (see the participants' overall key figures at the end of this publication).

The drinking water companies' actual operating costs increased slightly

Actual operating costs of drinking water companies (FADO) have increased by 2% compared to 2017. Actual operating costs for 2018 are € 0.63 per m^3 of drinking water sold. Actual operating costs are governed by the Water Sector Act's requirements for efficiency improvements, and they form the basis for comparing the companies' efficiency. Actual operating costs exclude VAT and other fees/taxes, non-controllable costs and any selected associated activities. 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.

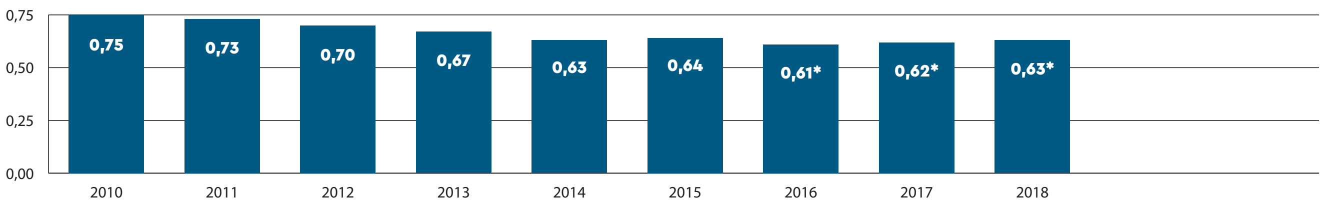
As of 2010, since the implementation of the price cap regulation under the Danish Water Sector Act, it is only the actual operating costs for which the companies are given efficiency requirements, and therefore, the companies made it a goal to continuously minimise their operating costs. Following the switch to the TOTEX regulation, where the efficiency requirement includes both operating costs and investments, there is not the same clear focus on reducing operating costs. It is always a balancing act in determining whether you need to maintain your equipment or invest in new equipment.

Total investments decreased in 2018

The calculation of investments made by drinking water companies in 2018 shows a decrease of almost 20% compared to 2017. The drop is due to major fluctuations in the investment level of individual companies. On the other hand, most companies agree that much more will

OPERATING COSTS, 2010 - 2018

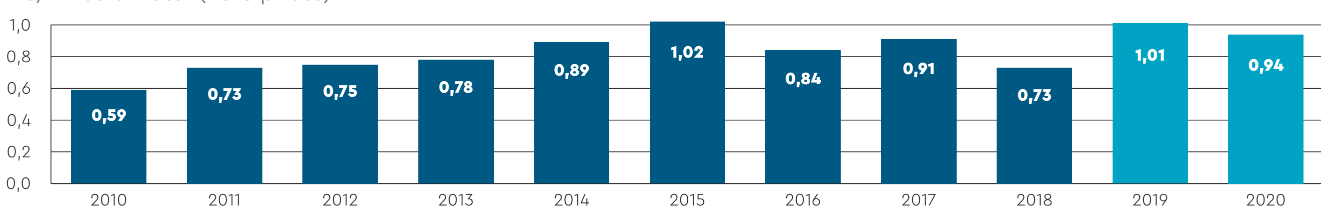
€/m^3 sold water (2018 prices)



2010–2018: Actual operating costs (57 – 74 companies)
* Changed method of calculation of actual operating costs (FADO)

INVESTMENTS, 2010 - 2018

€/m^3 sold water (2018 prices)



2010–2018: Implemented investments and renovations (54–71 companies)
2019–2020: Planned investments and renovations (66 companies)

be invested over the next 2 years, where the forecast for 2019 is a 30% increase compared to the 2018 level.

The distribution between costs and investments

In 2018, drinking water companies spent 33% of their actual operating costs on water production (wells and waterworks), 34% on water distribution, 11% on customer service and 22% on general administration. Investments are distributed as follows: 66% is invested in the distribution network and 29% is invested in drilling and waterworks. The remaining 4% will be invested in other things.

For the second year in a row, investments in wells and waterworks are at a historically high level of around 30%, which may be due to several factors: Newly built waterworks, increased pressure on water resources due to the discovery of undesirable substances, which have led to the need for new catchment areas, the restoration of existing catchment areas and increased groundwater protection in the form of, e.g., water protection zones and afforestation. ■

Large variations in actual operating costs

The average actual operating costs for the production and distribution of 1 m³of water is € 0.63. There is a wide spread between the lowest and highest costs, which can primarily be explained by the different 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 distribution network, all of which affects production costs. For distribution, factors such as urbanity, distribution network size, quality and age have an impact on costs.

ACTUAL OPERATING COSTS, 2018

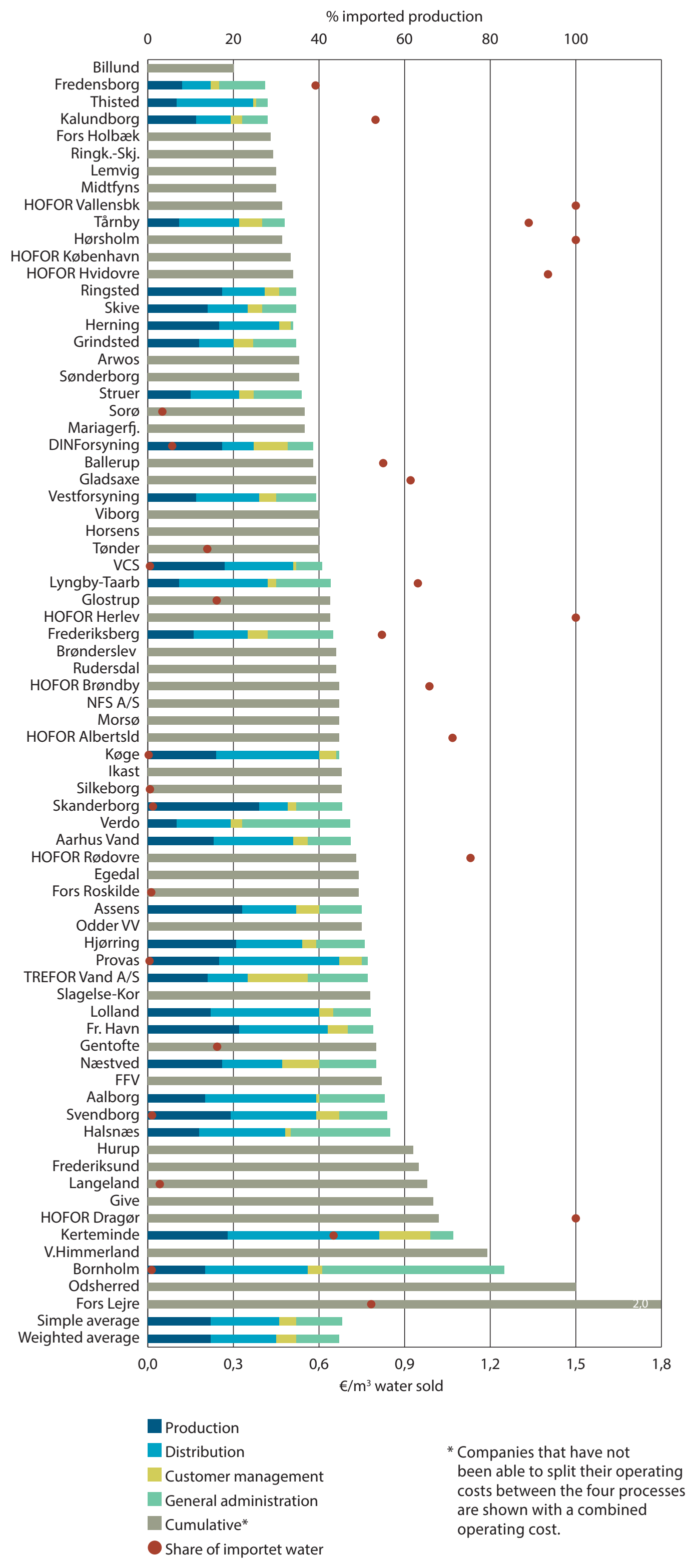


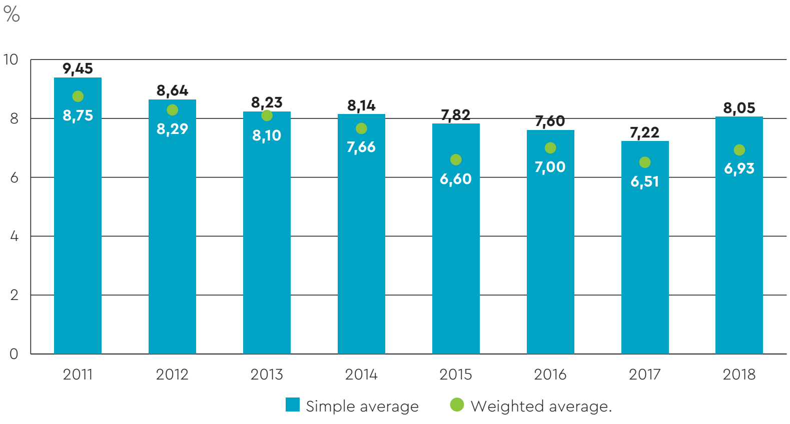
PHOTO: VANDCENTER SYD

The water loss curve takes a hit due to last summer's drought

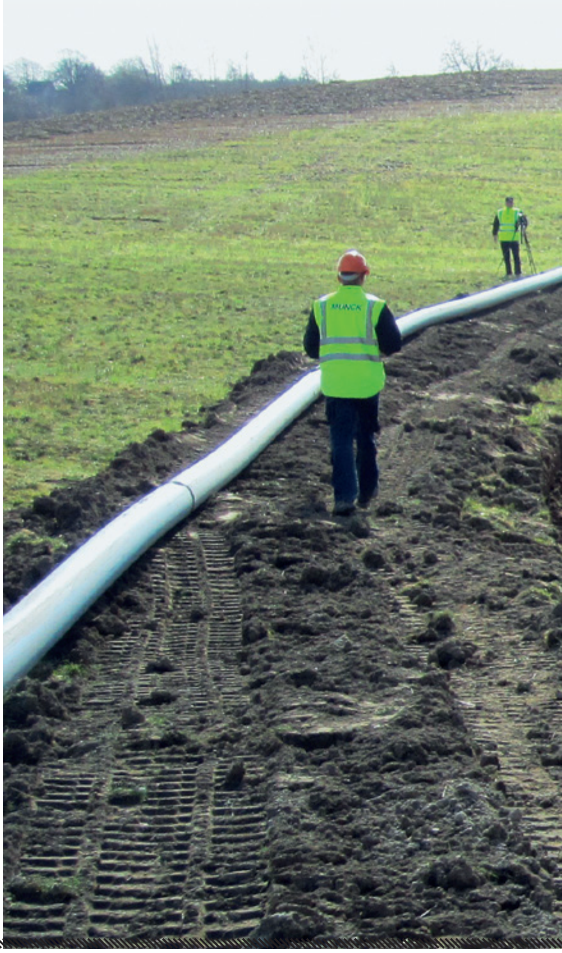
The Danish drinking water companies can be characterised as having a very low level of water loss in the pipelines. For the 50-52 drinking water companies that have participated in DANVA Benchmarking over the past 8 years, there has been a steady decline in water loss since 2011 until 2017, but the result for 2018 has shown an increase from 7.22% to 8.05%. A survey of drinking water companies shows that, in general, there have been several pipebursts, which are due to the drought of last summer, where the soil became very dry and led to a burst. This is confirmed by the burst statistics, which show an increase of 6% on average per company from 2017 to 2018. Some companies have also had a few large bursts, which have increased their water loss compared to what is normally seen.

Companies are continuously working to reduce water loss, and the steadily decreasing water loss over the past 8 years is an achievement which is further highlighted by the fact that a decline in water consumption among the population means an increasing percentage of water loss. This underlines the considerable efforts undertaken by the companies, which are still improving in their ability to leaks as well as repair and maintain the distribution pipes. In 1996, a general requirement for the installation of water meters was introduced for all water consumers. In 1993, a penalty was introduced for companies with more than 10% water loss, measured as the ratio between the water pumped out and the volume of water sold. These measures have had a major impact on the Danish water sector, making Denmark one of the countries with the lowest water loss. Water loss can be measured in several different ways, either as a percentage, water loss per km of distribution line or in more detail as an infrastructure leak index. The loss of water as a percentage or as m^3 per km of line is calculated as the difference between the volume of water pumped into a company's own distribution network and the volume of water sold by consumers. This calculation also includes volumes of water used for irrigation, fire-fighting and similar purposes, which cannot be regarded as a direct loss. The infrastructure leak index compares actual water loss and does not include water wasted due to the flushing of water pipelines after repairs, water used for fire extinguishing and unauthorised usage. The infrastructure leak index therefore calculates the real water loss that leaks into the soil in relation to the "unavoidable" water loss, which is calculated from plant size and water pressure. There are many different methods that can help water companies reduce water loss, such as segmentation of the pipelines, which, when installing flow measurement into the sections, provides significantly better data for leak detection, for example by analysing night flow measurements. Replacement for on-line remote metering can also provide very detailed and valuable data sets that can be used to detect water loss and generate an "alarm" signal in case of sudden unexpected water consumption. ■

NON-REVENUE WATER (WATER LOSS), 2011 - 2018



Average (%) based on 50–52 drinking water companies, which have participated in DANVA benchmarking for the past 8 years.



The number of remotely read meters is steadily increasing

The water companies' switch from the manual reading of water meters to remotely read meters provides solid data for the detection of leakage and reliable calculations of water consumption. The level of service to citizens can also be increased by, for example, the ability to provide an alarm for unexpectedly high water consumption due to, for example, a pipe burst at the holiday home.

The switch to remote meter reading is going strong, and the data from 55–60 drinking water companies show that the share of remotely read meters has gone from 15% in 2013 to 51% in 2018.

SHARE OF REMOTE METER READING

%

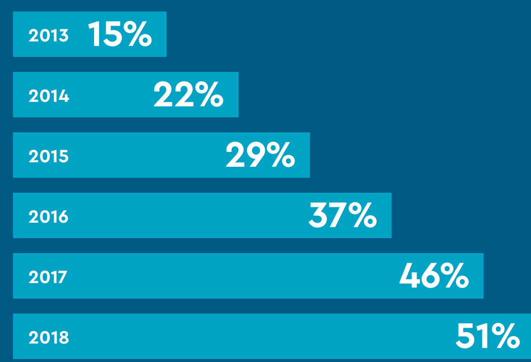
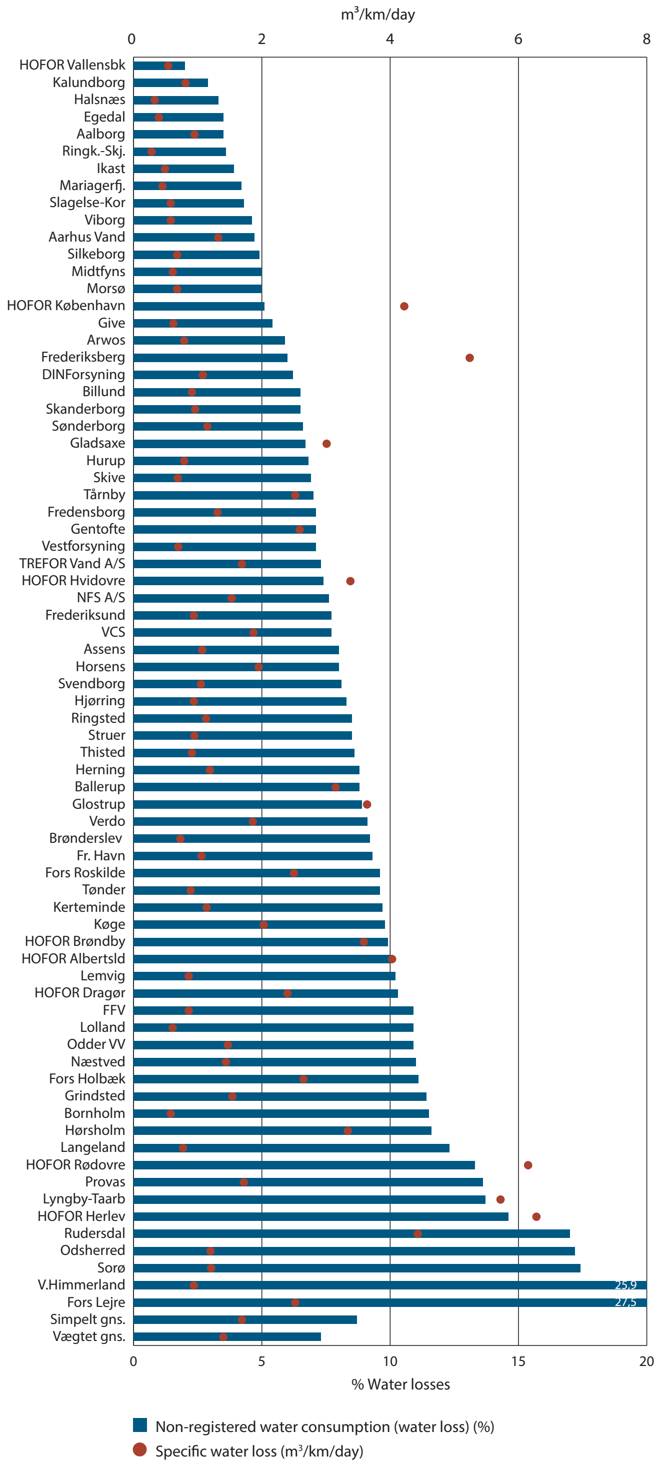


PHOTO: COLOURBOX

Non-Revenue water (water loss)

Drinking water companies' calculation of water loss, also known as "non-revenue water" shows significant differences between companies. The companies' rankings depend on the method of calculation, expressed either as a percentage or as the specific water loss, expressed in m³/km/day. Companies with a large distribution network but lower water consumption have better results when it comes to specific water losses, whereas companies with higher water consumption from a smaller distribution 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, but especially when replacing consumption meters or pumping meters at the waterworks, fluctuations can occur compared to the previous year. ■

NON-REVENUE WATER (WATER LOSS), 2018



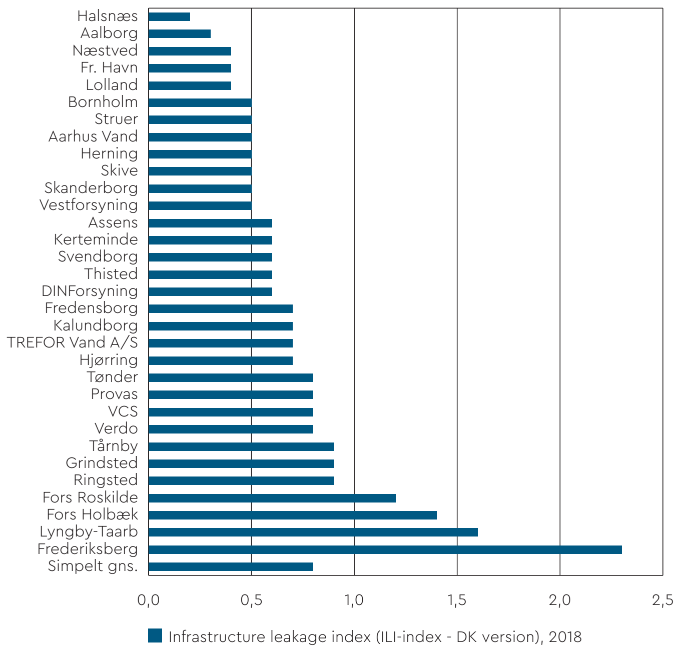
Note: No subsequent corrections to the water loss have been taken into account, e.g. water volumes used to flush the pipelines in connection with contaminants. An exemption is required to be able to subtract these volumes of water from the water loss calculation.

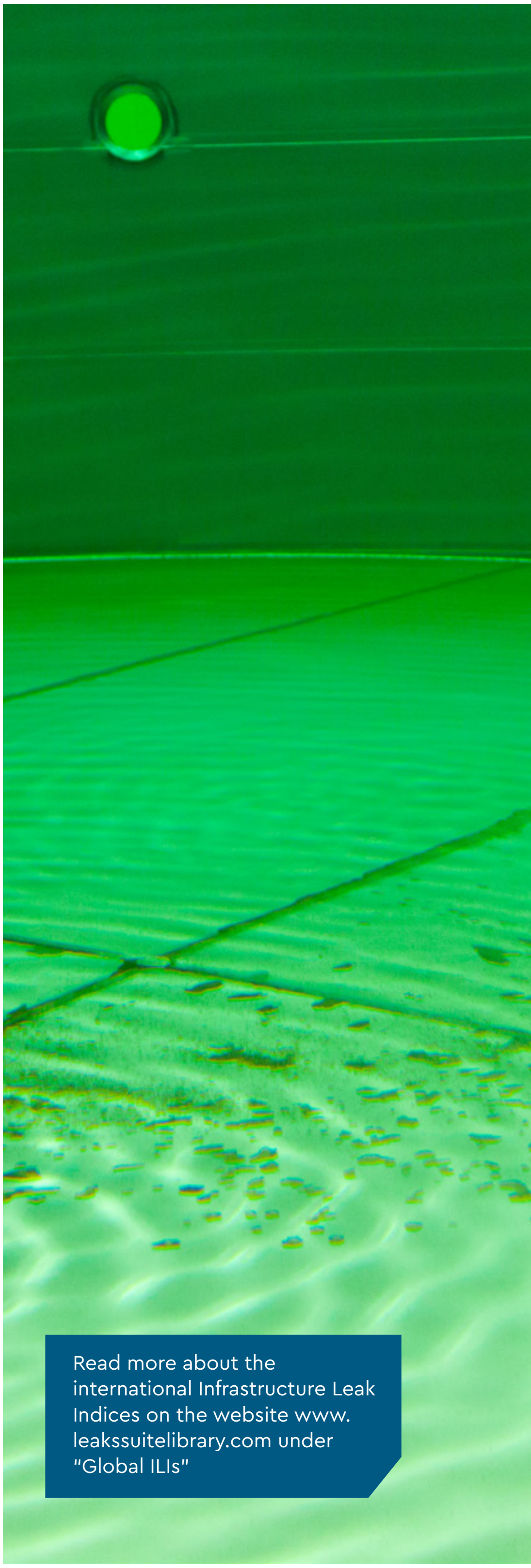
PHOTO: AARHUS VAND A/S

Infrastructure Leak Index (ILI)

The real water loss can be more accurately calculated and compared through the calculation of the Infrastructure Leak Index (ILI). It 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 (distritbution network size, density, pressure, etc.) and across borders. ILI is the relationship between actual physical water loss and "unavoidable water loss". Actual physical water loss is calculated as the difference between the amount of water sold and the amount of water pumped, minus authorised non-charged consumption (for example, flushing/drainage of the pipeline network after repairs, water used for fire fighting as well as unauthorised consumption (theft) and meter measurement uncertainties. The "unavoidable water loss" is a calculation based on the size of the pipelines and the water pressure, assuming that it is a well-run, healthy young pipe network. Based on the above, the figure is calculated based on what can be considered financially responsible and technically achievable water loss. The real, physical water loss can be reduced by, e.g., improving the speed and quality of repairs, introducing active leakage control and incorporating asset management into the renovation planning. ILI calculation is partly based on assumptions, such as the length of private ground lines, the average pressure in the pipeline and the calculation of water used for flushing. The measurement uncertainty is not included in the Danish calculations, which is why we call it "ILI index — DK version". ■

INFRASTRUCTURE LEAK INDEX (ILI), 2018





Read more about the international Infrastructure Leak Indices on the website www.leakssuitelibrary.com under "Global ILIs"

TEXT: JESPER WITH, JOURNALIST/ **PHOTO:** TREFOR VAND AND COLOURBOX

DNA ANALYSIS provides new opportunities in water supply

TREFOR Vand has used a new method that, through DNA analysis, can quickly find leaks where tree roots have found their way into a drinking water line. This saves money and increases security of water supply.

RUDI KRUPSDAHL
TREFOR VAND

It is very challenging and is often quite expensive to find a leak in a drinking water supply pipeline. It could require a lot of excavation work and end up costing tens of thousands of Euro. But by thinking out of the box and taking inspiration from other departments, TREFOR Vand has tested a method using DNA analysis to find the tree whose root is penetrating the water pipeline. The method allows the company to quickly find out where they need to dig.

"The experiment was a great success, because we were able to locate the spot where the root penetrated the pipeline. It saved us a lot of money, as we avoided a lot of excavation work. It has also strengthened the security of supply, since, over time, the leakage could have turned into a large and expensive water leakage on the transmission pipeline. In addition, the risk of penetration of rainwater or sewage into the leak was significantly reduced largely without interruption to the water supply," says a satisfied Rudi Krupsdahl.

Long stretch

The case started when an employee found a tree root in a buffer tank located between Tørskind Waterworks and the towns of Vejle and Fredericia. Usually, the company would start digging up and carrying out camera inspections at various points on the line between the buffer tank and the water station. But the leak, where the tree root had penetrated, could be anywhere on the 13.5 km long stretch, which could result in many failed excavations with heavy costs and compensation for landowners if the company had to be excavated on their land.

'I started thinking that when my colleagues do water quality tests, they sometimes use DNA analyses to identify the origin of a bacterium or other unwanted bacteria. I wondered if that same method could also be used to track down the location of a tree root in the pipeline? " says Rudi Krupsdahl, an installer at TREFOR Vand.

It was at least worth a try, so he sent samples of the tree root for DNA analysis to a laboratory in Germany. At the same time, it was determined that there were 40 trees on the 13.5 km long stretch from the waterworks to the water tank. The DNA analysis showed that it was a Willow Salix tree.

They then contacted the company Bush Craft, which specialises in primitive wilder-

A lot of money can be saved

- It costs up to DKK 75,000 per excavation and camera inspection plus any compensation for landowners. Therefore, troubleshooting the usual way can cost up to € 0.40 millions. And maybe even without finding the leak.
- The DNA analysis at the German laboratory cost about € 6,700, even though TREFOR Vand had submitted additional samples to be on the safe side, because this was the first time that the DNA method was used for this purpose. The method has not been tested before in Denmark. The next time there are problems with tree roots, fewer samples will be sent for DNA analysis, making it even cheaper.

ness experiences. They reviewed the pictures and found 10 possible willow trees of which 3 could be the source of the penetrating tree root. So TREFOR Vand sent samples of the three willow trees for new DNA analyses. Only one tree matched all the parameters.

It was found on the first try

"All we had to do is to go out and find that willow tree. We dug down and found the right place on the first try. The tree had found its way into the pipeline via a leaking gasket. This may be due to movements on the terrain and the pipeline is therefore leaking at the gasket," says Rudi Krupsdahl.

TREFOR Vand experiences challenges with tree roots about once every two years, and there is no doubt that the company will use DNA analysis in the future.

"We are an industry that likes to keep doing what we usually do. But we also need to think in new ways and be innovative. After all, this saves us a lot of money that we can use elsewhere to renovate and maintain the pipelines. We need to use the technologies in a smart way," says Rudi Krupsdahl. ■

Strengthening security of supply

The DNA analysis of tree roots in water pipelines provides the following benefits:

- Faster and much cheaper troubleshooting.
- Reduced time with a risk of contaminated sewage or rainwater entering with the roots.
- Increased security of supply, as it could eventually become a large and expensive water leakage. There is less risk of contamination and there is less need to disconnect the water supply.

Availability to customers

Security of supply, ensuring that water is always coming out of the consumers' taps, and making sure it is always clean are the main objectives of a drinking water company.

Security of supply can be affected on many fronts, for example:

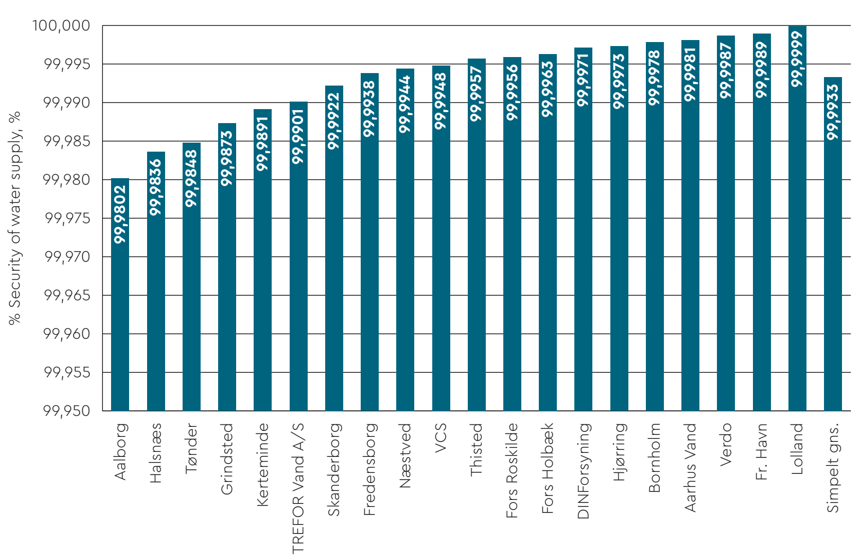
- Companies can ensure that they have sufficient reserve capacity to supply water if one of the company's waterworks goes down or becomes affected by contamination. This may have to do with ring connections and overcapacity between works or an "emergency connection" to another company, which can supplement water in case of an accident.
- Good pipeline maintenance standards to avoid unnecessary shut down of the water supply for customers, for example in case of bursts or leakages.
- For example, in the event of a power failure, water towers can continue to supply customers for a period of time using gravity, or the company can set up emergency power systems for the pumps in the water stations so that the pressure in the pipelines can be maintained.
- Segmentation and circular networks within the distribution network so that repairs can result in shut down for the smallest number of customers possible.
- Companies can also plan their maintenance works so that the "water supply's down time" to consumers is as short as possible. They can also notify consumers via an SMS notification, or the like, to minimise the inconvenience of not having water in the tap.

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 the proportion of the year the customer has tap water. If the companies, , record the length of time that the valve has been closed and how many households have been affected by this each time they close a valve that shuts down the water supply to one or more customers, an average number of interruption minutes per households can be calculated. The records can be divided into two types:

- Unplanned interruptions are defined as an interruption to the water supply for one or more customers where the company has not notified the customer within 48 hours before the interruption. Unplanned works are "works", which the company was not aware of 48 hours in advance.
- Planned interruptions where the company has informed customers in advance that the water will be shut down in connection with planned renovation of the pipelines, replacement of valves etc. Planned works and associated shutdowns of water in residential units are known more than 48 hours in advance and, most often, even several weeks/months in advance.

Unplanned interruptions are one of the parameters included in the mandatory performance benchmarking carried out by the Danish Environmental Protection Agency based on a requirement in the Danish Water Sector Act. In addition, several water companies have started to record the planned interruptions, which means that the average availability of water to customers can be determined. Availability to the customer can be calculated by taking the total number of minutes in one year and subtracting the average number of minutes/households where there have been unplanned interruptions, as well as the number of minutes/mailing address where there have been scheduled shut downs of the water supply. The average availability of the 20 companies participating in this calculation in DANVA Benchmarking is 99.9933%, which means that customers have only had to be without water on average for 35 minutes a year.

WATER SUPPLY SECURITY, 2018



Renewal of the pipeline supply network

The pipeline network's renewal rate shows what percentage of the pipeline network was replaced in the last year compared to the average per year for the past 10 years. There are many factors, such as materials, geological conditions, surface load and age that influence when the pipeline network is renewed. Another important factor is that many infrastructure and construction projects often require water companies to relocate their water pipelines even if they are not at the end of their service life.

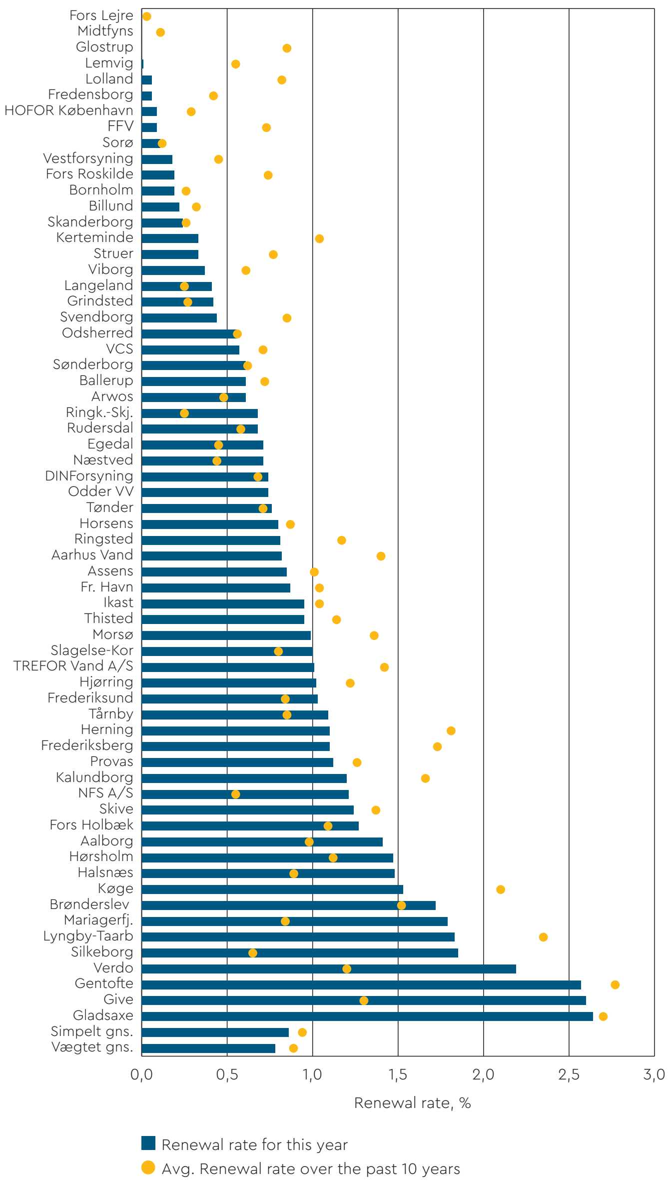
Dry summer increased the number of bursts

Repairing pipeline bursts is one of the major operational tasks that drinking water companies focus on. A burst in the network will probably mean that there will be customers who do not have water in their taps, and therefore, the companies of course try to reduce the number of bursts and the duration of the interruption. There is a substantial difference in the number of bursts that are registered on the pipeline network among the participating companies. Bursts are divided into two categories:

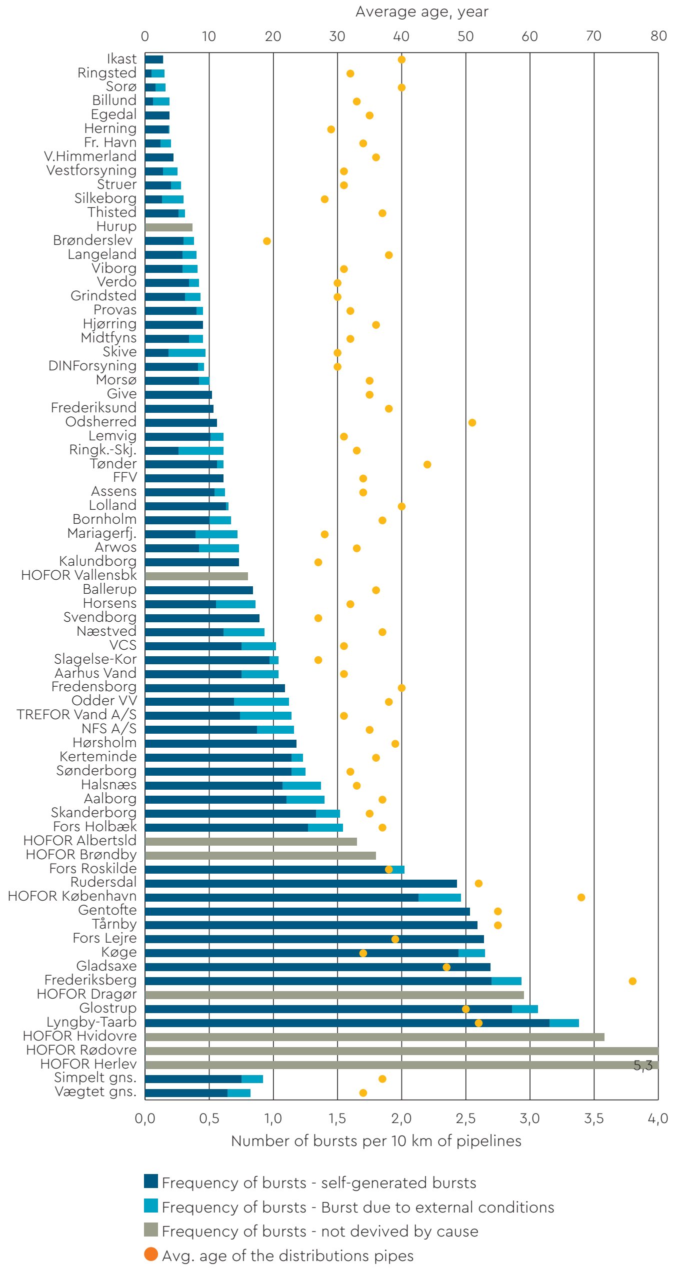
- Self-arising bursts in the pipeline network or house/building connections, where the pipeline's age, pipe material, drilling saddles, geology and the quality of work performed are often the cause of the burst.
- Bursts due to external conditions, where the burst is often due to excavation damage caused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

The graph shows self-arising bursts, as well as bursts due to external conditions on the main line and supply lines. It is calculated as the number of bursts per 10 km of supply line. The bursts are distributed over the entire pipeline network

RATE OF RENEWAL OF DISTRIBUTIONS PIPES, 2018



FREQUENCY BURST ON DISTRIBUTIONS PIPES, 2018



from the waterworks to the customer's water meter. The bulk of the pipeline belongs to the water company. The last few meters from the property boundary to the water meter, called the ground line, are owned by the landowner.

The 74 companies participating in DANVA Statistics & Benchmarking together had 2,870 bursts in 2018. This is an average of 38.8 bursts per company, which is 2 bursts more per company compared to 2017. The increase in bursts is related to the very long,hot summer of 2018, which caused the soil to settle due to dehydration, thereby pulling the water pipes and causing bursts.

The bursts recorded are distributed at approximately 46% on the service laterals and 54% on the main line and supply lines. Approximately 18% of the bursts were due to external conditions.

Bursts of the private ground lines have been registered by 20 of the companies. These companies had approximately 1163 bursts on their own lines and were aware of 181 bursts on the private ground lines. This figure may actually be significantly higher, as the companies are usually only aware of bursts when the landowner cannot find the stopcock during the repair, seeks advice and guidance from the water company or hopes that the water company will repair the burst on the ground line. ■

Checks to determine drinking water quality

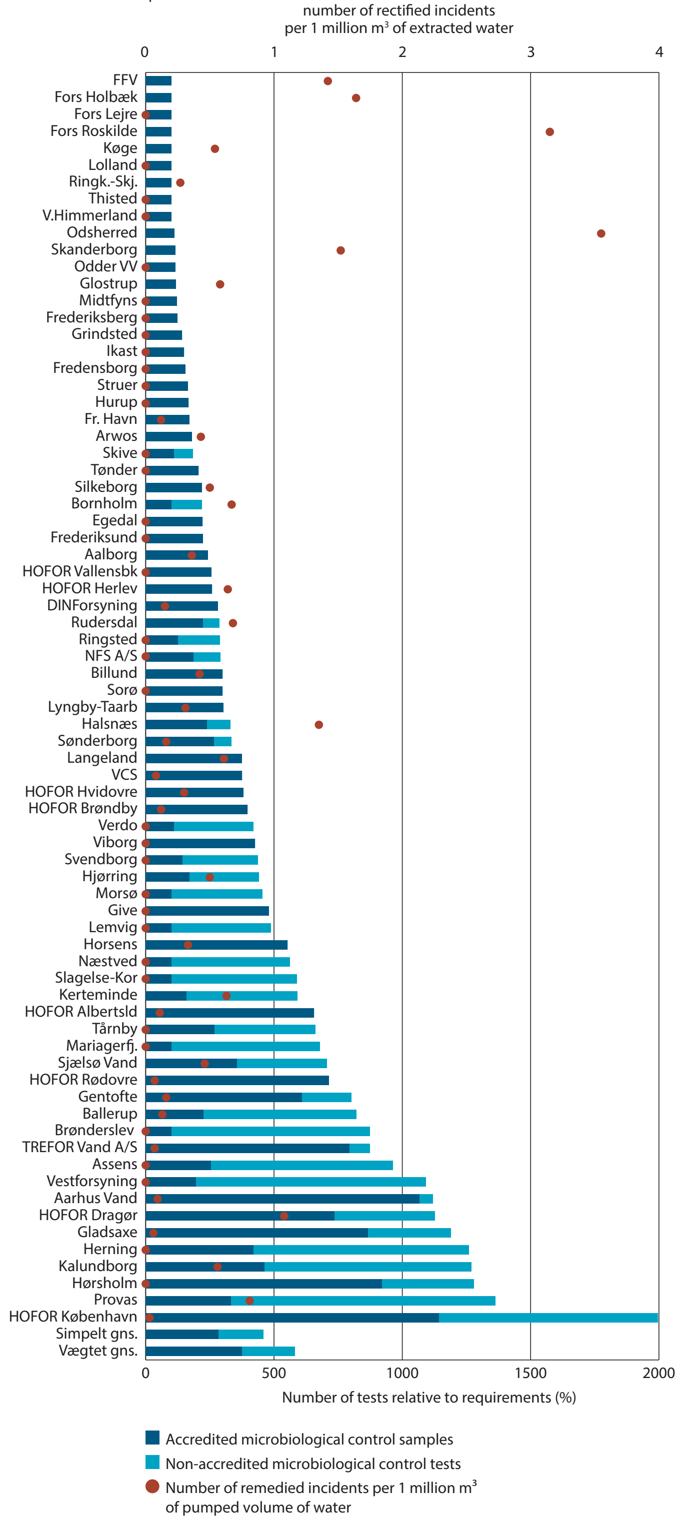
It is a statutory obligation to conduct inspections and controls of the drinking water before supplying it to the consumers. The control consists of analyses for selected chemical parameters, such as iron and manganese, but also for microbiological parameters, such as E-coli and bacteria counts. Water companies take samples from both the waterworks in the distribution network and at the customer's tap. Based on the size of the water company, a number of statutory control samples are to be analysed in an accredited laboratory and are to be carried out distributed across the year.

It is up to each water company to determine the scope of any sampling in addition to the statutory number of samples in agreement with 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 perform itself.

There is a substantial difference between the choices made by the companies. Some companies consider the statutory number of samples sufficient and others choose to extend their sample programme with many additional samples.

Approximately 2/3 of the 74 water companies participating in DANVA Statistics & Benchmarking take more than twice the number of samples for microbiological contaminants required by the supervisory authority. The

MICROBIOLOGICAL WATER QUALITY ANALYSES, 2018



results from the accredited analyses show that, based on 13,906 samples, 98.9% of the microbiological control samples taken fall within the threshold limits for all quality requirements. If only one analytical parameter on a water sample exceeds the quality requirements, it shall be recorded as an "incident". However, this does not mean that the water is harmful to human health. Usually, it simply means there are conditions that need to be investigated further. In 2018, 8 companies had to issue a boil-water advisory to their customers due to breaches of microbiological parameters.

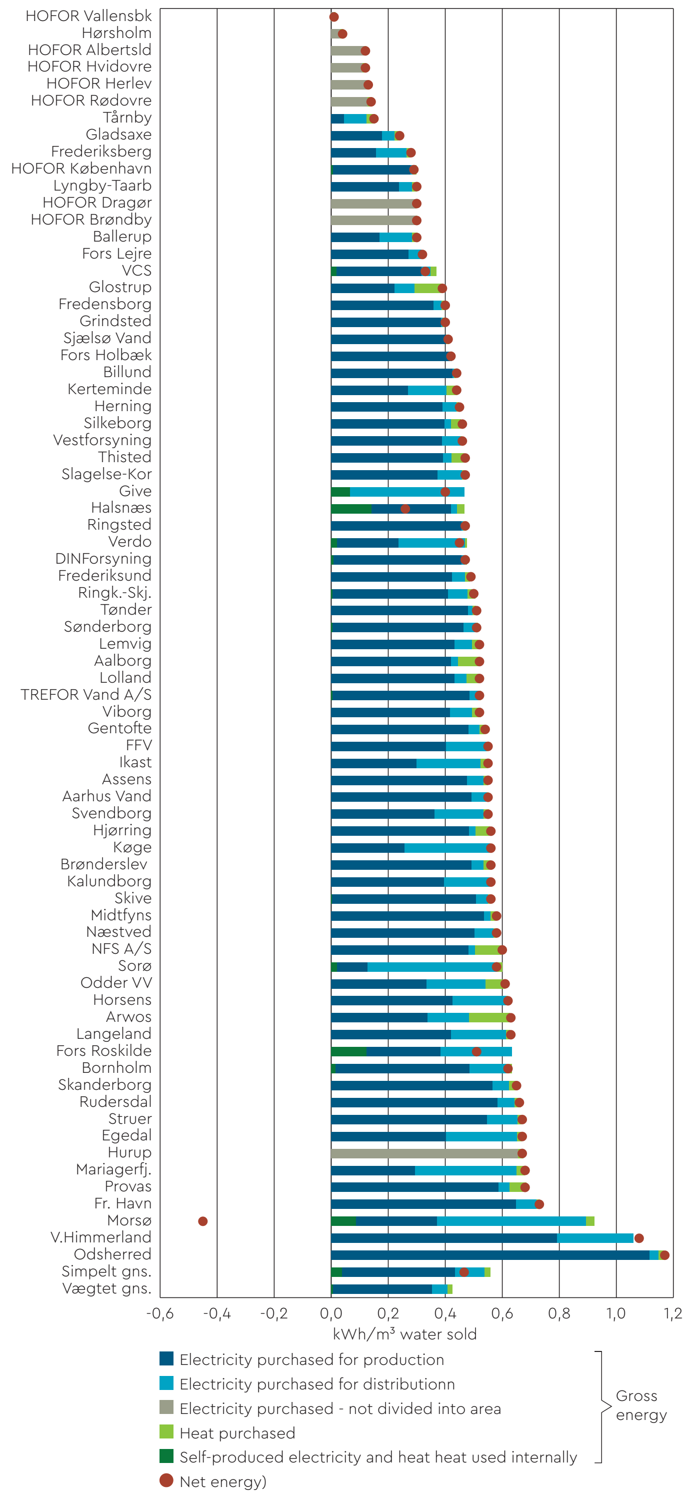
The key figure "Number of remedied incidents per 1 million m^3 of pumped water" is an expression for the number of incidents a company experiences per 1 million m^3 of pumped water, which is corrected for the additional risk involved in taking more control samples than is statutorily required. ■

Energy consumption in the water companies

There is a big difference in how much electricity and energy is consumed by the Danish water companies in supplying 1 m^3 of clean water to customers. Electricity consumption (purchased electricity) averages 0.40 kWh / m^3 sold, and the companies even produce and sell electricity equivalent to about 0.41% of the consumption. The average weighted gross energy consumption (electricity and heat) of drinking water is 0.43 kWh/ m^{3}sold. For most water companies, gross and net energy consumption is similar, since only a small proportion of the companies produce energy, most often in the form of solar cells. The exception is Morsø Vand A/S, which has a large heat production capacity based on a heat pump connected to one of the company's water towers, thereby producing more energy than is consumed in connection with drinking water production. You can read more about Morsø Forsyning's energy production later in this leaflet.

The bulk of the energy consumption in a water company comes from electricity, which can be divided into consumption by the catchment area and the waterworks, referred to as the "production", and consumption of electricity used on the distribution network from the waterworks to the customers, referred to as "distribution". 87% of the consumed electricity is used in the catchment areas and waterworks. However, what is very important for the calculations is whether the pumpout pumps are located in the production or distribution, which means that the most accurate approach is to compare the companies based on their total consumption of electricity. The difference in electricity consumption can be explained, for example, by particularly energy-intensive deep drilling, imports of treated water, topographic conditions on the pipeline or a very energy-intensive distribution system. ■

NET AND GROSS ENERGY FOR WATER COMPANIES, 2018



TEXT: JESPER WITH, JOURNALIST/ **PHOTO:** VANDCENTER SYD

VandCenter Syd: The aim is absolute sustainability

VandCenter Syd (VCS Denmark) is the first Danish water company to carry out an absolute sustainability assessment that takes into account a wide range of possible environmental impacts. This provides a much better overview and clearly demonstrates the stumbling blocks with regard to achieving the objective of becoming a sustainable business on a practical level.

TROELS KÆRGAARD BJERRE
VCS DENMARK

MORTEN RYBERG,
DTU MANAGEMENT

A lot of companies carry out sustainability assessments that include life cycle analyses, in which companies calculate their carbon and water footprint in order to document their impact on the climate and the environment. In collaboration with DTU, VCS Denmark has now gone a step further and has carried out a greatly expanded analysis - an absolute sustainability assessment.

The assessment method has been developed by DTU Management, and in addition to a "classic" life-cycle analysis, the assessment takes into account the actual tolerance of the environment in terms of resource consumption and emissions from enterprises. It provides a better overview of the environmental impact of the company and shows whether the company's activities are genuinely sustainable compared to the environment's carrying capacity.

"The analysis provides us with an understanding of where we can significantly reduce environmental impact by taking action in areas where it would have the greatest effect. It is, after all, our goal to become a sustainable company, and we have come a long way in several respects - for example by developing an energy producing wastewater treatment plant. However, the analysis shows that we need to significantly reduce our environmental impact within certain specific parameters. Some of the challenges seem almost unattainable, but now we know what our challenges are," says Troels Kærgaard Bjerre, Project Director at VCS Denmark.

What the planet can handle

The absolute sustainability assessment, unlike other sustainability assessments, addresses what the earth can carry - represented by the "planetary boundaries" - and thus does not assess sustainability according to how good a business is in relation to other companies. Planetary boundaries define absolute limits on the extent to which humans can push the earth, thus delineating a "safe space for mankind". The idea is that, in order for each company to make informed decisions about sustainability, it needs to know how close to, or far from, sustainability it is. This is necessary in order to be able to prioritise actions according to where the greatest potential can be found.

"As a company, this is interesting for us, as we influence the environment and climate in our work with drinking water and wastewater. We take responsibility for this, which is why we must act as efficiently as possible and make the most of our investments. To the benefit of our customers, our owner and, of course, Planet Earth," says Troels Kærgaard Bjerre.

He points out the discrepancy that, although we are constantly developing new, more environmentally friendly technologies and products and becoming increasingly energy efficient, things are still going the wrong way for the planet. Companies therefore need an absolute sustainability assessment that takes into account how much of an effect they can afford to have on the climate and the environment. This method grants the company the "right" to have some impact on the environment and climate in relation to how much benefit its products and services provide.

"This is not a trivial exercise, and it raises a lot of ethical dilemmas. However, we are now utilising the assessment in our strategy process, in which we set our long-term goals. The analysis has let us know several things that we were not previously aware of. For example, we learned that methane emissions from our sewers can potentially contribute significantly to our total greenhouse gas emissions. Or that degassing from our wastewater treatment plants results in the discharge of nitrous oxide, which is 265 times as powerful as CO_2. We need to pay extra attention to this," says Troels Kærgaard Bjerre.

Behind the method

Morten Ryberg and colleagues from DTU Management were the ones that developed the methodology, and they also carried out the assessment for VCS Denmark.

"Businesses need concrete targets in order to relate to how close to, or far from, sustainability they are. An absolute sustainability assessment allows them to do just that, although it is still new and is still being developed. The results thus carry a large degree of uncertainty and should be seen as an indication of the proportionality of a company's environmental impact and their scale in relation to the tolerance of the environment," says Morten Ryberg.

Some of this is not news to VCS Denmark, which is well aware that they emit greenhouse gasses and release nutrients as part of their operation. The new development is that it is now possible to set limits on how much VCS Denmark can emit in order to be sustainable.

"For example, we have found that VCS Denmark must reduce greenhouse gas emissions by approximately a factor of 8 in order to stay within their allotted climate impact limit. It is not easy to achieve such reductions, but it gives VCS Denmark concrete goals to aim for," says Morten Ryberg.

Moreover, VCS Denmark is among those companies that have already done a lot to reduce their environmental impact.

Who has the right to what?

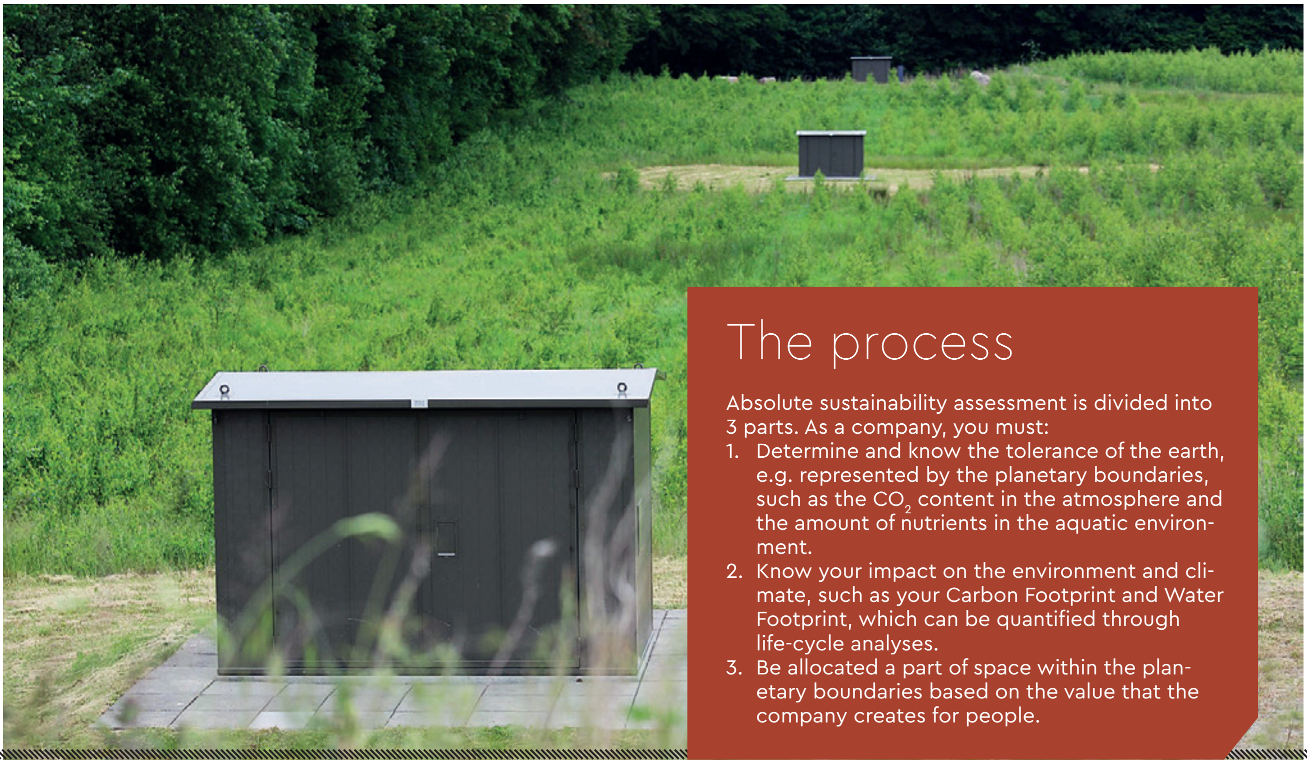
But who really has the "right" to emit into the "safe space"? It is hardly controversial, says Ryberg, that people and not, for example, companies have the moral right to use the safe space. Companies have the right to emit by way of their fulfilment of people's needs. How the right to emit should be distributed between people and between businesses is less clear and is something we are currently investigating.

"If we want to talk about absolute and not just relative sustainability, we need to discuss who should be allowed to occupy the safe space that the planetary boundaries delineate," says Morten Ryberg.

In this, the water industry has a very favourable position, as clean drinking water and wastewater treatment fulfil basic needs. It isn't hard to argue in favour of allocating space to activities that fulfil basic needs, and which are thus fundamentally important to create a good livelihood for our civilisation.

He believes that the advantage of the absolute sustainability assessment is that it provides companies with relevant and concrete goals that they can use themselves and set ambitious sustainability goals.

"In the longer term, I hope that more and more people will use it as they see others use it, and that being sustainable in an absolute sense might become a competitive factor," says Morten Ryberg. ■



The process

Absolute sustainability assessment is divided into 3 parts. As a company, you must:

1. Determine and know the tolerance of the earth, e.g. represented by the planetary boundaries, such as the CO_2 content in the atmosphere and the amount of nutrients in the aquatic environment.
2. Know your impact on the environment and climate, such as your Carbon Footprint and Water Footprint, which can be quantified through life-cycle analyses.
3. Be allocated a part of space within the planetary boundaries based on the value that the company creates for people.

PHOTO: COLOURBOX

SUSTAINABLE DEVELOPMENT GOALS

for better utilities

More and more Danish water and wastewater companies are using the sustainable development goals (SDGs) as a framework for creating better results for the environment and customers.

17 goals and 169 targets sound like quite a lot, but since the UN adopted the SDGs in the autumn of 2015, a large number of Danish water and wastewater companies now work with the SDGs to provide better services.

The study “Action areas and development trends in the utilities sector” conducted by Pluss Leadership and EY in August 2019 shows that out of 199 utilities surveyed:

- 31% of decision-makers are actively working with the SDGs and have either included the SDGs in their strategy or have indicated that the SDGs are an active part of their core business.
- 51% of decision-makers are either investigating what the SDGs might mean for their company or are in the process of creating an overview of the possibilities in working on the SDGs.
- The remaining companies replied that they do not work on the SDGs and/or do not consider them particularly relevant to their company.

The study shows that it is especially municipally owned utilities and inter-municipal waste companies that have implemented the United Nations SDGs or are actively working towards the SDGs.

The result of the study does not surprise DANVA, as the water and wastewater companies' interest in the SDGs was already noticeable in the summer of 2018, when we compiled a catalogue of inspiration for the endeavour. Many water companies have already made considerable efforts to integrate the SDGs into their activities, even though their approaches vary and depend on both internal and external factors.

Three approaches to the SDGs

- The SDGs are used as a tool for communicating with customers about the company's activities, and how they themselves might contribute to improving drinking water and the environment. The goals provide a common language and a strong framework for communication.
- The SDGs are used strategically. The focus is on how the goals contribute to change and are the starting point for prioritisation of action areas.
- The SDGs are used internally within the company as a means of communication, so employees see their work as part of a wider context, contribute to overcome daily challenges and solve global problems.

Many goals to choose from

It is often appropriate to go through the SDGs and prioritise what makes the best sense for each individual company. All water companies focus on goal 6 — the water goal, but otherwise the companies' priorities vary. Below are a few examples of selected goals:

- Herning Water prioritises goals 4, 6, 13 and 17.
- VCS Denmark base their approach on their business, relevance to the company and the achievability of the goals and therefore prioritize 6, 7, 9, 12, and 14.
- Aarhus Vand integrates and measures goals 6, 13 and 14 as part of their strategic efforts.
- BIOFOS works to integrate 6, 7, 11, 12, 13, 14, 17 into their strategy.

Read more about the work of water companies with SDGs on the DANVA website: https://www.danva.dk/publikationer/vandsektor-en-og-verdensmaalene/ ■

WASTEWATER COMPANIES in DANVA Statistics and Benchmarking

In 2019, 87 wastewater companies reported data to DANVA Statistics and Benchmarking. The reported figures are for 2018. Together, the companies provide services to approximately 4.99 million people and operate 471 treatment plants, which purify more than 576 million m³ of wastewater with a load of 7.26 million population equivalents. The wastewater is transported through approximately 80,400 km of sewage system with 2.28 million service pipes. In total, the sewerage area accounts for about 250,000 hectares. Total investments and renovations amounted to approximately € 630 millions and actual operating costs were just over € 369 millions. (see the participants' overall key figures at the end of this publication).

Slight decrease in the operating costs of wastewater companies

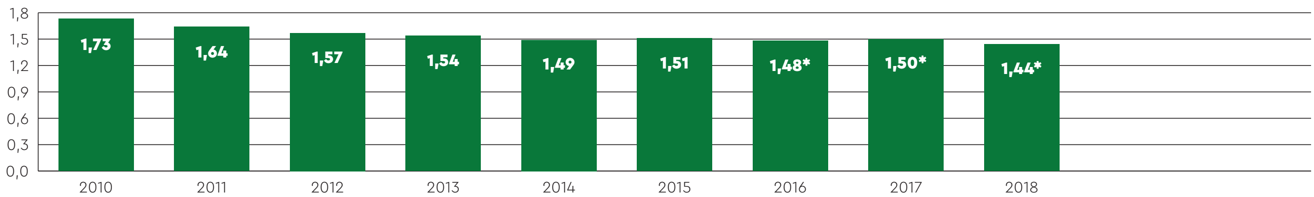
The inventory of actual operating costs of wastewater companies shows a drop in 2018 of 5.4 cents per m³ compared to last year. Actual operating costs are governed by the Danish Water Sector Act's requirements for efficiency improvements, and they form the basis for comparing the companies' efficiency. Actual operating costs exclude VAT and other charges/taxes, non-controllable costs and any selected associated activities. Since 2016, there has been a change in the calculation of actual operating costs, which in relation to how the old method, now includes operating costs for environmental and service objectives, part of the previous 1:1 costs, plus any selected associated activities.

Investments have declined significantly

The calculation of investments carried out by wastewater companies in 2018 shows a slowdown in investment for the fourth year in a row. From 2017 to 2018, the drop was significant at € 0.36/sold m³. However, the large drop is due to a few companies that have had significantly fewer investments than in previous years. However, all companies continue to expect increased investment in the coming years — up to € 0.94/m³ sold water than was realized in 2018. The reason for this may be attributable to the framework under which the wastewater companies are operated. Companies may be restricted in their ability

OPERATING COSTS, 2010-2018

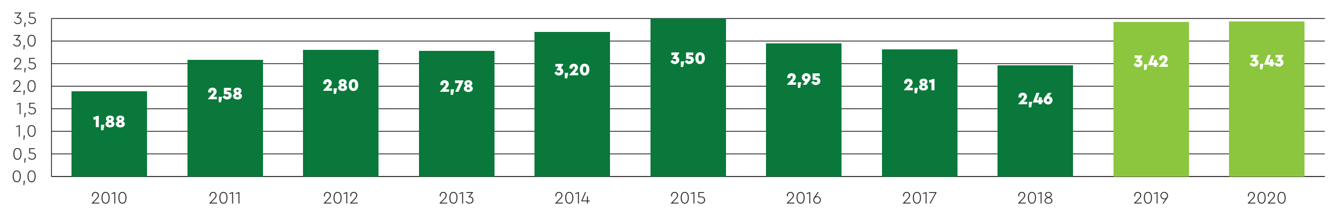
€/M³ SOLD WATER (2018 PRICES)



2010–2018: Actual operating costs (62–87 companies)
*: New calculation of actual operating costs (FADO)

INVESTMENTS, 2010-2018

€/m³ sold water (2018 prices)



2010–2018: Implemented investments (66–80 companies – Investments and renovations)
2019–2020: Planned investments (80 companies – Investments and renovations)

to invest due to economic regulation, even though there are a large number of climate investments that should be implemented.

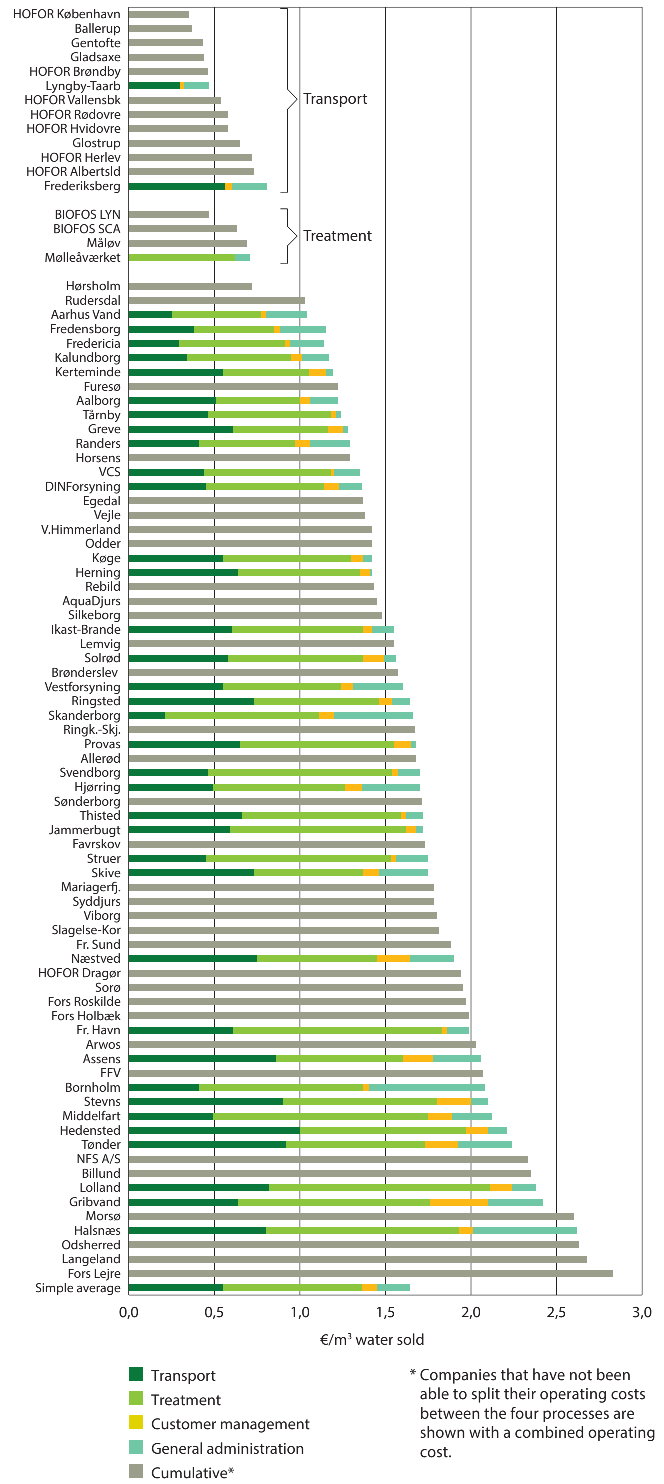
Breakdown of expenditure and investment

Wastewater companies spend, on average, 34% of their actual operating costs on the transport network, 48% on wastewater treatment, 5% on customer service and 13% on general administration. An account of investments and renovations shows that 85% of the implemented investments and renovations are used for improvements and upgrades and augmentations of the transport network, while 13% are used in the treatment plants. The remaining 2% is used for other investments. ■

Large variations in actual operating costs

It costs an average of DKK 10.75 to transport and treat 1 m³ of sold water. The variation between individual companies' expenses per m³ is relatively large and reflects the very different framework conditions under which the companies operate. These may, for example, include topographic differences, differences in population density, and the relationship between residential areas and large industries. The treatment and disposal of sludge also affects operating costs.

ACTUAL OPERATING COSTS, 2018



FOCUS ON DISCHARGE FROM OVERFLOW SPILLWAYS

There is an increased focus on discharge from overflow spillways on wastewater companies' combined sewerage, and the new government is also announcing actions to improve the knowledge regarding overflow. The government's goal is to improve the condition of the aquatic environment.

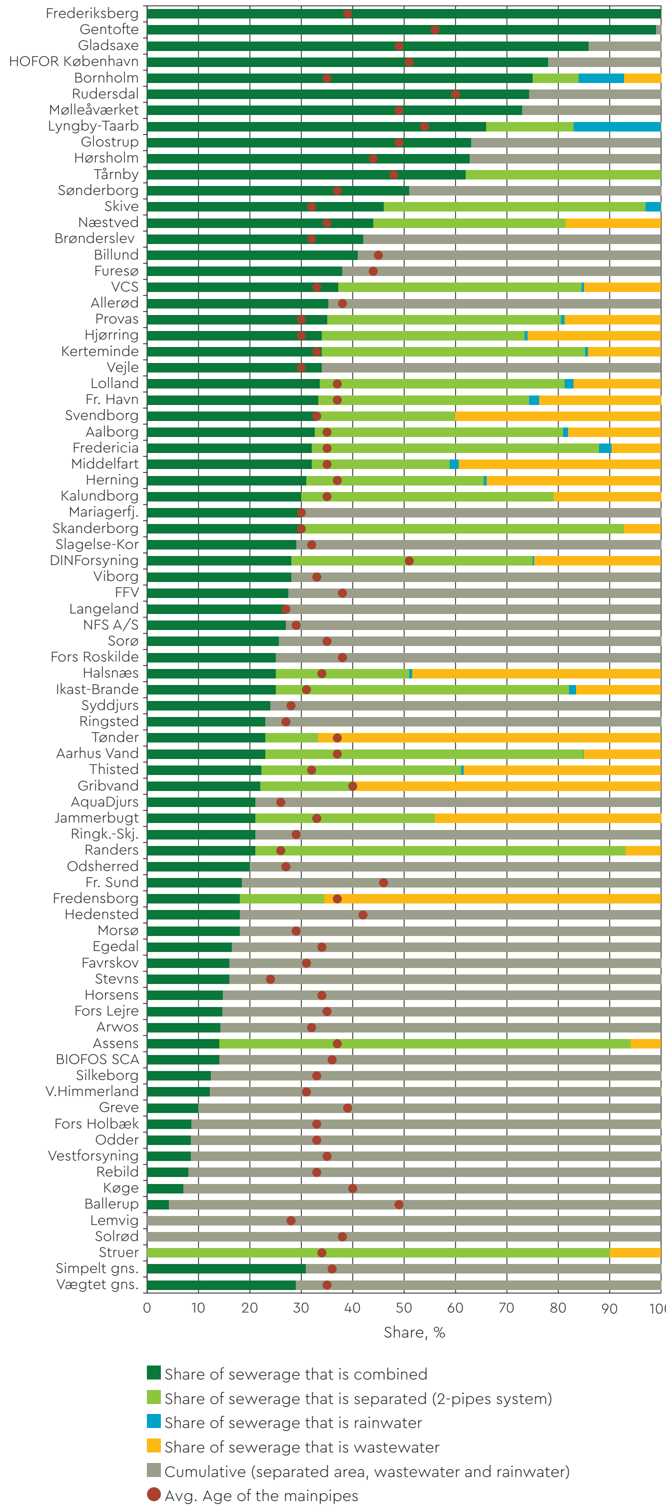
Combined sewer overflow

For historical reasons, the oldest parts of the wastewater systems have been set up as combined sewers, which means that rain and wastewater are routed through the same pipe to the treatment plant. In order not to have to build unreasonably large sewage pipes and have to clean very large volumes of water, the pressure on combined sewers is eased via overflow spillways through the discharge of diluted wastewater to nearby receivers during rainfall. Properly dimensioned overflow spillways have relatively little effect on the aquatic environment by ensuring that deposits and particles are passed on to the treatment plant, while the rainwater – with a relatively low nutrient content – is discharged to the receiver. Wastewater companies are continuously working to reduce the overflow from the combined sewers. This is done through various measures, including the removal of rainwater from the combined sewers through the seepage of rooftop water, decoupling and dissipation of rooftop water on the surface, or the total separation of rain and wastewater into separate pipeline systems. In effort to minimise discharge from the combined sewers, it is important to pay attention to whether it is the hygienic/health conditions and/or the environmental impacts that are significant in the specific situation, as it can otherwise be difficult to decide which would be the most effective method to achieve the desired effect.

According to the report: Point sources 2017 from the Ministry of Environment & Food, February 2019, 4,601 sewer outlets were registered from combined sewer areas in Denmark. Continuous work is being done to renovate sewage systems, and often this means that combined sewer areas are separated and the overflow structures from combined sewers are decommissioned. The number of overflow spillways was reduced by 279 between 2016 and 2017. The report to DANVA Benchmarking shows that 40% of the benchmark participants' structures are monitored. This monitoring may range from recording whether there is an overflow to calculating the amount of water discharged based on a recording of water level above the overflow edge and the duration of the overflow.

The point source report indicates that the total area of the combined sewer area has decreased by 5% and that the share of separate sewerage has increased accordingly. The fact that companies are deliberately working to reduce overflow effects can be seen in the point source

AREA ALLOCATION BETWEEN COMBINED AND SEPARATE SEWERAGE, 2018



report's statement that the reservoir volume of the combined sewers has risen (15%) even though the area has been reduced.

Separate sewerage

Wastewater companies may choose to expand the existing combined sewer network with larger pipelines and wastewater basins in order to cope with increased rainfall. The most commonly used method to avoid water rising up in basements is to separate the rainwater from the wastewater and to establish a 2-line sewerage system. Alternatively, the rainwater can be disconnected from the existing combined sewer and discharge locally on private property (local drainage of rainwater is referred to as LAR). The LAR-method is combined with cloudburst mitigation measures and flooding from surface runoff to solve several problems at once. This method can allow customers to find cheaper solutions and to take responsibility for climate adaptation by, for example, setting up rain gardens or dry wells for rainwater seepage. The work companies do to separate rainwater and wastewater is designed to prevent, i.a., basement flooding, surface water and unwanted discharges of nutrients and pathogenic bacteria through overflows from the sewerage network during heavy rain. In areas that are less densely inhabited, companies choose to do so for a number of reasons, including because they want to remove extraneous water (groundwater and drainage water), minimize the transport (pumping) of rainwater, or have a more even flow on treatment systems. But renovation needs are also a significant separation driver here.

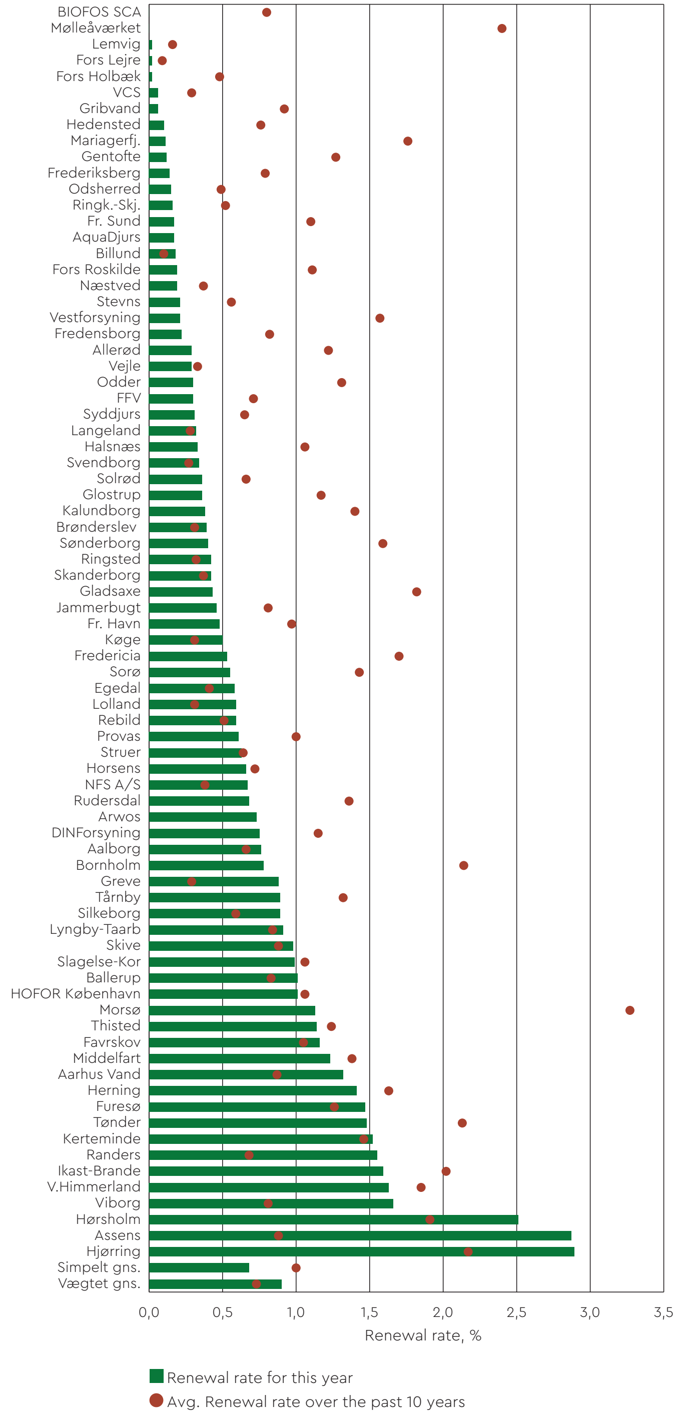
Distribution between combined and separate sewerage

There is a very substantial difference in the degree of separate sewerage among the benchmarked wastewater companies. Some companies have almost exclusively combined sewers, while others have mainly split wastewater and rainwater into separate sewerage/drainage systems.

Renewal of the transport network

The rate of renewal of the sewerage network shows how much of the pipeline 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 sewerage networks of recent years. Factors such as materials used, pipe dimensions, leaks and failures, geological conditions, surface load and age influence when the sewage system should be renewed. Another significant 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. ■

RATE OF RENEWAL OF SEWER PIPES, 2018



Energy consumed by the wastewater companies

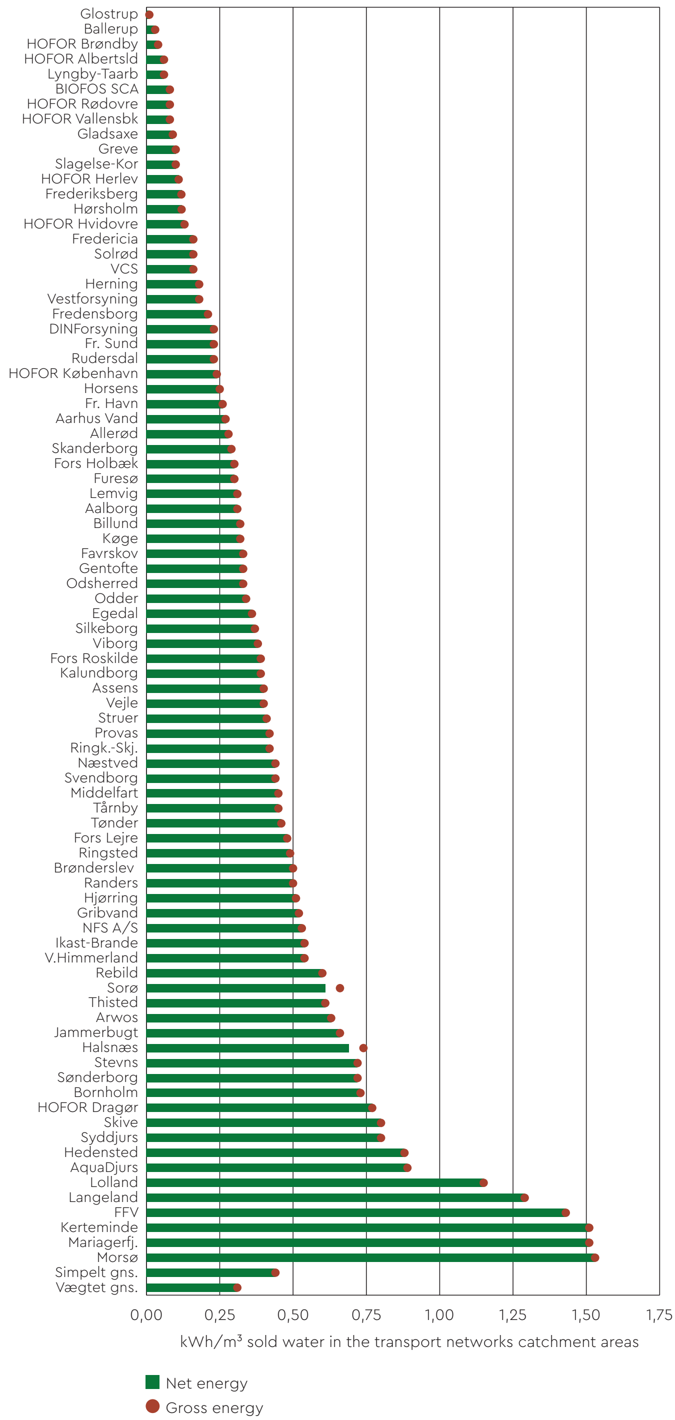
The consumption of energy by wastewater companies is divided into energy consumption in the transport network and energy consumption at the wastewater treatment plants, respectively. This has been done in order to produce appropriate comparable key figures such as kWh/sold m³ in the catchment area of the sewerage system and the wastewater treatment plant. This is necessary as there is often a large difference between the two accounts of water sold due to imports and exports across municipalities. Particularly in Copenhagen, wastewater is collected in a few large wastewater treatment plants, where the wastewater is supplied from several companies that only operate the sewerage system. The key figures reflect the amount of energy needed when a customer has purchased one m³ of water and discharged it into the sewer.

The graphs show the companies' net and gross energy use on the transport network, which is stated collectively for all the company's wastewater treatment plants. In the sewer system, the net and gross energy ratio remains the same for the vast majority of the companies, as very few companies have a very low energy production associated with their sewer system. However, there is a distinct difference between net and gross energy consumption for treatment plants, as treatment plants over a certain size have the potential to produce energy, most often at biogas plants that generate electricity and heat. Some companies carry out sludge incineration, which provides large amounts of heat. The latest trend in energy production is the use of heat pumps, which draw large amounts of heat out of lukewarm wastewater, which can be a stable and continuous source of heat all year round. Kalundborg Forsyning has, as the first wastewater company, reported heat production based on heat pumps, and they differ significantly from the other forms of energy production in the net energy balance in that they have a very high energy production in the form of district heating (see more on the following page). Some companies have chosen not to include energy production internally within the plant, but instead cooperate with, for example, a biogas plant, which converts sludge received from the wastewater company into energy in the form of gas, which is often subsequently converted into electricity and heat. Other companies do not have the means for biogas energy production, usually because sludge quantities are insufficient. These companies often have identical net and gross energy consumption.

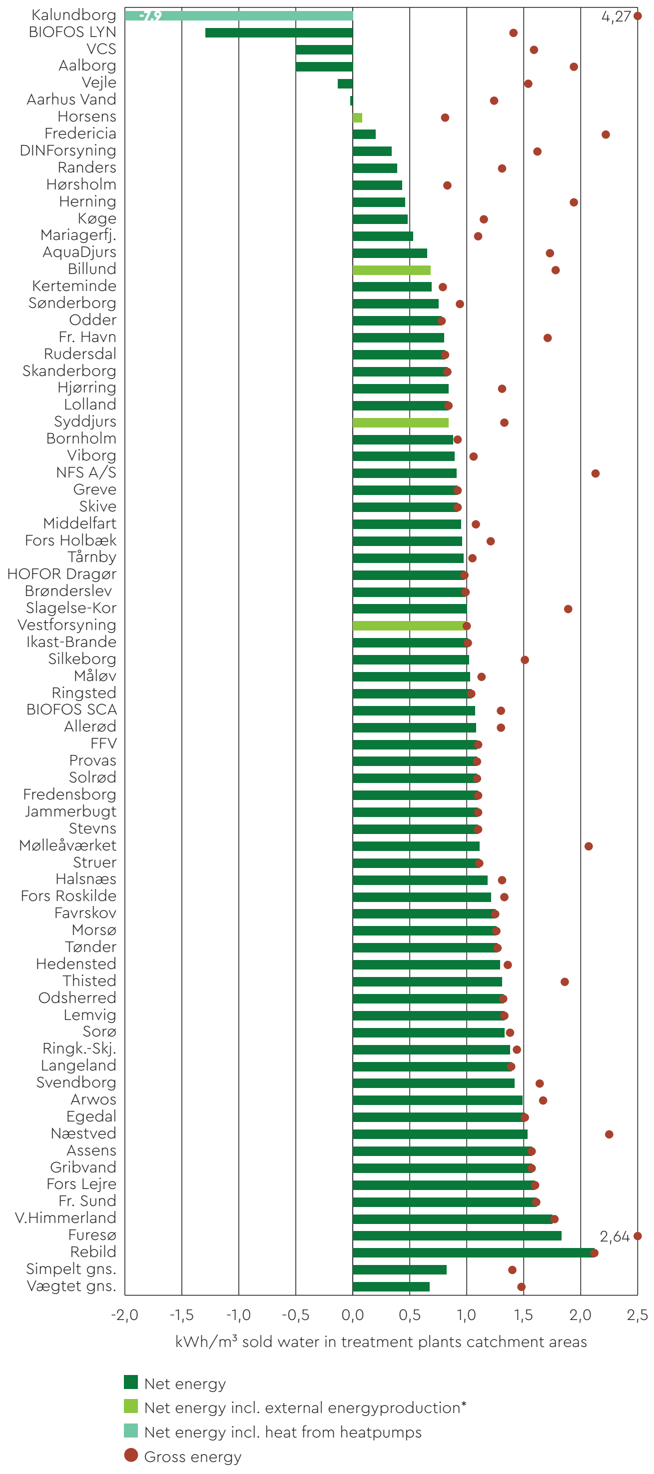
The average gross energy consumption per m³ of sold water for consumers is 1.79 kWh, divided into 0.31 kWh/m³ for the transport network and 1.48 kWh/m³ for purification.

The average net energy consumption per m³ of water sold by consumers is 0.48 kWh/m³ , divided into 0.31 kWh/m³ for transport and 0.17 kWh/m³ for treatment. The figure for treatment has more than halved compared to last year, which is due to Kalundborg Forsyning's new heat pump production. If heat pump energy is omitted for the purpose of comparing with last year, the net energy consumption is 0.34 kWh/m³, which is 0.04 kWh/m³ lower than in 2017.

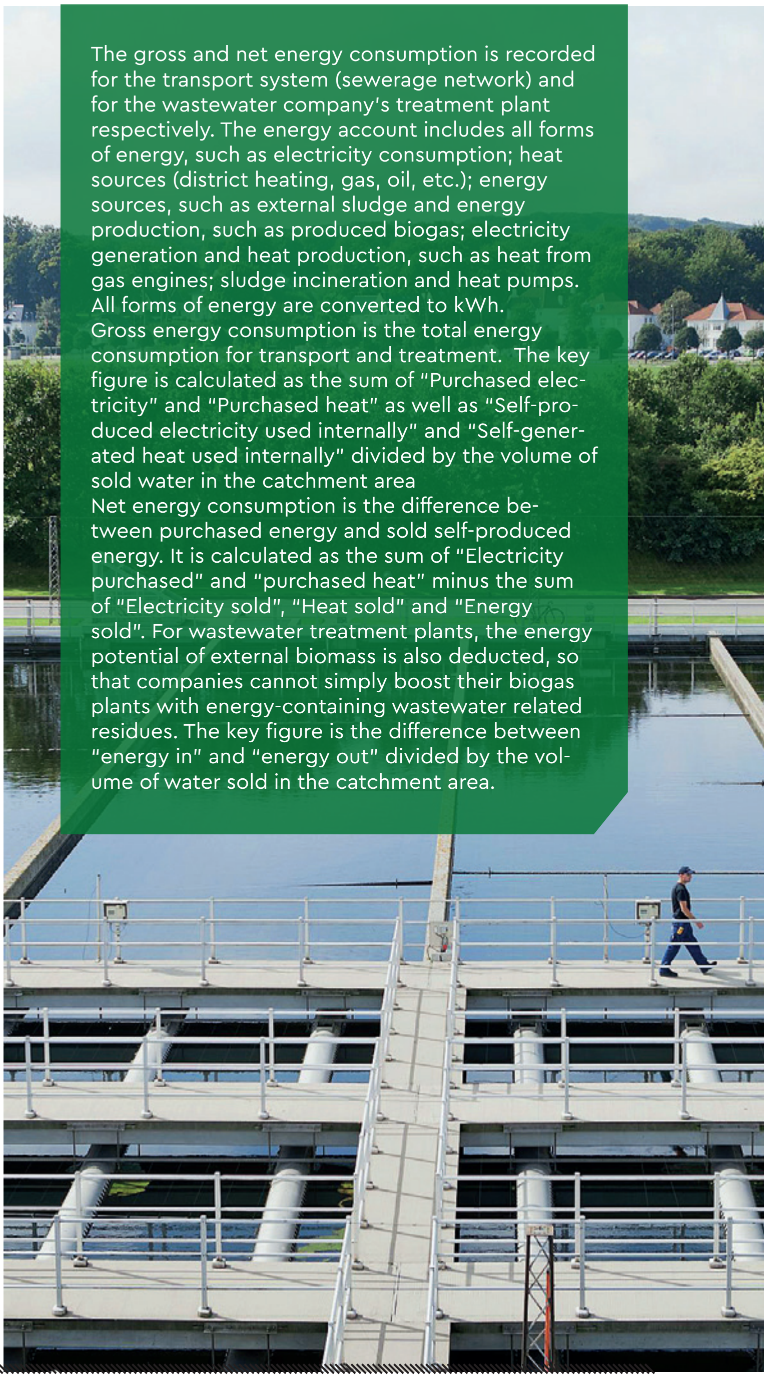
NET AND GROSS ENERGY FOR TRANSPORTATION, 2018



NET AND GROSS ENERGY FOR TREATMENT, 2018



The companies on average purchase electricity equivalent to 1.44 kWh/m³ water sold to customer, divided into 0.33 kWh for transport to the treatment plant and 1.11 kWh for treatment. If the sold electricity produced by the companies themselves is deducted, the net electricity consumption is 1.22 kWh/m³on average. The 36 wastewater companies with their own electricity production that is equivalent to about 28% of their own electricity consumption. ■



The gross and net energy consumption is recorded for the transport system (sewerage network) and for the wastewater company's treatment plant respectively. The energy account includes all forms of energy, such as electricity consumption; heat sources (district heating, gas, oil, etc.); energy sources, such as external sludge and energy production, such as produced biogas; electricity generation and heat production, such as heat from gas engines; sludge incineration and heat pumps. All forms of energy are converted to kWh.
Gross energy consumption is the total energy consumption for transport and treatment. The key figure is calculated as the sum of "Purchased electricity" and "Purchased heat" as well as "Self-produced electricity used internally" and "Self-generated heat used internally" divided by the volume of sold water in the catchment area
Net energy consumption is the difference between purchased energy and sold self-produced energy. It is calculated as the sum of "Electricity purchased" and "purchased heat" minus the sum of "Electricity sold", "Heat sold" and "Energy sold". For wastewater treatment plants, the energy potential of external biomass is also deducted, so that companies cannot simply boost their biogas plants with energy-containing wastewater related residues. The key figure is the difference between "energy in" and "energy out" divided by the volume of water sold in the catchment area.

TEXT: ANNELINE HØJRUP/ PHOTO: MORSØ FORSYNING AND KALUNDBORG FORSYNING

HEAT PUMPS
provide new energy to the water sector


HANS-MARTIN FRIIS MØLLER
CEO, KALUNDBORG FORSYNING


VILLY KRISTENSEN
OPERATIONS MANAGER
NYKØBING VANDVÆRK

Morsø Forsyning and Kalundborg Forsyning are the first two Danish water companies to own and use heat pumps, and they stand out clearly in the year's benchmarking of the companies' net and gross energy consumption. Heat pumps are expected to have a major impact on the overall energy accounts of the water industry and the quest to become energy neutral.

At Mors, the heat pump ensures cooler drinking water and reduces the risk of accumulation of bacteria, while Kalundborg Forsyning, with Denmark's largest heat pump, has been the frontrunner among the energy-producing wastewater companies.

Kalundborg Forsyning breaks the mould for energy production

On a sunny Wednesday in June 2017, H.M. Queen Margrethe inaugurated Denmark's largest heat pump plant at Kalundborg Forsyning. A plant that produces 80,000 MWh of district heating per year and thus covers 30% of the customer's district heating consumption — or all the district heating used by the 5,000 customers during the summer.

"Alternatively, this district heating would have to be produced using coal, so the heat pump helps to reduce CO_2 emissions by 16,600 tonnes per year," says Hans-Martin Friis Møller, CEO of Kalundborg Forsyning. He further explains that being a part of Kalundborg Symbiosis has been important for the project, which is a close collaboration between eight private and public companies that have been working since 1972 to create a circular approach to production and resource utilization. Among the private companies in the symbiosis are Novo Nordisk, Novozymes and Equinor Refining.

"Industrial cooperation is a prerequisite for the project. For example, we have separate sewerage systems from the industries, allowing us to draw out as much heat as we can. It also allows us to reuse the water in several ways. These solutions can also be attractive for other wastewater companies with nearby industries," says Hans-Martin Friis Møller.

The wastewater company as a heat producer

The process water Kalundborg Forsyning receives from the city's largest companies has a temperature of 25 degrees all year round. The industrial water is mixed with the sanitary wastewater from the city, resulting in faster biological processes, and it is then treated before being run through the heat pump, where it is cooled down by 10 degrees. The excess heat can then be sold by the wastewater company to the heat supplier.

"It was important for us that our companies were organised correctly, so that the heat pump is owned by Renseanlæg A/S and not by Varme A/S. This is because the Danish Water Sector Act allows wastewater companies to produce energy as part of their core service. We saw a great opportunity to create a green solution and a profit by selling the excess heat from our wastewater to the heat supplier, which was why we were ready and sent the application on the same day the revision of the Danish Water Sector Act went through," says Hans-Martin Friis Møller, who believes that other wastewater companies might benefit from organising themselves in the same way if they want to produce energy for district heating.

Healthy project economy

Since then, Denmark's largest heat pump facility has become a reality.

"We had a budget of € 8.72 millions and spent € 8.59 millions. Additionally, under the Energy Saving Scheme, Rens A/S was able to sell the energy savings we achieved, which generated a revenue of € 4.16 millions," says the Director.

The facility is not permanently staffed, but is monitored, and employees can start it up and run troubleshooting from home.

"It has produced more heat than expected, but there have also been some technical challenges, which the supplier has thankfully been good at following up on," says Hans-Martin Friis Møller, who is very satisfied overall with the project economy. The plant has a measured COP value of 4.0, which is an expression of the efficiency that tells how much heat comes out in relation to the amount of power put in.

"We maintain our budgets, and the fact that we can sell surplus heat from the wastewater means that the cost of wastewater treatment is reduced. In this way, the heat pump is of benefit to both the businesses and the citizens of Kalundborg."

Heat pump provides colder drinking water on Mors

Morsø Forsyning is the first water company in Denmark to install a heat pump — and now they actually have two.

"It started with us thinking that the electric heating bill for the water plant was too expensive, and then we had a heat pump installed on a partial stream from our pumping plant, so it then supplied the heat we needed ourselves. It works very well," says Villy Kristensen, Operational Manager for Nykøbing Vandværk.

The heat pump provides heat all year round to the waterworks' premises of 130 sqm, a workshop of 110 sqm, which is kept frost-free, and hot water in the showers and taps at Nykøbing Vandværk.

Cold drinking water provides heat

Morsø Forsyning also wanted to supply cooler water to the approximate 9,300 inhabitants in the supply area, and based on their good experience with the smaller heat pump, a larger 140 kW heat pump system was installed in 2014 at the one of the island's two water towers.

"During hot summer periods, the water in the tower can reach up to 15 degrees, while in winter it drops down to 6-7 degrees. We want it to be as cold as possible, without the formation of ice," says Villy Kristensen.

With the help of the heat pump, the water can be cooled 3-4 degrees, and the heat extracted can be sold to the heating plant that is next door to the water tower.

Less risk of bacteria

In 2018, which so far has been the best performing year for the pump, 715 MWh of district heating was produced. The efficiency of the heat pump has a COP value of 2.9, but according to Villy Kristensen, this is not entirely satisfactory.

"We want the COP value to go up to at least 3.1. But we have two challenges. In winter, there is too little flow in the water tower and too little heat for us to draw out, while in the summer, we find it difficult to sell the heat, partially because we have several schools and the island's upper secondary school among our receivers, and they shut down completely during the summer."

If the project is to succeed financially, it therefore requires an option for storing heat, for example, in an energy storage tank. On the other hand, the project has another great advantage. The cooling of drinking water means that the risk of accumulation of bacteria is minimized. ■

Need for new solutions to remove extraneous water

Extraneous water is present, to varying degrees, among the various wastewater companies. Conditions such as the origin of the sewerage system, groundwater level, soil conditions, rainfall and the state of the sewerage system are parameters which affect the amount of extraneous water directed to the treatment plants.

Extraneous water comprises, among other things:

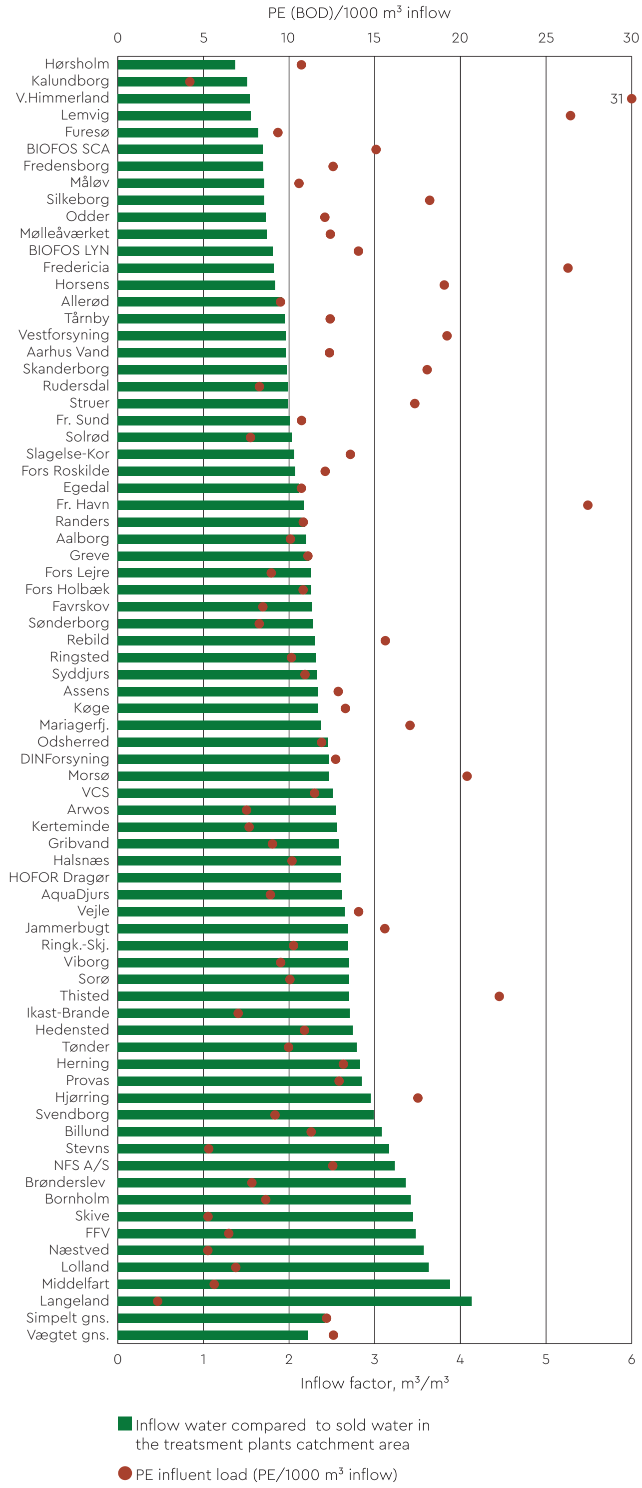
- Seeping groundwater in areas where the sewerage pipes are below the groundwater level.
- Faulty connections in rainwater pipes and road drainage into wastewater systems.
- Drainage water connected to wastewater systems.
- Previous drainage lines and piped streams which have eventually become wastewater systems over time without disconnecting the streams.

When the amount of extraneous water is totalled, it is compared with the expected volume of wastewater that the wastewater treatment plant should receive. This largely corresponds to the amount of drinking water sold. The graph shows that the flow rate to the treatment plants varies and that the inflow factor is between 1.5 and 4 — corresponding to 150-400% of the volume of water purchased and discharged by customers into the sewer. There has been an average decrease of 24% in the volume of extraneous water from 2017 to 2018. This corresponds to about 85 million m^3 and is likely to be attributed to the difference between the record high annual rainfall in 2017 and the relatively low rainfall in 2018.

In 2018, the Danish Environmental Protection Agency estimated the total volume of extraneous water at 150-200 million m^3 of water annually. The amount of extraneous water is expected to increase due to the influence of climate change on increased rainfall and rising terrestrial groundwater levels. Problems are already occurring in several places due to rising groundwater in the form of damp basements, paludification of residential areas, reduced security of supply, etc.

Wastewater companies have the tools to frequently address the challenges of rising groundwater in cooperation with municipalities, but legislation prevents both municipalities and wastewater companies from implementing the best environmental and societal solutions. ■

INFLOW FACTOR AND INFLUENT LOAD TO THE TREATMENT PLANTS, 2018



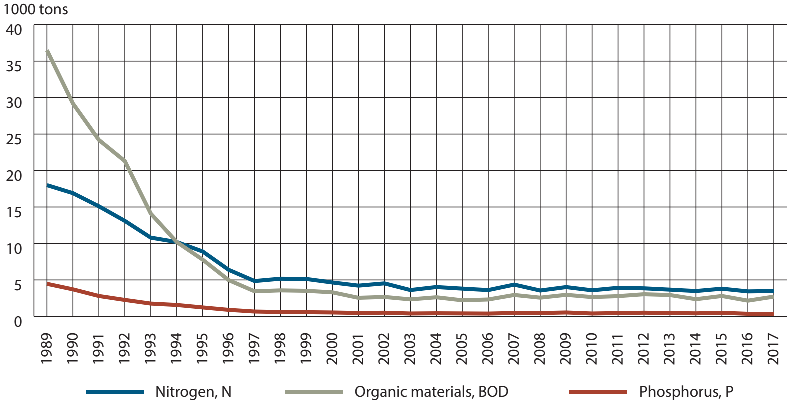
Loads at the wastewater treatment plants

There is a very large variation in the organic matter content of the wastewater flowing to the wastewater treatment plants. Companies such as slaughterhouses or breweries emit large quantities of organic matter, and wastewater treatment plants having this kind of industry within the catchment area have "thick" wastewater. If the treatment plant mainly receives wastewater from residential areas, the wastewater is defined as "thin". The wastewater's load is calculated in person equivalents, called PE. One person equivalent is defined as what one adult person contributes in the way of organic biodegradable material, nitrogen and phosphorus per day. 1 PE corresponds to 60 g of BI5/day, 12 g N/day and 2.7 g P/day.

Discharges from wastewater treatment plants

Initiated by the Environmental Plan for Water 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 to lakes and fjords. This led to a sharp increase in wastewater tariffs in the late 1980s, equivalent to a doubling between 1985 and 1990, as wastewater companies had to spend a lot of money on the development of wastewater treatment facilities. The result was clearly shown in the reduction of nutrients discharged from treatment plants over the next 10 years. From 1989 to 1998, organic matter was reduced by 90%, nitrogen by 71% and phosphorus by 87%. For many years, discharge has been at a reasonably low and constant level.

OUTLET OF NUTRIENTS FROM WASTEWATER TREATMENT PLANTS, 1989 - 2017



Source: Point sources 2017, Ministry of Environment and Food.

Wastewater companies' treatment of sludge

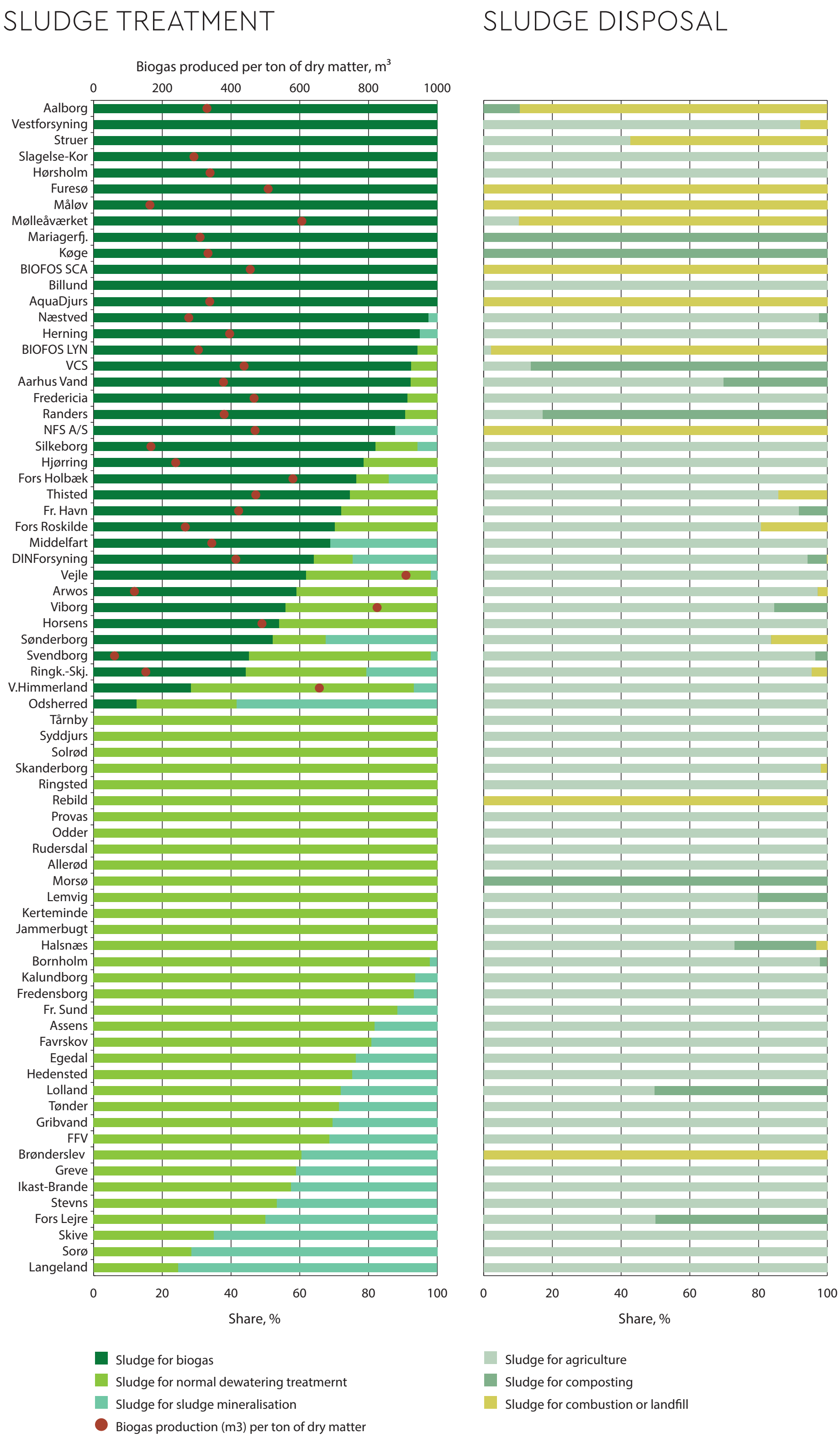
When the Danes' wastewater has been led to a treatment plant, treated and subsequently discharged to a recipient, the companies are left with the biological sludge, which is a surplus product from the treatment. The sludge treatment at the treatment plants represents about 28% on average of the operating costs of internal sludge treatment and disposal, called sludge disposal. For wastewater companies without biogas plants, the average is around 21% of operating costs, and for companies with biogas plants, the average is 31% of operating costs.

Internal sludge treatment

The production of surplus sludge extracted from the biological aeration tanks by the wastewater companies is divided into three groups defined under the regulation:

- Sludge that only undergoes ordinary dewatering before disposal (normal treatment).
- Sludge used for biogas production and which is subsequently dewatered before disposal.
- Sludge run directly onto sludge mineralisation beds where the sludge is slowly degraded. The sludge beds are usually emptied every 10 years.

It is up to each wastewater company to decide which type of treatment is chosen. It is often larger plants with large quantities of surplus sludge that are able to build a biogas plant and thereby gain extra energy from the sludge while making the final product more stable. There is a relatively large difference in how much biogas the various companies can extract from their excess sludge. This is due, among other things, to the difference between the composition of the sludge, for example the proportion of organic matter and whether the companies add anything other than sewage sludge to their biogas plants, such as industrial



waste. The sewage companies' costs for treating sludge in the treatment plants represent approximately 15% of the total operating costs of the wastewater treatment plants.

Sludge disposal

As a rule, dewatered sludge is disposed of in 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 content of heavy metals in the sludge.

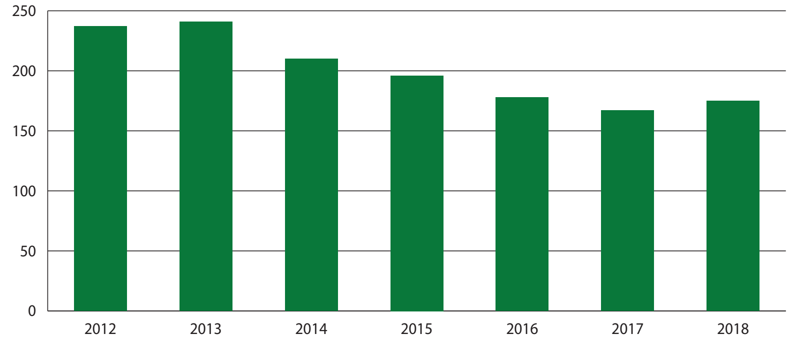
It is the wastewater company itself that determines the method of disposal based on analyses of the sludge and the company's own strategy for sludge management. The wastewater companies subject to the Danish Water Sector Act have a total surplus sludge of approximately 140,000 tonnes of dry matter, and the disposal of sludge accounts for an average of about 13% of the wastewater companies' total operating costs at the treatment plants.

The price of disposing of sludge on agricultural land rose in 2018

Over the last few years, there has been a focus on the price of sludge disposed of on agricultural land. The costs mainly consist of the transport costs and payments to the recipient. DANVA Benchmarking previously performed an analysis of factors that influence the price. The most important factors are the dry matter content of sludge, which determines the number of lorries required for transport and, of course, the distance to the recipient. The option of having storage on site at the wastewater treatment plant as well as the duration of the disposal agreements also have an effect on the price. In a market where prices are falling, shorter contracts will be most advantageous. The price for disposing of sludge on agricultural land has decreased by approximately 30% between 2012 and 2017. In 2017, new rules were introduced regarding the amount of sludge, based on phosphorus content, that can be applied to agricultural land, which means that a larger area is needed to dispose of the same amount of sludge. This, in combination with other tightening of land-use rules, has led to an increase from 2017 to 2018 of around 6.5% based on the prices of 24 wastewater companies. Sludge disposal agreements are usually multi-year agreements and it can thus be expected that the average price will increase over the next few years. ■

AVERAGE PRICES FOR DISPOSAL OF SLUDGE FOR AGRICULTURE

€ PER TONNE OF DRY MATTER



Simple average based on 11 companies participating for the last 7 years.

DRINKING WATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2019

(DATA FOR 2018)

	BASIC DATA					
	Inhabitants in the supply area	Total quantity of water sold	Boreholes (water catchment area)	Waterworks	Hardness of extracted water	Distribution network (supply pipes)
Company	persons	m^3/year	number	number	dH	km
Arwos Vand A/S	16,500	1,213,160	13	3	12.3	261
Assens Vandværk A/S	8,400	611,757	7	2	19.0	129
Billund Drikkevand A/S	7,250	742,375	7	1	7.4	157
Bornholms Energi & Forsyning A/S	20,000	1,318,224	27	4	15.0	780
Brønderslev Vand A/S	15,500	950,747	12	3	11.4	361
DIN Forsyning Vand A/S	118,800	8,728,624	79	10	7.4	1,471
Energi Viborg Vand A/S	53,675	2,461,458	12	4	8.0	561
FFV Vand A/S	9,363	688,460	8	2	18.0	212
Fors Vand Holbæk A/S	31,673	2,226,373	14	2	15.2	221
Fors Vand Lejre A/S	5,468	222,447	3	1	21.0	87
Fors Vand Roskilde A/S	56,018	3,167,566	12	1	21.3	356
Fredensborg Vand A/S	40,210	1,781,823	12	2	14.0	284
Frederiksberg Vand A/S	103,960	5,177,905	5	1	29.0	174
Frederikshavn Vand A/S	54,000	4,562,000	96	5	8.0	1,211
Give Vandværk A.m.b.a	5,000	305,606	8	2	7.2	77
Glostrup Vand A/S	22,615	1,339,233	13	2	25.0	98
Grindsted Vandværk A.m.b.a.	12,019	1,137,171	11	2	6.6	260
Halsnæs Vand A/S	10,400	579,054	11	2	18.0	169
Herning Vand A/S	78,282	3,251,255	20	3	8.5	718
Hjørring Vandselskab A/S	40,000	3,233,629	46	5	14.0	841
HOFOR Vand Albertslund A/S		1,269,784				97
HOFOR Vand Brøndby A/S		1,926,015				161
HOFOR Vand Dragør A/S		675,413				88
HOFOR Vand Herlev A/S		1,537,669				115
HOFOR Vand Hvidovre A/S		3,270,117				212
HOFOR Vand København A/S	613,288	52,800,406	380	7	20.0	1,085
HOFOR Vand Rødovre A/S		1,835,197				125
HOFOR Vand Vallensbæk A/S		471,315				50
Horsens Vand A/S	56,273	4,007,560	24	4	14.0	487
Hurup Vandværk A.m.b.a.		424,890				108
Ikast Vandforsyning A.m.b.A	16,000	919,039	9	2	8.5	211
Kalundborg Vandforsyning A/S	14,200	3,379,438	45	4	15.0	343
Kerteminde Forsyning – Vand A/S	17,000	902,204	9	2	24.0	220
Køge Vand A/S	33,284	1,670,084	14	2	21.0	242
Langeland Vand ApS	9,240	757,955	25	4	21.4	379
Lemvig Vand og Spildevand A/S	20,000	1,900,782	17	5	7.0	688
Lolland Vand A/S	26,205	1,636,147	29	4	19.0	904

PROCESS BENCHMARKING (MAIN KEY FIGURES)						TARIFFS 2019 (Level 1)		
Actual operating costs for production, distribution, customer management and general administration in relation to the sold volume of water flow	Operating costs of production of water produced at own waterworks	Operating costs related to distribution compared to sold water in own supply area	Operating costs on customer by water meter	Operating costs on general administration in relation to sold water	Implemented investments and renovations	Fixed annual price, incl. VAT	Variable water price, incl. VAT and other taxes	Costs for a consumption of 100 m³/year
€/m³ sold	€/m³	€/m³ sold	€/water meters	€/m³ sold	€/m³ sold	€	€/m³	€
0.53					0.47	109.06	1.74	283.15
0.75	0.30	0.20	12.91	0.15	4.65	86.24	2.63	349.60
0.30					0.82	98.99	1.85	284.09
1.26	0.18	0.38	6.45	0.64	1.09	167.52	2.34	401.61
0.66					0.47	104.03	2.23	327.52
0.57	0.26	0.11	26.56	0.09	0.51	126.01	1.94	320.10
0.60					1.15	114.09	1.87	301.48
0.82					0.69	117.45	2.45	362.01
0.43					0.14	83.89	1.86	269.53
2.00					0.81	83.89	2.52	336.38
0.74					0.57	83.89	2.44	328.19
0.41	0.19	0.10	4.67	0.16	0.51	34.10	2.26	259.73
0.65	0.34	0.19	67.72	0.23	0.69	49.66	3.15	365.10
0.80	0.29	0.31	12.18	0.09	0.49	176.17	2.42	417.92
1.00					0.47	92.79	1.91	283.52
0.64					1.16	37.95	2.45	282.92
0.52	0.16	0.12	17.13	0.15	0.60	97.82	1.74	271.91
0.85	0.17	0.29	1.82	0.35	1.66	131.54	2.75	406.17
0.52	0.23	0.22	7.37	0.01	0.37	104.49	1.63	267.71
0.75	0.29	0.23	7.50	0.17	0.88	180.70	2.06	386.74
0.67						13.42	2.90	303.49
0.67						16.78	3.61	377.32
1.02						59.21	2.99	357.74
0.64						0.00	2.69	269.26
0.51						0.00	2.43	242.68
0.50					0.54	64.43	2.30	294.63
0.73						0.00	2.72	272.48
0.47						16.78	3.26	342.95
0.60					0.63	129.19	1.74	303.29
0.93						109.06	1.91	299.93
0.68					0.25	83.89	1.99	283.09
0.42	0.36	0.12	20.31	0.09	0.37	0.00	2.88	288.05
1.07	0.43	0.56	22.27	0.08	0.85	102.68	2.62	364.43
0.67	0.22	0.36	12.10	0.01	3.43	28.49	2.60	288.90
0.98					0.36	133.56	2.01	334.63
0.45					0.17	119.74	2.19	339.07
0.79	0.20	0.39	5.57	0.13	0.67	130.17	3.22	451.91

DRINKING WATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2019

(DATA FOR 2018)

	BASIC DATA					
	Inhabitants in the supply area	Total quantity of water sold	Boreholes (water catchment area)	Waterworks	Hardness of extracted water	Distribution network (supply pipes)
Company	persons	m^3/year	number	number	dH	km
Lyngby-Taarbæk Vand A/S	55,790	2,794,160	7	2	17.0	213
Mariagerfjord Vand a/s	15,000	1,399,479	10	3	8.9	335
Midtfyns Vandforsyning A.m.b.a.	16,000	1,878,558	13	5	17.0	437
Morsø Vand A/S	9,387	557,980	9	2	13.0	120
NFS A/S	18,619	1,174,571	21	2	18.3	173
NK-Forsyning A/S	45,000	2,142,612	15	2	16.0	505
Novafos Vand Ballerup A/S	48,458	3,136,812	10	4	18.0	263
Novafos Vand Egedal A/S	16,500	618,749	9	1	19.0	155
Novafos Vand Frederikssund A/S	27,000	1,318,401	22	5	18.0	319
Novafos Vand Gentofte A/S	75,176	3,738,049	22	1	19.0	304
Novafos Vand Gladsaxe A/S	69,450	3,460,885	9	2	18.0	227
Novafos Vand Hørsholm A/S	25,094	1,266,947				136
Novafos Vand Rudersdal A/S	33,596	1,626,315	13	3	20.0	206
Novafos Vand Sjælsø A/S		6,661,576	43	1	17.0	33
Odder Vandværk a.m.b.a.	11,889	912,151	9	2	15.0	188
Odsherred Vand A/S	5,200	377,363	14	3	17.0	179
Provas	26,495	1,574,945	16	3	10.6	402
Ringkøbing – Skjern Vand A/S	36,480	3,646,059	28	5	7.9	1,225
Ringsted Vand A/S	27,102	1,734,376	13	4	18.0	383
Silkeborg Vand A/S	56,100	2,609,615	11	3	4.0	540
SK Vand A/S	69,900	3,525,762	48	4	18.0	752
Skanderborg Forsyningsvirksomhed A/S	19,442	1,069,991	17	5	15.8	211
Skive Vand A/S	34,400	2,491,754	28	9	10.0	728
Sorø Vand A/S	10,000	521,003	8	1	19.0	250
Struer Forsyning Vand A/S	13,970	946,992	9	2	6.5	253
Svendborg Vand A/S	38,528	1,934,101	27	6	20.0	451
Sønderborg Vandforsyning A/S	41,230	2,176,933	21	6	15.0	369
Thisted Vand A/S	32,480	3,253,917	34	8	13.0	920
TREFOR Vand A/S	147,000	11,386,834	68	10	13.0	1,441
Tønder Vand A/S	25,118	1,689,591	12	4	11.3	555
TÅRNBYFORSYNING Vand A/S	42,984	2,755,129	10	1	19.0	189
Vandcenter Syd as	171,100	9,106,384	48	6	16.0	1,055
Verdo Vand A/S	50,000	2,413,007	21	5	12.5	356
Vestforsyning Vand A/S	48,163	3,708,173	26	5	11.5	1,104
Vesthimmerlands Vand A/S	350	44,229	6	6	7.0	46
Aalborg Vand A/S	121,489	6,738,903	55	12	17.0	707
Aarhus Vand A/S	283,350	14,277,790	84	8	15.0	1,489

PROCESS BENCHMARKING (MAIN KEY FIGURES)						TARIFFS 2019 (Level 1)		
Actual operating costs for production, distribution, customer management and general administration in relation to the sold volume of water flow	Operating costs of production of water produced at own waterworks	Operating costs related to distribution compared to sold water in own supply area	Operating costs on customer by water meter	Operating costs on general administration in relation to sold water	Implemented investments and renova-tions	Fixed annual price, incl. VAT	Variable water price, incl. VAT and other taxes	Costs for a consumption of 100 m³/year
€/m³ sold	€/m³	€/m³ sold	€/water meters	€/m³ sold	€/m³ sold	€	€/m³	€
0.62	0.25	0.31	6.78	0.19	0.87	0.00	3.16	316.11
0.55					0.53	87.88	1.75	262.91
0.45					0.69	107.38	1.74	281.34
0.67					0.65	97.05	1.87	284.30
0.67					0.63	83.89	2.08	291.41
0.80	0.23	0.21	18.78	0.20	0.90	121.19	2.36	356.76
0.58					0.40	0.00	3.08	307.79
0.74					0.48	50.34	2.47	296.91
0.95					0.87	114.09	2.63	376.91
0.80					0.84	0.00	2.75	275.17
0.59					1.10	0.00	3.12	312.08
0.47					0.99	0.00	3.45	344.97
0.66					2.24	59.73	2.46	306.17
0.26					0.02			
0.75					0.77	95.97	2.29	324.56
1.50					5.06	193.46	2.14	407.68
0.77	0.21	0.41	11.17	0.02	1.08	121.49	2.43	364.31
0.44					0.74	177.35	1.97	374.13
0.52	0.24	0.15	13.58	0.06	0.77	24.91	2.64	288.53
0.68					0.57	105.70	1.82	288.12
0.78					1.17	174.33	2.18	392.18
0.68	0.37	0.10	5.39	0.16	0.97	98.99	2.08	306.64
0.52	0.19	0.14	9.43	0.12	0.60	100.67	2.18	318.39
0.55					0.83	74.59	2.48	322.91
0.54	0.14	0.17	8.02	0.17	0.48	112.42	1.83	294.97
0.85	0.27	0.30	11.23	0.17	1.85	110.74	2.58	368.59
0.53					0.84	74.50	2.22	296.51
0.41	0.09	0.27	2.76	0.04	0.43	101.85	2.17	318.36
0.78	0.20	0.15	48.20	0.21	0.74	167.79	2.24	392.08
0.60					0.56	140.54	2.31	371.28
0.47	0.40	0.25	21.98	0.08	0.78	35.07	2.38	273.32
0.62	0.25	0.25	2.60	0.09	0.59	80.54	2.41	321.61
0.71	0.09	0.19	7.68	0.38	0.73	93.12	1.81	274.19
0.59	0.16	0.22	11.57	0.14	0.54	124.66	2.04	328.56
1.19					0.68	124.16	2.11	335.03
0.83	0.19	0.39	4.03	0.23	1.28	167.79	1.96	363.62
0.71	0.22	0.27	11.04	0.15	0.79	92.28	2.43	335.77

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2019

(DATA FOR 2018)

	BASIC DATA					
	Inhabitants in the catchment area	Sewer system (wastewater and rainwater)	Amount of water sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
Company	persons	km	m^3/year	Number of	m^3/year	PE. person equivalents
AquaDjurs A/S (Spildevand)	37,558	1,151	2,059,967	3	4,424,966	39,410
Arwos Spildevand A/S	49,600	1,547	2,587,423	7	6,594,428	49,610
Assens Spildevand A/S	34,915	1,345	1,820,298	8	4,263,572	54,864
Billund Spildevand A/S	22,240	463	1,334,215	5	4,545,434	51,303
BIOFOS Lynettefællesskabet A/S		3	44,823,979	2	81,352,000	1,142,917
BIOFOS Spildevandscenter Avedøre A/S	253,091	57	13,318,919	1	22,568,000	340,252
Bornholms Energi & Forsyning A/S	30,000	913	1,880,922	7	6,441,949	55,671
Brønderslev Spildevand A/S	28,000	602	1,301,769	3	4,377,110	34,284
DIN Forsyning Spildevand A/S	169,456	2,666	8,874,666	18	22,245,604	283,071
Energi Viborg Spildevand A/S	97,113	2,035	4,084,091	18	10,739,229	102,153
Favrskov Forsyning A/S	42,200	1,231	1,849,066	6	3,959,476	33,517
FFV Spildevand A/S	51,735	1,160	2,295,746	8	7,990,325	51,775
Fors Spildevand Holbæk A/S	60,676	1,251	3,044,979	7	6,894,284	74,611
Fors Spildevand Lejre A/S	25,040	608	1,097,486	8	2,471,230	22,130
Fors Spildevand Roskilde A/S	85,549	1,103	4,062,113	5	8,415,019	101,894
Fredensborg Spildevand A/S	40,513	652	1,806,491	3	2,426,765	30,503
Fredericia Spildevand og Energi A/S	51,427	1,039	5,019,000	1	9,125,641	239,860
Frederiksberg Kloak A/S	103,960	204	5,043,489			
Frederikshavn Spildevand A/S	52,127	1,093	3,817,228	9	11,058,861	303,411
Glostrup Spildevand A/S	22,533	205	1,342,084			
Greve Spildevand A/S	49,895	788	2,186,581	1	4,868,298	54,033
Gribvand Spildevand A/S	48,163	1,022	1,884,582	9	4,862,821	43,920
Halsnæs Spildevand A/S	28,450	635	1,291,451	3	3,505,194	35,660
Hedensted Spildevand A/S	33,350	971	1,896,236	5	5,198,296	56,656
Herning Vand A/S	67,441	1,335	4,158,360	14	11,785,424	155,211
Hjørring Vandselskab A/S	52,000	1,373	3,133,928	8	9,200,482	161,188
HOFOR Spildevand Albertslund A/S		616	1,264,402			
HOFOR Spildevand Brøndby A/S		355	1,900,127			
HOFOR Spildevand Dragør A/S		180	648,316		1,702,147	
HOFOR Spildevand Herlev A/S		271	1,494,296			
HOFOR Spildevand Hvidovre A/S		492	3,191,434			
HOFOR Spildevand København A/S	613,288	1,472	30,832,831			
HOFOR Spildevand Rødovre A/S		273	1,769,446			
HOFOR Spildevand Vallensbæk A/S		175	656,760			
Horsens Vand A/S	90,636	1,698	4,825,839	3	8,895,747	169,553
Ikast-Brande Spildevand A/S	36,000	841	1,874,564	3	5,083,217	35,751
Jammerbugt Forsyning A/S	45,700	1,002	1,776,930	4	4,784,278	74,609

PROCESS BENCHMARKING (MAIN KEY FIGURES)						TARIFFS 2019 (Level 1)		
Actual operating costs for transport, treatment, customer management, and general administration compared to sold volume of water	Operating costs to sewer system related to the amount of water sold in the sewerage catchment area	Operating costs to treatment in relation to the amount of water sold in the treatment plant's catch-ment area	Operating costs to customer management by water meters	Operating costs to general administration in relation to the amount of water sold	Implemented investments and renovations	Fixed annual price, incl. VAT	Variable price incl. VAT and taxes	Costs for a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water me-ter	€/m³ sold	€/m³ sold	€	€/m³	€
1.45					0.65	104.49	4.36	540.73
2.03					2.37	102.35	7.12	814.56
2.05	0.90	0.74	20.46	0.28	9.41	102.35	9.23	1,025.17
2.35					2.93	104.49	5.87	691.74
0.47					0.55			
0.63					0.13			
2.08	0.41	0.96	2.68	0.68	1.96	91.95	5.32	623.89
1.57					2.18	0.00	5.77	576.51
1.37	0.45	0.68	15.14	0.13	1.01	104.03	4.36	539.73
1.80					3.86	0.00	6.77	677.05
1.73					3.98	95.84	5.85	680.94
2.07					2.70	104.49	6.61	765.56
1.99					2.66	83.89	5.66	649.80
2.83					4.37	96.34	5.57	653.12
1.97					4.28	0.00	5.25	525.37
1.14	0.37	0.59	4.41	0.27	2.55	0.00	5.36	535.97
1.15	0.29	0.62	9.57	0.20	1.14	58.72	4.82	541.14
0.80	0.56		40.70	0.21	0.19	0.00	2.03	203.36
2.00	0.46	0.92	5.55	0.13	1.98	104.53	6.37	741.31
0.65					0.28	0.00	3.66	365.77
1.28	0.61	0.55	14.25	0.03	3.82	0.00	3.69	369.13
2.42	0.64	1.12	23.69	0.32	4.59	104.49	7.82	886.77
2.61	0.76	1.09	7.32	0.61	11.23	99.16	6.71	770.30
2.21	1.00	0.97	14.10	0.11	1.26	104.53	6.21	725.34
1.43	0.64	0.71	7.80	0.01	1.66	104.49	4.61	565.97
1.70	0.50	0.78	11.82	0.34	4.99	104.03	6.82	785.91
0.73					0.90	0.00	5.39	539.06
0.46					1.10	0.00	4.52	452.08
1.94						0.00	5.37	536.78
0.72					0.71	0.00	4.06	406.04
0.58					4.72	0.00	4.58	458.12
0.35					0.40	0.00	2.86	286.04
0.58					1.29	0.00	3.10	310.07
0.54						0.00	4.74	473.69
1.29					3.82	104.53	4.65	569.63
1.55	0.60	0.77	6.54	0.13	2.32	104.49	5.45	649.86
1.72	0.59	1.03	5.42	0.04	2.89	104.43	3.69	473.56

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2019

(DATA FOR 2018)

	BASIC DATA					
	Inhabitants in the catchment area	Sewer system (wastewater and rainwater)	Amount of water sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
Company	persons	km	m³/year	Number of	m³/year	PE. person equivalents
Kalundborg Spildevandsanlæg A/S	48,698	966	5,456,698	8	8,223,210	34,647
Kerteminde Forsyning – Spildevand A/S	23,756	555	1,053,408	4	2,028,914	15,557
Køge Afløb A/S	56,300	989	2,536,482	4	5,946,902	79,057
Langeland Spildevand ApS	9,119	520	575,240	8	2,377,444	5,536
Lemvig Vand og Spildevand A/S	19,200	621	1,436,818	3	2,233,253	59,022
Lolland Spildevand A/S	19,580	1,563	1,642,102	45	7,335,790	50,535
Lyngby-Taarbæk Spildevand A/S	55,790	428	2,789,497			
Mariagerfjord Spildevand A/S	30,000	1,113	2,051,524	1	4,839,124	82,574
Middelfart Spildevand A/S	38,553	847	1,615,703	6	6,271,925	35,285
Morsø Spildevand A/S	15,970	634	872,888	3	2,146,849	43,778
Mølleåværket A/S		7	5,120,928	1	8,919,287	110,658
NFS A/S	36,166	693	1,493,638	4	5,613,186	70,473
NK-Forsyning A/S	71,500	1,422	2,873,591	8	10,261,028	53,959
Novafos Måløv Rens A/S			1,998,837	1	3,420,743	36,198
Novafos Spildevand Allerød A/S	24,418	365	1,133,398	3	2,174,497	20,647
Novafos Spildevand Ballerup A/S	48,178	439	2,713,203			
Novafos Spildevand Egedal A/S	41,495	671	1,565,067	3	2,385,918	25,577
Novafos Spildevand Frederikssund A/S	41,744	764	1,963,873	6	3,949,787	42,387
Novafos Spildevand Furesø A/S	40,586	421	1,665,396	1	1,415,360	13,233
Novafos Spildevand Gentofte A/S	75,728	493	3,759,428			
Novafos Spildevand Gladsaxe A/S	69,484	353	3,373,865			
Novafos Spildevand Hørsholm A/S	24,806	221	2,511,576	1	3,392,376	36,367
Novafos Spildevand Rudersdal A/S	55,412	530	2,747,680	3	3,361,374	27,804
Odder Spildevand A/S	7,919	510	955,527	2	1,656,163	20,024
Odsherred Spildevand A/S	26,100	802	1,127,368	9	2,827,990	33,648
Provas	50,815	1,232	2,495,052	11	7,110,084	91,831
Rebild Vand & Spildevand A/S	23,000	764	1,199,508	11	584,000	9,123
Ringkøbing – Skjern Spildevand A/S	41,000	1,436	2,664,269	16	7,177,398	73,613
Ringsted Spildevand A/S	28,640	692	1,879,619	3	4,334,847	43,963
Silkeborg Spildevand A/S	83,890	1,865	3,923,491	11	6,722,524	122,388
SK Spildevand A/S	62,500	1,351	3,449,830	20	7,062,506	95,917
Skanderborg Forsyningsvirksomhed A/S	56,402	1,161	2,567,316	6	4,994,837	90,200
Skive Vand A/S	15,955	1,101	1,813,477	5	6,261,711	32,974
Solrød Spildevand A/S	23,000	359	938,643	1	1,904,402	14,753
Sorø Spildevand A/S	21,000	395	1,052,583	6	2,840,504	28,543
Stevns Spildevand A/S	19,217	575	810,649	4	2,568,757	13,639
Struer Forsyning Spildevand A/S	19,083	502	936,435	3	1,868,014	32,384

PROCESS BENCHMARKING (MAIN KEY FIGURES)						TARIFFS 2019 (Level 1)		
Actual operating costs for transport, treatment, customer management, and general administration compared to sold volume of water	Operating costs to sewer system related to the amount of water sold in the sewerage catchment area	Operating costs to treatment in relation to the amount of water sold in the treatment plant's catch-ment area	Operating costs to customer management by water meters	Operating costs to general administration in relation to the amount of water sold	Implemented investments and renovations	Fixed annual price, incl. VAT	Variable price incl. VAT and taxes	Costs for a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water me-ter	€/m³ sold	€/m³ sold	€	€/m³	€
1.17	1.01	0.61	20.73	0.16	0.50	0.00	7.21	720.94
1.19	0.55	0.66	10.07	0.04	1.70	104.50	4.36	540.74
1.43	0.55	0.75	10.86	0.05	5.87	0.00	6.95	694.63
2.68					0.97	104.49	6.89	793.48
1.55					0.90	104.49	4.61	565.97
2.38	0.81	1.05	11.59	0.14	3.21	104.49	8.35	939.25
0.46	0.30		3.67	0.15	1.03	0.00	4.58	457.58
1.78					3.40	87.88	5.72	659.42
2.11	0.49	1.26	13.06	0.23	4.76	0.00	8.10	809.53
2.60					2.71	104.48	7.05	809.18
0.72		0.62	5,756.54	0.09	1.02			
2.33					2.84	83.89	6.10	693.83
1.89	0.75	0.70	21.26	0.26	2.89	104.49	7.42	846.10
0.69					0.57			
1.68					2.77	0.00	6.96	695.97
0.37					1.79	0.00	4.28	428.05
1.37					2.87	0.00	6.17	617.18
1.88					2.48	100.00	6.20	719.87
1.22					2.33	0.00	6.30	630.20
0.43					0.56	0.00	4.50	449.66
0.44					2.15	0.00	4.03	403.36
0.72					2.11	0.00	4.70	469.80
1.03					1.41	0.00	4.68	468.19
1.42					1.46	104.53	4.97	601.17
2.63					7.36	104.43	7.17	821.48
1.67	0.65	0.90	13.44	0.03	3.13	100.74	6.86	786.51
1.43					3.69	100.95	4.53	553.70
1.67					3.52	104.19	6.81	785.40
1.65	0.99	0.73	15.24	0.10	4.50	0.00	6.81	680.54
1.48					2.89	88.09	4.03	490.77
1.81		0.98			3.72	100.84	6.21	721.64
1.66	0.21	0.91	11.85	0.46	4.50	92.28	5.12	604.09
1.76	0.73	0.64	10.67	0.29	2.48	100.67	5.67	667.79
1.56	0.58	0.79	15.26	0.07	2.15	0.00	5.64	563.76
1.95					4.44	85.68	7.38	823.26
2.10	0.90	0.90	19.77	0.10	2.77	101.17	7.57	857.95
1.75	0.45	1.08	3.28	0.19	2.31	0.00	4.36	436.24

PHOTO: SAMN FORSYNING

WASTEWATER COMPANIES THAT PARTICIPATED IN BENCHMARKING AND STATISTICS 2019

(DATA FOR 2018)

	BASIC DATA					
	Inhabitants in the catchment area	Sewer system (wastewater and rainwater)	Amount of water sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
Company	persons	km	m³/year	Number of	m³/year	PE. person equivalents
Svendborg Spildevand A/S	57,560	1,023	2,710,351	5	8,097,195	74,297
Syddjurs Spildevand A/S	35,100	1,010	1,677,993	11	3,016,306	32,972
Sønderborg Spildevandsforsyning A/S	74,650	1,060	3,288,715	5	7,493,447	61,905
Thisted Vand A/S	52,405	1,012	2,443,625	5	6,607,043	147,164
Tønder Spildevand A/S	29,497	879	1,807,702	17	5,048,958	50,342
TÅRNBYFORSYNING Spildevand A/S	43,063	266	2,298,564	1	4,481,087	55,561
Vandcenter Syd as	229,000	2,588	11,114,866	8	27,948,254	320,992
Vandmiljø Randers	92,616	1,783	4,616,923	5	10,213,972	110,638
Vejle Spildevand A/S	98,839	2,151	5,698,624	9	15,104,096	212,436
Vestforsyning Spildevand A/S	52,000	1,279	3,585,153	6	7,020,312	134,932
Vesthimmerlands Vand A/S	29,530	1,048	2,084,786	3	3,208,417	100,832
Aalborg Kloak A/S	209,849	2,523	10,340,553	2	24,926,423	251,243
Aarhus Vand A/S	337,960	3,623	14,950,868	4	29,323,200	362,537

PROCESS BENCHMARKING (MAIN KEY FIGURES)						TARIFFS 2019 (Level 1)		
Actual operating costs for transport, treatment, customer management, and general administration compared to sold volume of water	Operating costs to sewer system related to the amount of water sold in the sewerage catchment area	Operating costs to treatment in relation to the amount of water sold in the treatment plant's catchment area	Operating costs to customer management by water meters	Operating costs to general administration in relation to the amount of water sold	Implemented investments and renovations	Fixed annual price, incl. VAT	Variable price incl. VAT and taxes	Costs for a consumption of 100 m³/year
€/m³ sold	€/m³ sold	€/m³ sold	€/water meter	€/m³ sold	€/m³ sold	€	€/m³	€
1.70	0.46	1.08	4.04	0.13	1.67	104.70	5.37	641.61
1.78					4.48	104.49	6.43	747.72
1.71					4.97	0.00	6.17	617.45
1.72	0.66	0.93	4.41	0.10	1.80	104.49	5.12	616.97
2.24	0.92	0.81	16.74	0.32	2.96	81.21	5.97	678.52
1.25	0.46	0.72	7.40	0.03	0.89	0.00	4.29	429.26
1.35	0.44	0.74	3.07	0.15	2.01	100.67	5.03	604.03
1.28	0.45	0.55	14.35	0.23	3.02	96.31	4.61	557.11
1.38					2.80	105.29	5.37	642.20
1.61	0.55	0.69	13.40	0.29	2.37	103.84	4.65	568.67
1.42					2.78	96.48	6.17	712.99
1.22	0.51	0.45	11.49	0.16	2.60	104.49	3.94	498.58
1.04	0.25	0.52	5.42	0.24	2.19	83.89	3.80	463.49

DANVA

DANVA, Dansk Vand- og Spildevandsforening (the Danish Water and Wastewater Association), is a national industry and stakeholder organisation for Denmark's drinking water and wastewater companies. Read more about us at www.danva.dk

Information

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KEY FIGURES

- One litre of water costs 0.93 cents on average.
- The average consumption of water in Danish households is 105 litres per person/per day.
- The actual average operating costs of the drinking water companies are € 0.63 per m^3, and the investments implemented amount to € 0.73 per m^3.
- The actual operating costs of the wastewater companies, on average, are € 1.44 per m3, and the investments implemented amount to € 2.46 per m^3.
- 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 0.40 kWh. Transport, purification/treatment and drainage of water to the recipient use an average of 1.44 kWh. Overall, it provides a purchased electricity consumption of 1.84 kWh. If the number is offset by the electricity that the companies produce themselves, the net consumption of electricity amounts to 1.62 kWh per 1,000 l.
- An average family of 2.15 people annually uses 82.69 m^3 of water, the net cost of which is 1.62 kWh/m^3 in electricity consumed by the drinking water company and the wastewater company. This means that the family's annual consumption of water costs 134 kWh. By comparison, this is less power than the family consumes to operate the dishwasher or TV.