DANVA
The Danish Water and Wastewater Association

WATER IN FIGURES
2017

DANVA STATISTICS & BENCHMARKING

Stable water prices that take up a minimal part of household expenses

The water companies act with efficiency and create value for households and industry. This is what is demonstrated in the water sector's indicators and key figures, put together by DANVA in "Water in Figures 2017."

Danish water companies act of their own accord according to the highest ideals and provide their core services at stable prices, which result in minimal expenses for households. The water companies support public health, environmental protection as well as local and national growth.

The water sector's key figures from 2016 show a minimal price growth, a decline in operating expenses and a clear tendency of slowing down the pace of capital investments. In addition, Danes are now using historically low amounts of water. Last year, on average, each Dane used only 104 litres of water per day, which is almost two litres less than the previous year. As a general rule, lower consumption will cause the tariffs to rise, as it will be the exact same customers who pay for the joint investments. If they buy less, the price per unit increases. However, the water price rose by only 1.84 per cent to € 9.00 m^3 in 2016, which is at the same level as the price trend in society in general.

Even though large discounts on wastewater tariffs for large users remain in effect, such as for slaughterhouses, refineries and breweries, the cost of water in the household budget has fallen to an average of less than € 740 per year. The cost of clean, fresh, controlled drinking water directly from the tap, safe disposal of wastewater and flood prevention as well as groundwater protection account for only 1.3 per cent of an average family's annual living expenses. By comparison, electricity accounts for 2.1 per cent, while insurance accounts for 6.0 per cent of household expenses.

In 2016, water companies saw a further reduction in operating costs to the lowest level since 2010, and DANVA's members continually strive to become better and to lower costs for the benefit of customers. At the same time, 2016 brought a significant decline in capital investments in connection with both drinking water and wastewater treatment. This could be due to, i.a. the natural uncertainty inherent in the transition from one regulatory model to another one. In addition, there are a number of inadequate regulatory impediments that DANVA is working to have changed, but which so far continue to be a barrier to the implementation of new projects.

Denmark remains a clear world champion in the effort to carefully manage water resources, from when the water is extracted from the ground until it is tapped by the customers into their glasses. Only 7.6 per cent of the drinking water is lost during transport. Six years ago, it was 9.48 per cent. The low water loss arouses great attention internationally, where clean drinking water is becoming an increasingly expensive and precious resource. Water technology for reducing water loss is also part of the Danish exports of water solutions, which in 2016 amounted to € 2.66 billion (compared with € 2.27 billion for 2011).

The water companies are one of the most important foundations of our social structure. This responsibility will not be diminished in the future. DANVA's benchmarking proves that water companies, with their targeted, effective management, entirely live up to the expectations of their customers, public authorities and public policy-makers.

DANVA's members take responsibility for our society. ■

Carl-Emil Larsen

KEY FIGURES

- One litre of water costs on average € 0.009.
- Consumption of water in Danish households is 104 litres per person/per day on average.
- The actual operating expenses of drinking water companies are, on average, € 0.58 per m^3, and the implemented investments amount to € 0.81 per m^3.
- The actual operating expenses of wastewater companies are € 1.42 per m^3 on average, and the implemented investments amount to € 2.84 per m^3.
- Electricity consumption (purchased electricity) for 1,000 litres of water pumped from the ground, delivered to the consumer and taken from the tap amounts to an average of 0.41 kWh. Transport, purification/treatment and discharge of water to the recipient use an average of 1.45 kWh. Collectively, this results in purchased consumption of electricity of 1.86 kWh. If the electricity which the companies produce themselves is offset, the net consumption of electricity amounts to 1.63 kWh per 1,000 l.

(Data for 2016)

What's the price of water?

The water sector's decentralised structure results in a great variety in the price of water.

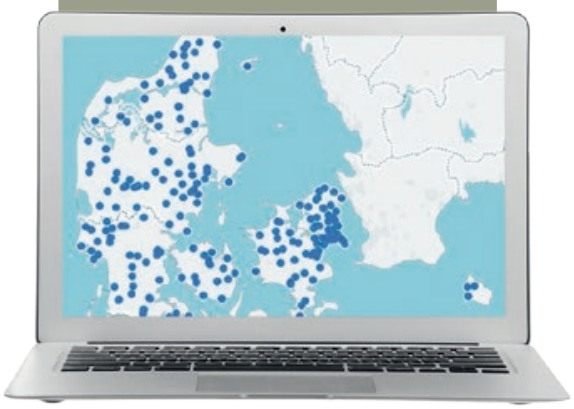
"What's the price of water?" and "What does the price include?" Those are two good questions that DANVA is often asked. The price of water is not the same throughout the country. This is partly due to structural differences and partly because the price composition may vary from company to company. Some companies have chosen to establish a fixed annual basic contribution for water and wastewater plus a price per consumed cubic metre, while others only calculate and bill for the water according to the consumed amount. As the fixed annual basic contribution 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. The price of drinking water includes the costs of groundwater protection, abstraction and treatment as well as distribution of the water from the waterworks to the consumers. The price charged for wastewater includes operation and maintenance, renovation and expansion of sewers as well as operation and inspection of wastewater treatment plants so that the water fulfils the requirements before it is discharged to the recipient.

The average price of water in Denmark in 2016 was € 9.00 per m^3 based on an average family of 2.15 family members, with an average water consumption of 104 litres per person per day. This means that an average Danish household pays less than € 740 per year for water.

The average price of water is slightly higher for single-person households, namely € 10.12 per m^3 based on an annual consumption of 50m^3 (as the fixed contribution represents a larger part of the bill), while the price for a family with 3 children is somewhat lower, namely € 8.08 per m^3 based on an annual consumption of 170 m^3, as the fixed contribution here represents a minor proportion due to the larger consumption.

Water prices on the map of Denmark

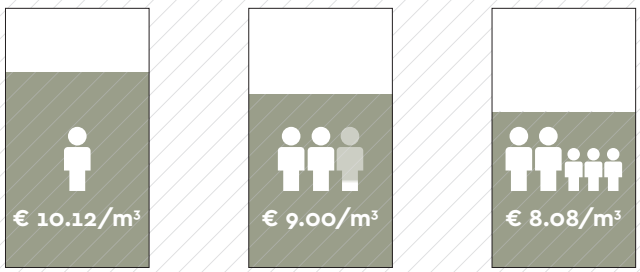
There is an interactive map on DANVA's website: "Water prices on the map of Denmark" (www.danva.dk/vandprispaadanmarkskort) – with water prices for companies that are subject to the Danish Water Sector Act (*Vandsektorloven*). The map shows the prices of drinking water and wastewater for households of 50 m^3, approx. 83 m^3 and 170 m^3 respectively.



Benchmarking provides an overview

Benchmarking is a tool for identifying efforts, work processes and methods with a potential for increasing efficiency via learning from "best practice." A total of 139 drinking and wastewater companies have participated in the report to Water in Figures 2017, with data from 2016. The participating drinking water companies collectively supply water to 55 per cent of the Danish population. Collectively, the participating wastewater companies receive and process water from 80 per cent of the Danish population.

AVERAGE PRICE OF WATER BASED ON CONSUMPTION (2016) €/M^3



Single-person households (50 m^3/yr)

Avg. family (2.15 persons) (81.49 m^3/yr)

Family with 3 children (170 m^3/yr)

Simple average based on 207 water utilities and 97 wastewater utilities. The price is inclusive of VAT and other taxes.

Compared with last year, the average price of water has risen from DKK 65.72/m^3, corresponding to an increase of 1.84 per cent.

The average water price for 2017 based on the same water consumption as in 2016 is DKK 68.70/m^3 for an average family, DKK 77.30m^3 for a single person, and DKK 61.63/m^3 for a family with children.

Information about the price of water

What does the water cost?
This depends on which water company you get your water from. Contact your local water company to obtain information concerning your specific price. On average, 1 litre of water costs DKK 0.067.

What does the water price consist of?
The water price consists of a total of five elements:
- Fixed contribution for drinking water
- Cubic metre price for drinking water consumed
- Fixed contribution for wastewater removal
- Cubic metre price of wastewater removed
- VAT and other taxes

Why does the price of water vary?
There is a significant variation between lowest and highest prices from one water company to another. In general, the difference in overall water prices is due to several factors.
- It can be relatively less expensive to supply water-consuming industries than small customers, such as holiday homes.
- Particular geological conditions can make it more expensive to extract water from the ground for some companies, compared to others.
- In some places, groundwater pollution may necessitate the need for investing in new catchment areas.
- The treatment requirements for wastewater depend on the receiving environment.
- Decentralised wastewater treatment is usually more expensive than central wastewater treatment.
- The older a plant is, the more maintenance it requires.
- Environmental conditions that require additional or extraordinary 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.
- Some drinking water companies invest heavily in groundwater protection. Other companies are "born" lucky, as their water catchments are located in already protected nature reserves.
- Differences in service levels.
- Different degrees of security of supply.

The general currency used in this magazine is Danish kroner (DKK) except pages 2, 3 and the back page.

The exchange rate used to convert from DKK to EUR (€) is:
100 € = 743 DKK
1 DKK = 0.13 €

(Exchange rate by 31.12.2016 - source: valutakurser.dk)

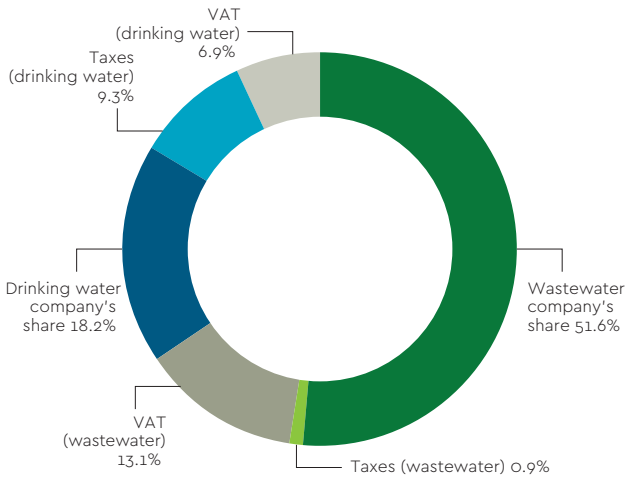
Composition of **water price**

The price of water can be divided into the price of purification and delivery of clean drinking water, plus the collection, treatment and subsequent discharge of wastewater. Out of the total water price, 18.2 per cent go to the drinking water company, 51.6 per cent to the wastewater company, while 30.2 per cent go to the State in the form of VAT and taxes.

If we look at the price, incl. at the distribution of costs between drinking water and wastewater, the distribution is as follows:

- The delivery of clean drinking water includes groundwater protection, abstraction, purification and delivery of clean water, which altogether amounts to DKK 23.02, incl. VAT and taxes, corresponding to 34.4 per cent of the total price of water. 34 per cent of the revenues of the drinking water companies from the sale of water come from the fixed contribution and another 66 per cent come from the variable consumption. 92 per cent of the water companies use a fixed contribution.
- The collection of wastewater/sewage in the sewers, wastewater treatment and discharge amounts to DKK 43.91, incl. VAT and taxes, corresponding to 64.6 per cent of the total water price. 12 per cent of the revenues from water removal of wastewater companies come from the fixed contribution and another 88 per cent come from the variable contribution. 65 per cent of the wastewater companies use a fixed contribution.

SHARE OF WATER PRICES BY CATEGORY, 2016

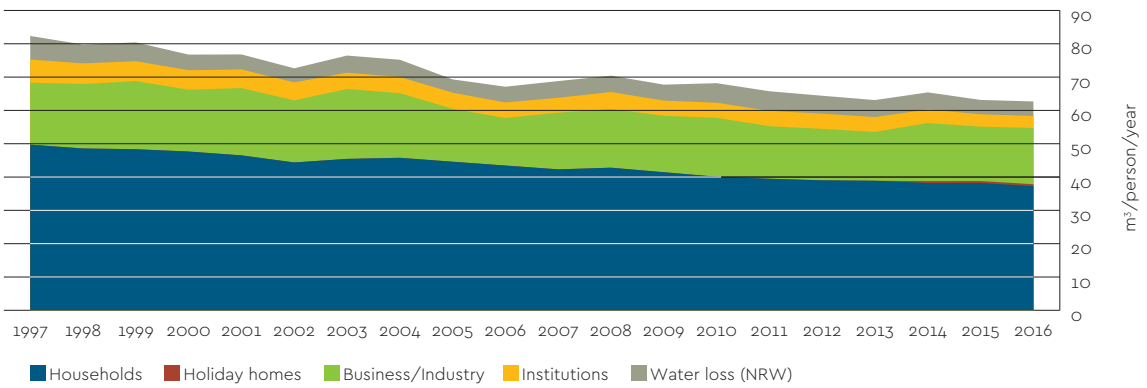


Water consumption is historically low

The total water consumption in 2016 measured at households, holiday homes, businesses, institutions and water losses is on average 62.67 m³ per person/per year. This is a decline of a full 0.7 per cent compared to the level in 2015.

Households account for 65 per cent of the total volume of water sold. An individual uses an average of 37.8 m³ per year, corresponding to 104 litres per day. Over the past 10 years, water consumption in households has fallen by almost 9 per cent. As from 2014, a new category, "Holiday homes", has been introduced, which is now included in the calculation of household consumption in order to make the figures comparable to previous years.

DECLINE IN THE CONSUMPTION OF WATER, 1997-2016



Reduction of wastewater tariffs for large consumers

Based on a growth plan adopted in April 2013, a political decision was made to reduce wastewater payments for large water consumers by DKK 700 million by 2018. The discount is being phased in over a five-year period and is to be fully phased in by 2018.

The discount is to be based on a three-step tarif model. Level 1 is the wastewater companies' regular tariffs for the removal and treatment of wastewater from households and business enterprises. 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.

The Three-step mode has a particular significance for the large water-consuming businesses, and it is here that the water companies are going to give substantial discounts. The water companies are to compensate for this discount by either raising their efficiency or raising the tariffs for Level 1.

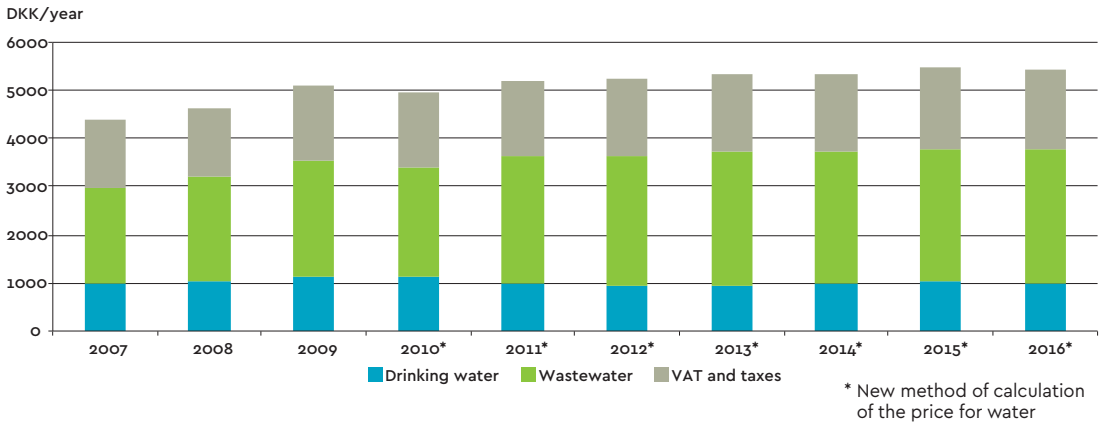
	LEVEL 2 Water consumption: 500 m^3-20,000 m^3 The cubic metre tariff is	**LEVEL 3** Water consumption: Over 20,000 m^3 The cubic metre tariff is
2014	4% lower than Level 1	12% lower than Level 1
2015	8% lower than Level 1	24% lower than Level 1
2016	12% lower than Level 1	36% lower than Level 1
2017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

Water expenses have decreased

An average Danish family pay less than DKK 5,500 per year to have fresh, clean and inspected drinking water delivered to it, while at the same time getting rid of its wastewater and making sure that it is properly treated before it is discharged into nature. In addition, the price of water also covers groundwater protection and climate adaptation.

The price for an average family has decreased by 1 per cent compared to last year, measured in constant prices.

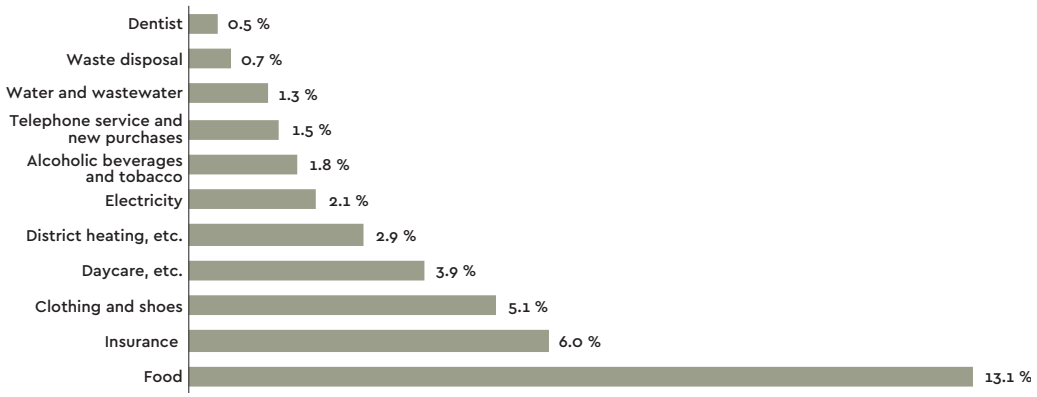
AVERAGE HOUSEHOLD'S EXPENSES FOR WATER, 2007-2016 (2016 PRICES)



* New method of calculation of the price for water

A household's expenses for clean drinking water and treatment of wastewater stand only at approx. 1.3 per cent of the household's annual living expenses, which is less than the cost of telephone service, heating or electricity.

A HOUSEHOLD'S ANNUAL LIVING EXPENSES – SELECTED CATEGORIES



Data from www.statistikbanken.dk/FU51 – data from 2014 and 2015, current prices. The example covers a family with 2 adults, with one or more children living at home, with annual expenditure of DKK 420,950.

The Danish **water sector**

All drinking water in Denmark is based solely on groundwater. The total volume of water pumped for public waterworks in 2015 was estimated at 359 million m^3/yr [*1)].

The Danish drinking water sector is highly decentralised and consists of approx. 2,600 public waterworks. There are approx. 87 municipally-owned drinking water companies, which in total comprise approx. 330 waterworks. The remainder of the waterworks are privately-owned, either as independent individual waterworks or collected together into small utility companies with additional facilities, which are usually owned by the consumers. In addition, there are approx. 50,000 small plants, primarily in the category "own water supply for single-family households" [*1)].

Wastewater treatment takes place primarily at the approx. 110 municipally-owned wastewater companies. In 2015, there were a total of 780 treatment plants over 30 PE registered in Denmark, which collectively had a total load of 7 million PE and altogether discharged approx. 768 million m^3 of treated wastewater. 93.2 per cent of the wastewater discharged was treated at tertiary wastewater treatment plants, which is the most advanced type of wastewater treatment plant (MBND and MBNDK).[*2)]

The Danish Water Sector Act, which applies to all drinking water and wastewater companies selling over 200,000 m^3 water per year, requires the establishment of a financial framework for each individual company, as well as setting out a general efficiency requirement plus additional individual efficiency requirements for companies selling over 800,000 m^3.

The Danish water sector is built on the a break-even principle, which means that there should be a balance between the company's expenses and income, measured over a number of years. Water companies are 100 per cent financed by tariffs, and all measures, capital investments and operating expenses are to be paid by their consumers.

The Danish Water Sector Act applies to approx. 220 drinking water companies, which collectively sold well over 273 million m^3 water in 2015. The companies had a turnover of approx. DKK 4.5 billion, made capital investments amounting to DKK 1.9 billion and incurred operating expenses of DKK 1.3 billion.

The Water Sector Act also applies to approx. 110 wastewater companies, which in 2015 collectively processed more than 358 million m^3 water sold in their catchment areas. The companies had a turnover of approx. DKK 8.8 billion, made capital investments amounting to DKK 6.7 billion and incurred operating expenses of DKK 2.9 billion. ■

Sources:
*1: Groundwater Monitoring 2016, Geological Survey of Denmark and Greenland (GEUS).
*2: Point Source Report 2015, The Danish Nature Agency – Ministry of Environment and Food.

TARGETED FOCUS ON EXPORT

The export of Danish water technology and know-how must be strengthened further, and this should take place, i.a. via a series of initiatives that showcase Danish solutions.

Foreign countries have become aware of the Danish water sector, and there is a significant potential for growth for Danish water technology out there, according to the Danish Minister for Energy, Utilities and Climate, Lars Chr. Lilleholt, among others. International cooperation and export of technology and solutions – including the water utility sector's "way of doing things" – benefits not only Danish producers and consultants but also water companies – both large and small. They become smarter when local challenges turn into solutions, solutions which can then be exported.

We have to strike while the iron is hot, and a large number of measures will now strengthen the further development of water technology and solutions. A good example of this is the research and development centre that has been established in Lemvig, the Klimatorium, which, with its location at Limfjord and the North Sea, is basically surrounded by water on all sides. The centre, with its geographical location, will provide equipment and buildings for close cooperation between research institutions, companies, public authorities and the society-at-large.

Lemvig Vand and the Municipality of Lemvig are behind the Klimatorium, and the goal of the centre is to find technical solutions to the municipality's challenges posed by climate change.

"It is equally important to simultaneously help Danish companies, universities and publicly-owned companies find the solutions that Denmark needs via research and demonstration projects. Hopefully, it can also lead to the creation of new local businesses," comments Lars Holmegaard, Director of Lemvig Vand og Spildevand.

Joint collaboration with New Zealand

The first research project, "Geophysics in Filter Flushing", is intended to reduce the use of water at waterworks. The Klimatorium is one of 24 projects that form part of the Central Denmark Region's Coast2Coast initiative, which has received a 6-year financial support package from the EU.

The Klimatorium will provide the basis for the further development of Danish technology solutions which can be exported to the rest of the world. Thus a cooperative effort with the city of Auckland in New Zealand has already been established, a city struggling with some of the same some challenges faced by Lemvig and Denmark.

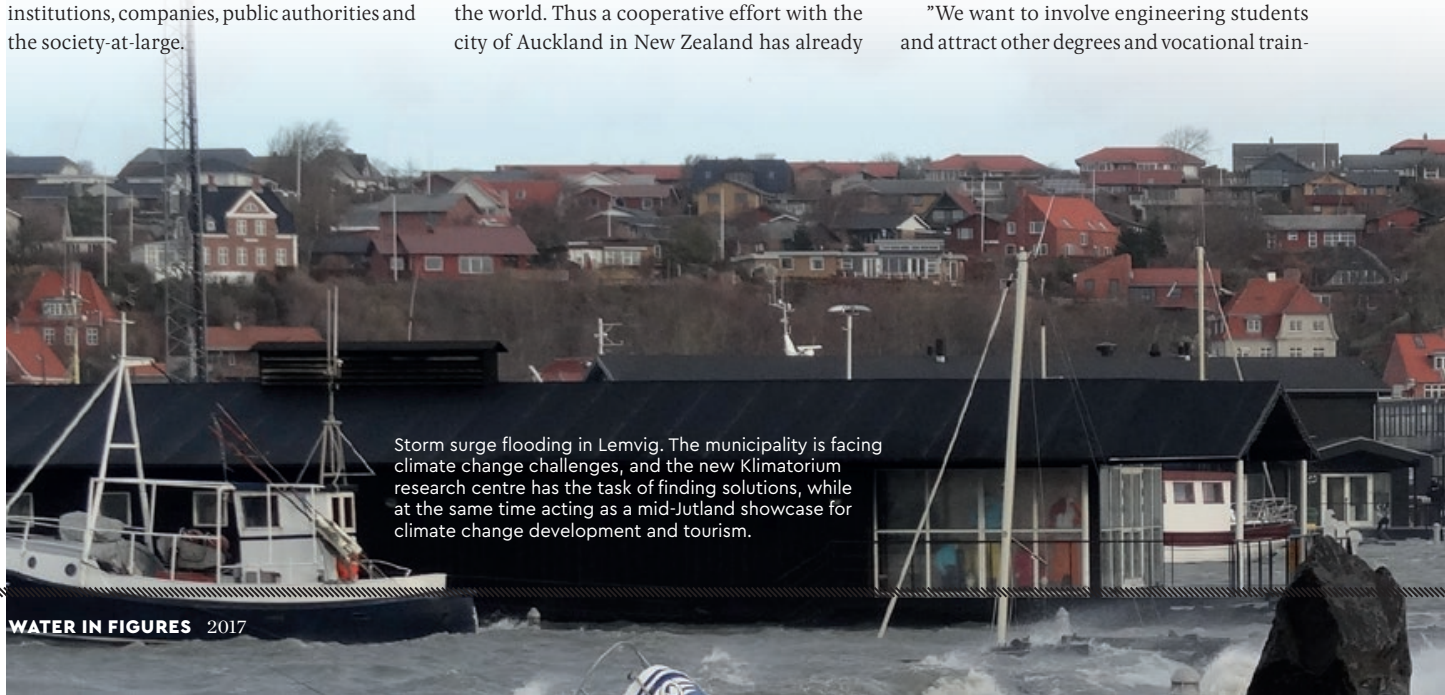
"New Zealanders are extremely interested in learning from our water management model where universities, public authorities and private companies work closely together in order to find solutions," comments Lars Holmegaard, who is also the head of the Klimatorium's working group.

A delegation has been in Auckland and has met a number of stakeholders, politicians, consulting engineers and water companies in New Zealand, something which has led to extensive joint cooperation.

"On our next visit to Auckland, we will meet, together with the Ministry of Foreign Affairs, municipalities and water companies and focus more, in a targeted manner, on meeting their needs. We will hopefully see specific exports of Danish companies as a result of this," comments Lars Holmegaard.

He adds that the municipality and Lemvig Vand og Spildevand are working to make the Klimatoriet a mini-campus.

"We want to involve engineering students and attract other degrees and vocational train-



Storm surge flooding in Lemvig. The municipality is facing climate change challenges, and the new Klimatorium research centre has the task of finding solutions, while at the same time acting as a mid-Jutland showcase for climate change development and tourism.

TEXT: JESPER WITH / **PHOTO CREDIT:** DANISH COASTAL AUTHORITY / RINGKØBING-SKJERN FORSYNING A/S

Ringkøbing-Skjern Forsyning A/S and the Aquatarium waterworks desire to contribute to the development of new technologies and methods for the operation of modern waterworks, at both the national and international level. The Aquatarium waterworks are, according to the company, an optimal platform for realising this vision.

ing courses at the centre," comments Lars Holmegaard.

The purpose of the Aquatarium is to strengthen development

A little further south on the west coast, Ringkøbing-Skjern Forsyning has established the Aquatarium – a state-of-the-art waterworks which, in addition to supplying drinking water, intends to provide a venue for students, researchers and companies to develop, test and showcase new water supply technology.

"We have built a laboratory together with the waterworks, where the students can experiment based on the technologies the waterworks are equipped with. For instance, by using improved filter techniques, finding new ways to improve raw water of poor quality and optimise the filtration. There is real export potential in this," comments Søren Jacobsen, Operations Manager at Ringkøbing-Skjern Forsyning.

Ringkøbing-Skjern Forsyning has been designated as a party in a national lighthouse project, which will develop and present the water supply technologies of the future to the public. Environmental Technology Development and Demonstration Program (MUDP) and The Foundation for Development of Technology in the Danish Water Sector (VTU-Fonden) are providing support to the project to the amount of DKK 13 million. Other partners included in the project are the country's largest water utilities, HOFOR, VandCenter Syd and Aarhus Vand. The objective is for the four water companies to set the agenda for the next generation of water supply technologies.

Things are going well for Danish water technology

Even though Danish water technology exports have not grown significantly from 2015 to 2016, the experience of the Danish Water Technology Group, which represents 66 export companies in the fields of water and wastewater technology, is that its members are exceptionally busy.

"In China, sales figures are very good, and we often experience that local Chinese entrepreneurs ask for Danish products because they need technologies with a green profile. There are now harsh measures under way against companies in China that discharge poorly treated wastewater, and this is what has set things in motion," comments Ilse Korsvang, who heads the Danish Water Technology Group China.

Many Danish companies have established local sales offices in this large country, and this has assisted them in adapting their products to the particular needs of the Chinese, she explains.

For instance, the company AVK in Galten, near Aarhus, has seen strong growth in the sales of valves to the water sector in China. This has been boosted by their own local sales offices and the establishment of production facilities that produce specifically for the local market.

"And so China's increased focus on the enforcement of environmental legislation naturally helps everyone who has sustainable products," continues Ilse Korsvang in her comments. ■

Export of water technology

According to a report by the Damvad consulting company, the exports of water technology grew from DKK 16.6 billion in 2011 to DKK 19.8 billion in 2016. Out of the DKK 19.8 billion in 2016, exports of products amounted to DKK 16.8 billion, exports of product-related services amounted to DKK 2.7 billion, and exports of consulting services amounted to more than DKK 300 million.

Drinking water companies in DANVA Statistics and Benchmarking

61 drinking water companies have reported data to DANVA's Statistics and Benchmarking in 2017. The stated figures are for 2016. Collectively, the companies have 1,800 water wells, 244 waterworks and 29,284 km of pipes. The participating companies extracted approx. 212 million m^3 of drinking water and supplied it to over 3.2 million people. Their total implemented investments and costs, exclusive of taxes, amounted to approx. DKK 2.36 billion. (see the participants' overall key figures rearmost in this publication).

The actual operating expenses of the drinking water companies are at their lowest levels

The survey of the drinking water companies' actual operating costs shows that they are at their lowest levels ever. The actual operating expenses amount to DKK 4.34 per m^3 of sold water. Actual operating expenses 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 taxes, non-controllable expenses and possibly selected associated activities.

From 2016 onwards, there has been a change in the calculation of actual operating expenses, which in relation to how it was done before now includes operating costs for environmental and service objectives, part of the previous 1:1 costs, plus any selected associated activities. Therefore, it is even more impressive that the drinking water companies can continue to become more efficient and maintain the low level.

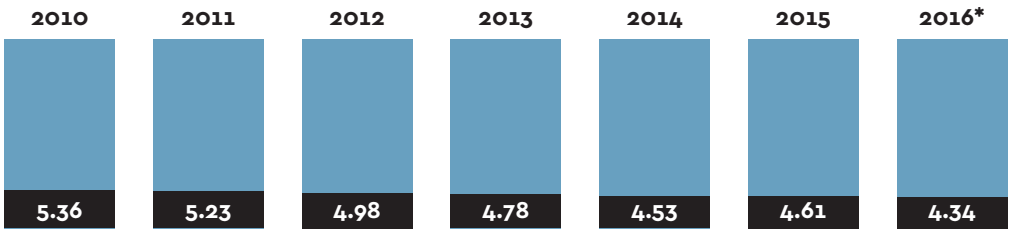
Slower rate of capital investment

The calculation of investments made by drinking water companies in 2016 shows a substantial decline in investments. In 2016, the capital investments that were made amounted to DKK 6.00 per m^3, which is significantly lower than in 2015.

The level of capital investments has been steadily growing over the previous 5 years, while the already budgeted investments have been increasing even more. The calculations for 2016 show that capital investment has slowed down and does not follow the previous expectations for future investments in the coming years. Similarly, the expectations for the next two years are significantly less ambitious than previous budgets for the coming years.

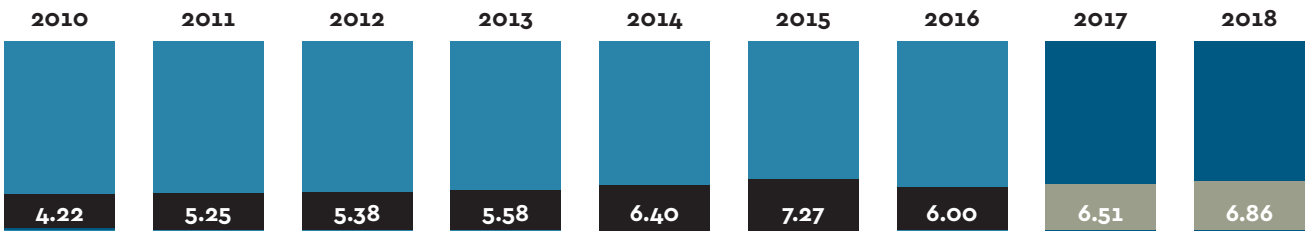
The reason could perhaps be explained with the high level of uncertainty that the water companies face in their operations, as it remains unknown what the revised Water Sector Act, with the introduction of the TOTEX regulation, will mean for the individual companies plus the fact that the companies have begun to feel pressure from the regulation and are therefore hesitant to implement new capital investments.

OPERATING COSTS, 2010-2016 (2016 PRICES IN DKK)



2010–2016: Actual operating expenses (57–61 companies)
*: New calculation of actual operating expenses (FADO)

INVESTMENTS, 2010-2018 (2016 PRICES IN DKK)



2010–2016: Implemented investments and renovations (54–61 companies)
2017–2018: Planned investments and renovations (61 companies)

Breakdown of costs and investments

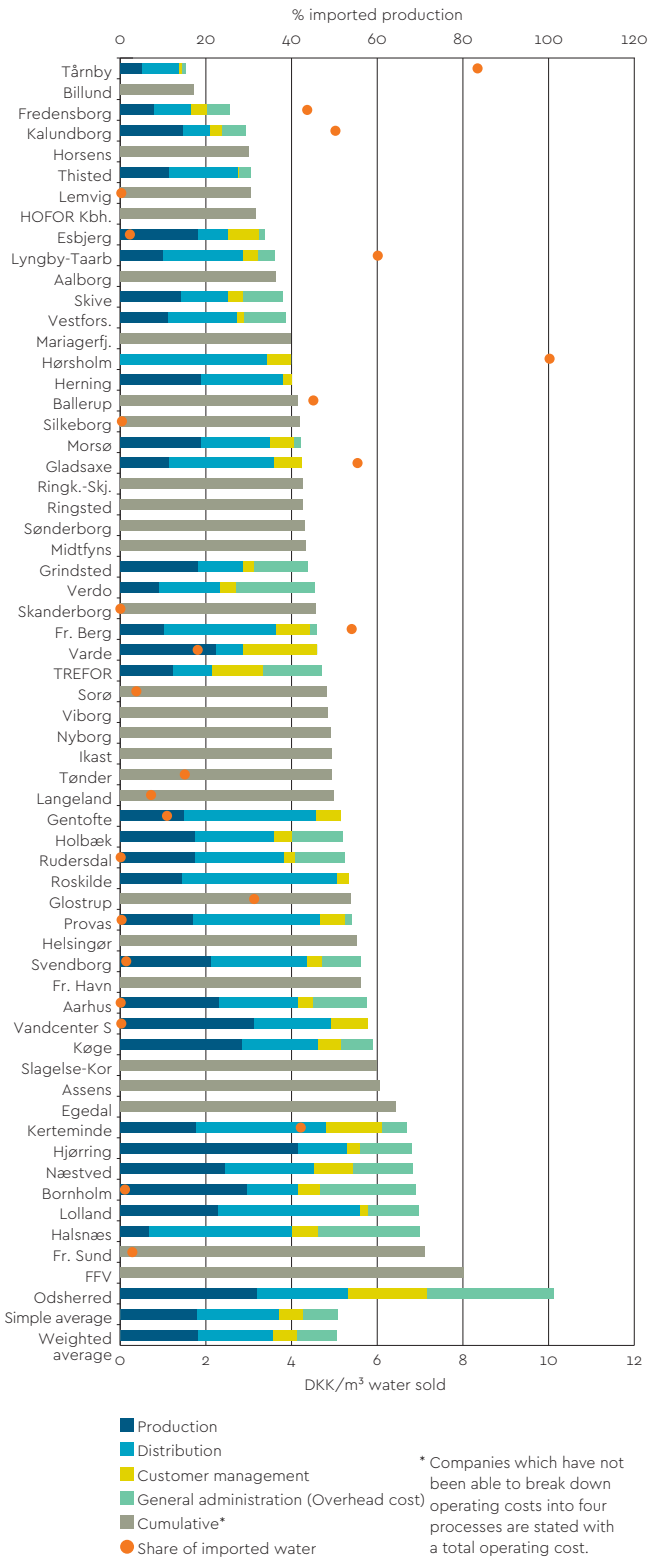
In 2016, the drinking water companies used 37 per cent of their actual operating expenses for the production of clean water (drilling and waterworks), 36 per cent on distribution of the water to their customers, 12 per cent on customer management and 15 per cent on general administration. Based on the Secretariat for Water Supply's bookkeeping posting instructions, a new process has been introduced in relation to previous years, where general administration has been introduced.

The capital investments are distributed, as follows: 78 per cent are used on the distribution network, while 17 per cent go to drilling and production facilities. The remaining 5 per cent are used for other investments. ■

Significant cost differentials

The average for actual production and distribution costs for 1 m³ of water is DKK 4.34.
The large spread between the lowest and highest levels of expenses can be explained primarily by the very different framework conditions under which the companies operate. These include, i.a. geological conditions, access to groundwater, extent of groundwater protection and the necessary processing steps before the water is pumped into the pipeline network, all of which affects the production costs. As for distribution, it is factors such as urbanisation, scope of the pipeline network's coverage, quality and age that affect the costs.

ACTUAL OPERATING COSTS, 2016



WASTEWATER COMPANIES
in DANVA's Statistics and Benchmarking

78 wastewater companies have reported data to DANVA's Statistics and Benchmarking in 2017. The reported figures are for 2016. Altogether, the companies serve approx. 4.7 million people and operate a total of 495 wastewater treatment plants that treat more than 633 million m³ of wastewater with a load of 7.79 million PE via approx. 73,000 km of sewers with 2.2 million house/building connections. In total, the combined sewer area covers more than 304,000 hectares.

Their total implemented investments and costs, exclusive of taxes/fees, amounted to approx. DKK 8.4 billion. (see the participants' overall key figures rearmost in this publication).

Slight increase in wastewater companies' operating expenses

The calculation of wastewater companies' actual operating costs shows a decrease in 2016 of 1.9 per cent, down to DKK 10.59 per m³. Actual operating expenses 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 taxes, non-controllable costs and possibly selected associated activities. From 2016 onwards, there has been a change in the calculation of actual operating costs, which in relation to how it was done before now includes operating costs for environmental and service objectives, part of the previous 1:1 costs, plus any selected associated activities.

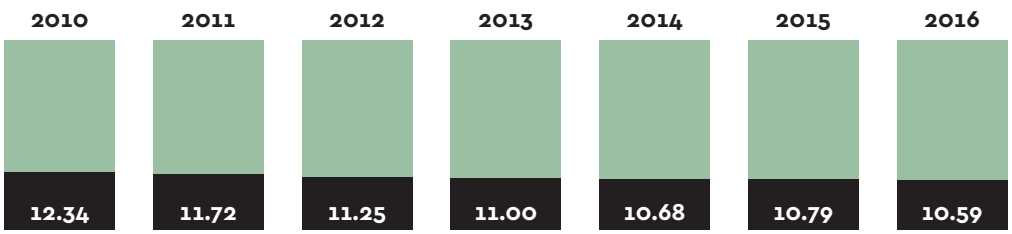
The wastewater companies continue to manage to reduce their operating costs, even though the change in the method of calculation will pull in the opposite direction.

Investments have fallen compared with previous years

The calculation of wastewater companies' capital investments in 2016 shows a sharp slowdown in investments, since they invested, on average, DKK 21.11 per m³ of drinking water sold in the treatment plants' catchment areas. This is a decrease of 15 per cent compared to the previous year. However, 2015 marked a substantial increase in capital investment compared with the previous year.

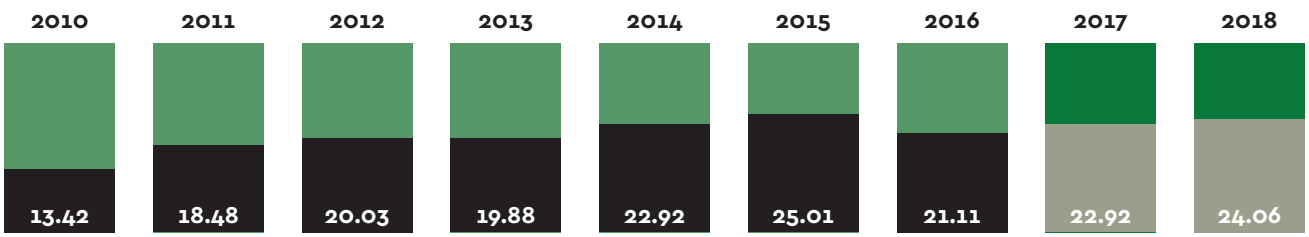
Expectations for increased investments in the coming years remain, albeit at a slightly lower level than before. The reason could perhaps be found in the great uncertainty about the framework under which wastewater companies operate, since it remains uncertain what the introduction of the TOTEX regulation means for each individual company and whether the companies will be restricted in their possibilities for investment. Naturally, companies are understandably somewhat hesitant to launch capital investments, even though there are a good number of investments related to climate change that should be initiated.

OPERATING COSTS, 2010-2016 (2016 PRICES IN DKK)



2010–2016: Actual operating expenses (62–78 companies)

INVESTMENTS, 2010-2018 (2016 PRICES IN DKK)



2010–2016: Implemented investments (66–78 companies – Investments and renovations)
2017–2018: Planned investments (78 companies – Investments and renovations)

Breakdown of costs and investments

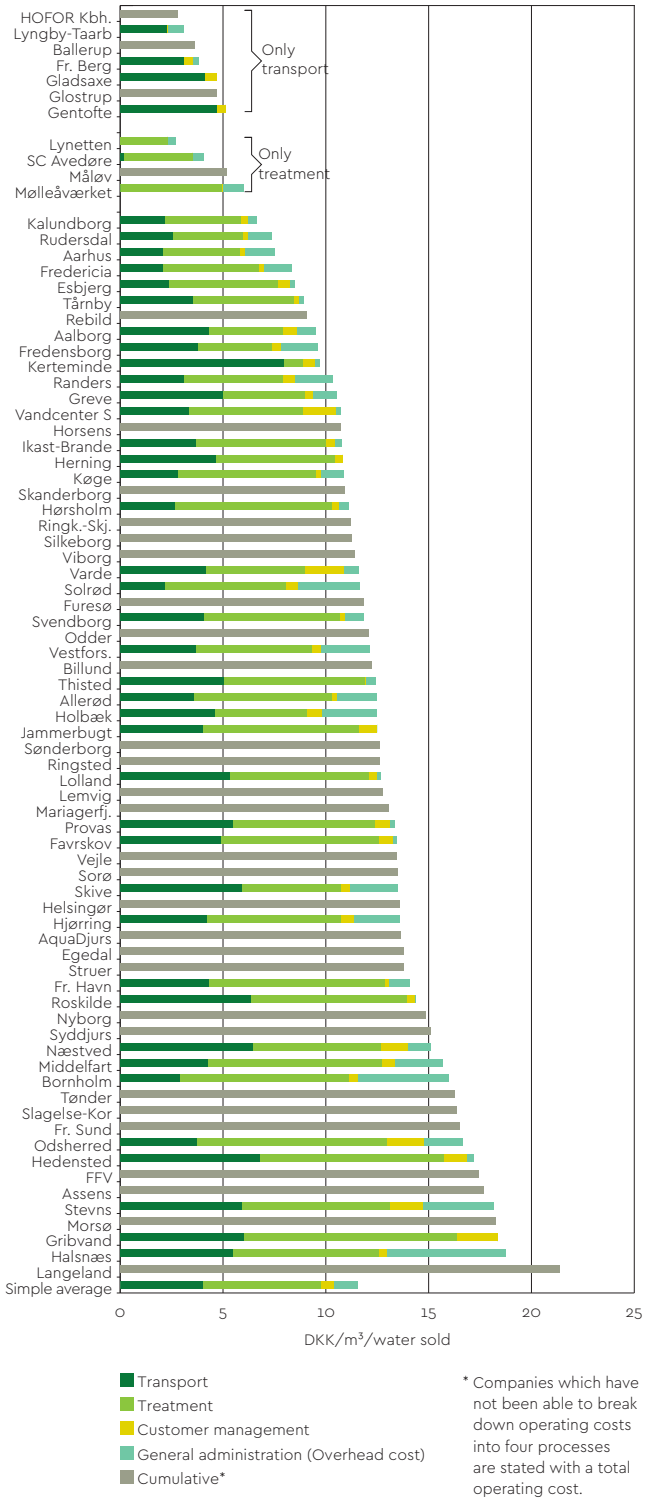
On average, wastewater companies use 47 per cent of their actual operating expenses on the transport network, 31 per cent on wastewater treatment at the treatment plants, 8 per cent on customer management and 14 per cent on general administration. Based on the Secretariat for Water Supply's bookkeeping posting instructions, a new process has been introduced in relation to previous years, where general administration has been introduced.

An inventory of investments and renovations shows that 81 per cent of the implemented investments and renovations are used for improvements and upgrades of the transport network, while 17 per cent are used in the treatment plants. The last 2 per cent are used for other investments. ■

Large variations in actual operating costs

It costs an average of DKK 10.59 to transport and treat 1 m³ of water sold.
The variation between individual companies' expenses per m³ is relatively large and reflects the very different framework conditions under which the companies operate. This refers to topographical differences, differences in population density and the relationship between residential areas and large industries, among others. The method of disposal and the possibility of of excess sludge are also of importance for the treatment costs.

ACTUAL OPERATING COSTS, 2016



* Companies which have not been able to break down operating costs into four processes are stated with a total operating cost.

NEW STRUCTURE for working with benchmarking in DANVA

The new DANVA Benchmark annual cycle will provide faster reporting and better possibilities for utilisation of the results.

DANVA Benchmarking has introduced a new annual cycle. The objective is faster reporting of results and more time for using the results to facilitate further development in the industry.

And the objective to have faster reporting has been achieved, as the results of the reports were already available to the companies before the summer holidays. In the past, these results were not available until the autumn.

The objective of creating development in the industry through an increased focus on the usage of data has commenced by asking the senior management of companies that have enrolled in benchmarking about the topics/subjects they think are most important to work with.

During the benchlearning courses, the participants, based on the figures of their own companies, will be guided to analyse the figures, define necessary changes in their own work processes and exchange experiences at a number of workshops on each particular topic.

Two workshops were held in September, one in Copenhagen and another one in Skanderborg, where the received proposals were discussed and prioritised. The two workshops resulted in the offer of four benchlearning courses and two analyses/studies in the autumn.

The two workshops identified an additional couple of analyses and studies that are being conducted concurrently alongside the benchlearning courses during the autumn.

The following Benchlearning courses are offered in the autumn of 2017:

- **Optimisation of capital investments by utilities**

  The water sector is a sector with heavy reliance on facilities that requires many capital investments, and it is therefore important for water companies that they optimise their investments. In this course, the focus is placed

Two workshops were held in September – one in Copenhagen and another Skanderborg.

Performance Benchmarking

In connection with the amendments to the Danish Water Sector Act, a requirement was introduced for mandatory performance benchmarks applicable to all water companies subject to the Water Sector Act. The performance benchmark has been introduced as a tool for dialogue between the company and stakeholders, including the municipallity, and is meant to compare companies according to selected, non-financial performance parameters in the areas of health, security of supply, energy consumption, climate and the environment.

It is the Danish Environmental Protection Agency that is responsible for the collection and reporting of data. The system becomes mandatory as from 2018, with data for 2017, but in 2017 it has been possible to voluntarily participate with data for 2016. The Danish Environmental Protection Agency's report can be found on the website: www.mst.dk

A large proportion of the participants in DANVA's Statistics and Benchmarking have chosen to participate in the voluntary reporting, as there are many overlaps between the data that are ordinarily transmitted to and included in Water in Figures and the data that must prospectively be reported to the Danish Environmental Protection Agency. This concerns water loss, frequency of breaches, microbiological tests and energy consumption.

on the cost of various different projects requiring capital investments. Key figures are compiled for cost-effectiveness, and as part of the course, the companies will discuss the causes of the variation in the pre-prepared efficiency and performance targets. The purpose is to partially provide the water companies with better management tools and partially help with identifying measures that can increase cost-effectiveness.

- **What is your company's real lifespan for the selected assets, and how can these be optimised?**
  Based on the participants real lifespan of the company's pipes, the aspects and factors that have been decisive for the replacement of these particular assets have been identified. What is your company's potential for minimising immediate depreciation and investment, if the real lifespan is increased by 5, 10 or 20 years? What can be done to achieve higher useful lives in practice and thereby reduce the need for investment without compromising the utility's security of control?

- **Overflows from combined sewers**
  Overflows from combined sewers are on the political agenda in Denmark and Europe, and the Danish Environmental Protection Agency has a focus on this in the performance benchmarking, with a key figure of cubic metres discharged per reduced hectare. How does the industry ensure that it is in a strong position in the political debate, and how is the uniformity of possible regulation in the area ensured? One of the answers is better data. Therefore, the benchlearning course will work with how the reporting to the government in PULS can be improved and how companies can clear up existing data in the database. In addition, it will also take a look at the "state of the art" in measurement technology, calculation models and technologies for reducing overflows from combined sewers.

- **Companies' efficiency**
  The course focuses on: What actually is a healthy company? Which parameters should the companies be measured against and compared to? How is comparability ensured despite different framework conditions? ■

UN's Global Goals for Sustainable Development

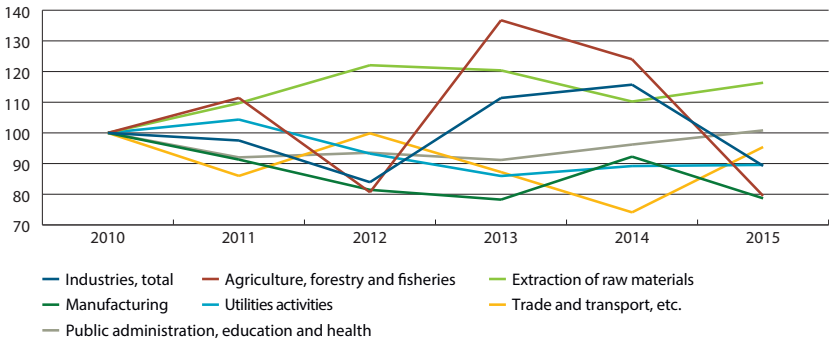
The 17 specific global goals developed by the UN are supposed to set a course for a more sustainable development for both people and the planet as we approach 2030. Water has its own Global Goal, 6: "Clean Water and Sanitation – We must achieve universal and equitable access to safe and affordable drinking water as well as adequate and equitable sanitation and hygiene for all."

Global Goal 6 has a series of sub-goals, where global goal 6.4 deals with water resources.

Global Goal 6.4 is measured based on 2 indicators. Indicator 6.4.1 *Changing water consumption efficiency over time as well as indicator 6.4.2 Water consumption as a percentage of available freshwater resources.* (Refer to the groundwater utilisation map).

Indicator 6.4.1 can be calculated on the basis of data from www.statistikbanken.dk as water consumption per value added in DKK. The chart contains the six most groundwater-consuming industries, where there can be, in particular, major fluctuations in the categories of *Agriculture, Forestry and Fisheries*, with indexes between 79 and 136. The fluctuations are primarily due to the varying needs for field irrigation from one year to another one. As illustrated by the chart, only the categories of *Raw Material Extraction* and *Public Administration, Education and Health*, had an index of over 100 in 2015, because they had higher water consumption per value added in DKK than in 2010, which means that these industries have become less "water-efficient."

Water consumption per value added in DKK for the category of Utility Company has been decreasing since 2010, which means that this sector has become more water-efficient.

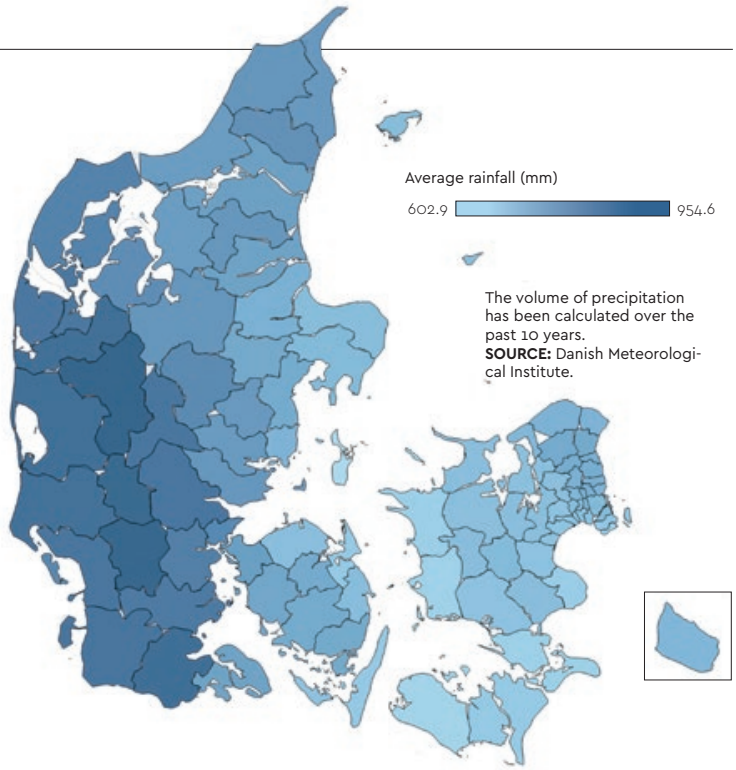


SOURCE: www.statistikbanken.dk/NABP10 and /VANDRG2; Green National Accounts/Grønt Nationalregnskab 2014–2015 (published March 2017) www.dst.dk/publ/GronNatDK; unstats.un.org/sdgs/indicators/indicators-list/

Large regional **variations in rainfall**

Despite the fact that Denmark is a relatively small country, which finds itself 134th on the list of the United Nation's 193 Member States as measured by land area, there is a significant variation in precipitation from region to region. Based on data from the Danish Meteorological Institute, it can be observed that there have been marked regional differences in precipitation in Denmark. It can be concluded that the municipalities in Southern Zealand, Western Zealand and the southwestern part of the Danish Capital Region have had an average precipitation of between 622 mm and 690 mm. This is in sharp contrast with the 10 municipalities in Central, Western and Southern Jutland, which have had an average rainfall in the past ten years of between 906 and 955 mm. The difference in precipitation of between 32 per cent and 55 per cent is one factor that affects sustainable abstraction, as this is an important factor in groundwater recharge.

See the rainfall map on www.danva.dk/nedboersvariation.



The volume of precipitation has been calculated over the past 10 years.
SOURCE: Danish Meteorological Institute.

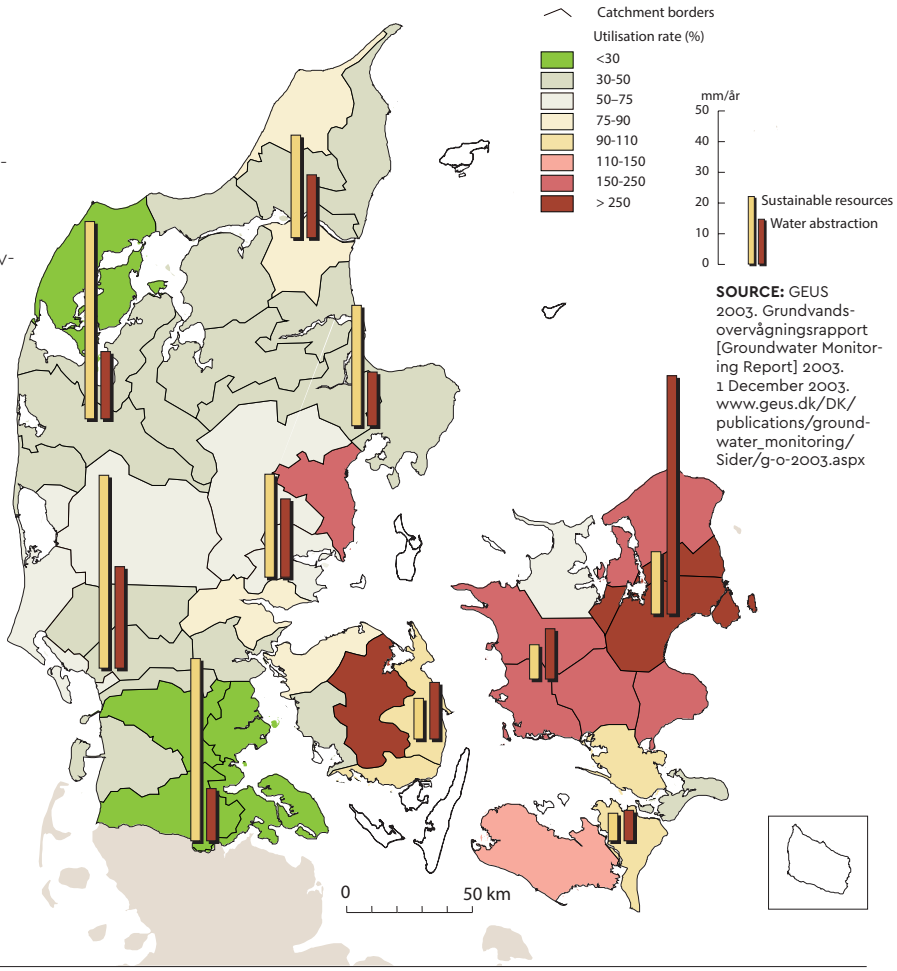
Utilisation of groundwater resources

Based on data from the Geological Survey of Denmark and Greenland (GEUS), it can be seen that the utilisation rates of groundwater resources in Denmark are geographically different.

The bars show usable resources and actual catchment of water in 2002 accumulated for 10 catchments areas.

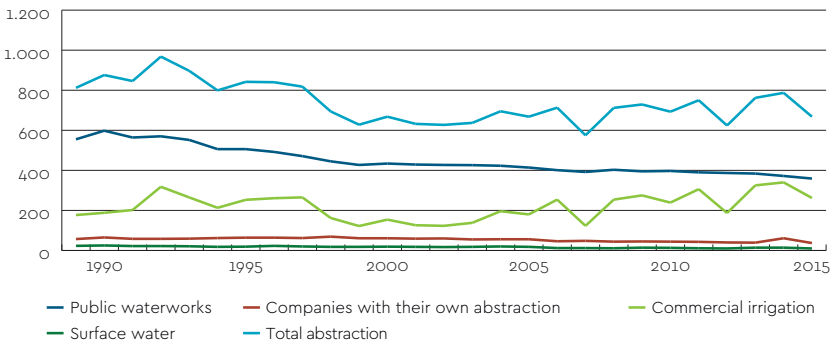
The GEUS map clearly indicates in which catchments groundwater resources are heavily overexploited. In the investigation of the utilisation rates of groundwater, GEUS finds that resources are heavily overexploited in certain locations. For example, more than 5 times the exploitable resource is pumped in the Copenhagen metropolitan area districts of Søndersødal and Copenhagen City, while the districts of Næstved and Odense pump 2 to 3 times too much. The areas of Svendborg, Kalundborg, Slagelse, Hillerød, Faxe, Falster, Lolland and Aarhus pump 1 to 2 times too much in relation to the utilisable water resource. Less water was extracted than what was estimated to be sustainable in the other regions of Denmark in 2002, (see the utilisable water resource).

Extraction for field irrigation was fairly limited in 2002, which is why the utilisation rate for normal field irrigation, primarily in the central and western parts of Jutland, will increase in years where field irrigation is required.



SOURCE: GEUS 2003. Grundvandsovervågningsrapport [Groundwater Monitoring Report] 2003. 1 December 2003. www.geus.dk/DK/publications/groundwater_monitoring/Sider/g-o-2003.aspx

Varied **water abstraction** over the years



SOURCE: Thorling, L., Hansen, B., Larsen, C.L., Larsen, F., Mielby, S., Johnsen, A.R., & Troldborg, L. (2016): Grundvand. Status og udvikling 1989 – 2015. Teknisk rapport, GEUS 2016. Page 109

Water abstraction in Denmark is divided into four categories: public waterworks, companies with their abstraction, commercial irrigation and surface water. Abstraction of groundwater for public water supply needs has decreased from 1990 to 2015. There was a significant decline in abstraction until 1999, after which abstraction levels have been declining only slightly. Commercial irrigation usage has seen many fluctuations, but remains at the same level. Part of the explanation to this is fluctuations in land irrigation. The abstraction of water from companies with their own catchment and surface water is largely unchanged. Total water abstraction has fallen by between 15 and 20 per cent since the beginning of the 1990s.

DANISH DRINKING WATER COMPANIES continue to reduce their water losses

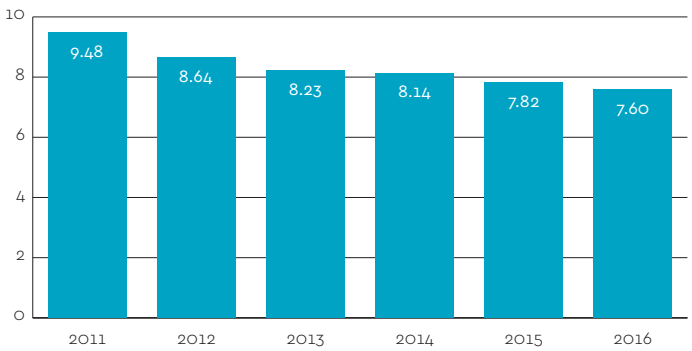
Danish drinking water companies can be characterised as having a very low level of water loss in the distribution. For the 52 drinking water companies that have participated in DANVA Benchmarking in the past 5 years, there is a steady reduction in water loss since 2011, from 9.48 per cent to 7.60 per cent in 2016. This is despite the fact that the continued decline in water consumption would mean an increasing percentage of water loss. The reduction in water losses is due to the significant efforts made by the companies, which get continuously better at tracking leaks, which are then repaired, thereby reducing water losses.

At the end of the 1990s, a general requirement for setting up water meters for all water users was introduced, and a penalty payment was imposed on companies experiencing a water loss of more than 10 per cent, measured as the ratio between the volume of water pumped and water sold. These measures have vastly contributed to placing Denmark nowadays among the leading countries with lowest water losses. Water loss is measured as the difference between the volume of water pumped by the utility company for its own distribution network and the amount it has charged its customers for water. Water loss can be calculated in any of several ways, either as a percentage, as water loss per km of pipe, or in a more detailed way, as an Infrastructure Leakage Index.

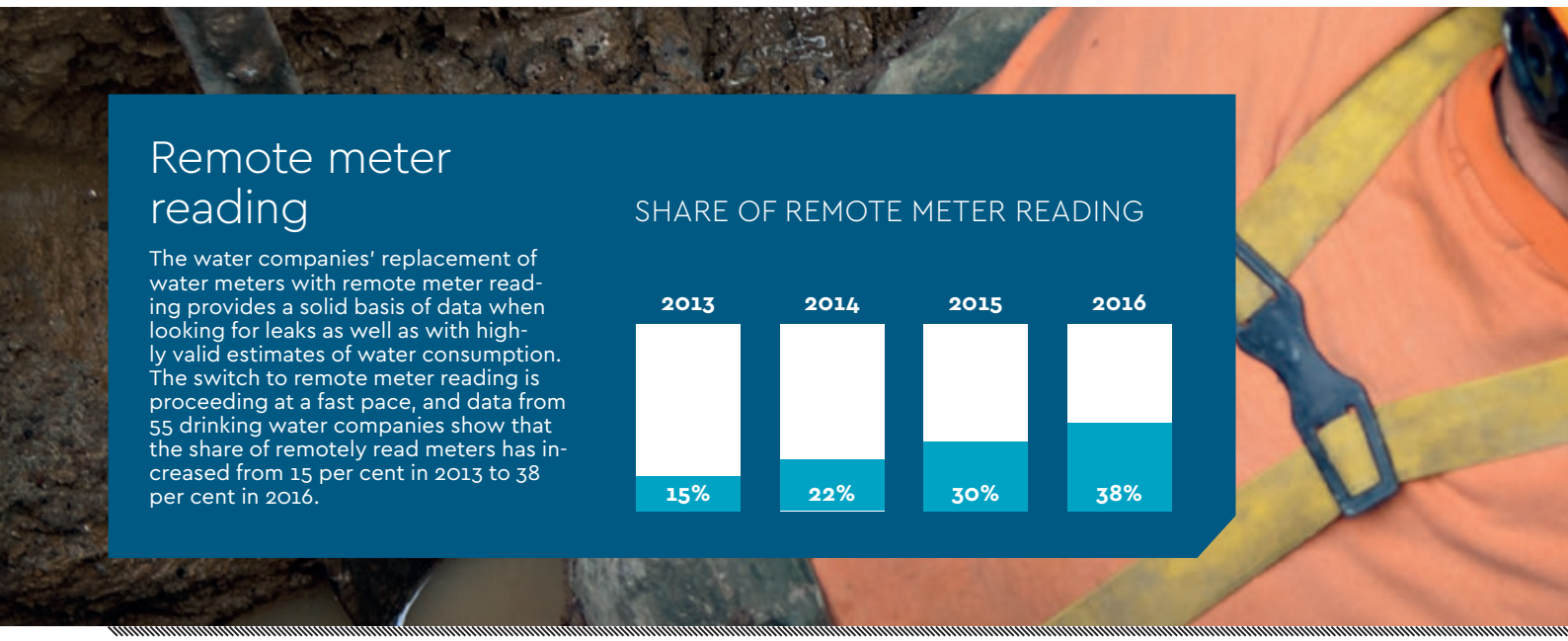
The Infrastructure Leakage Index compares actual water loss, as it does not include wastage of water due to the flushing of water pipelines after repairs, water used for fire extinguishing and unauthorised usage. The Infrastructure Leakage Index calculates actual water loss that leaks into the ground in relation to the "inevitable" loss of water, which is calculated on the basis of the size of the plant and water pressure.

There are many different methods that can assist the water companies in reducing their water losses, such as segmentation of the pipeline network, which, with the installation of flow measurements in the various sections,

NON-REVENUE WATER (WATER LOSS), 2011-2016



Simple average (per cent) based on 52 drinking water companies which have participated in DANVA Benchmarking for the past 6 years.



Remote meter reading

The water companies' replacement of water meters with remote meter reading provides a solid basis of data when looking for leaks as well as with highly valid estimates of water consumption. The switch to remote meter reading is proceeding at a fast pace, and data from 55 drinking water companies show that the share of remotely read meters has increased from 15 per cent in 2013 to 38 per cent in 2016.

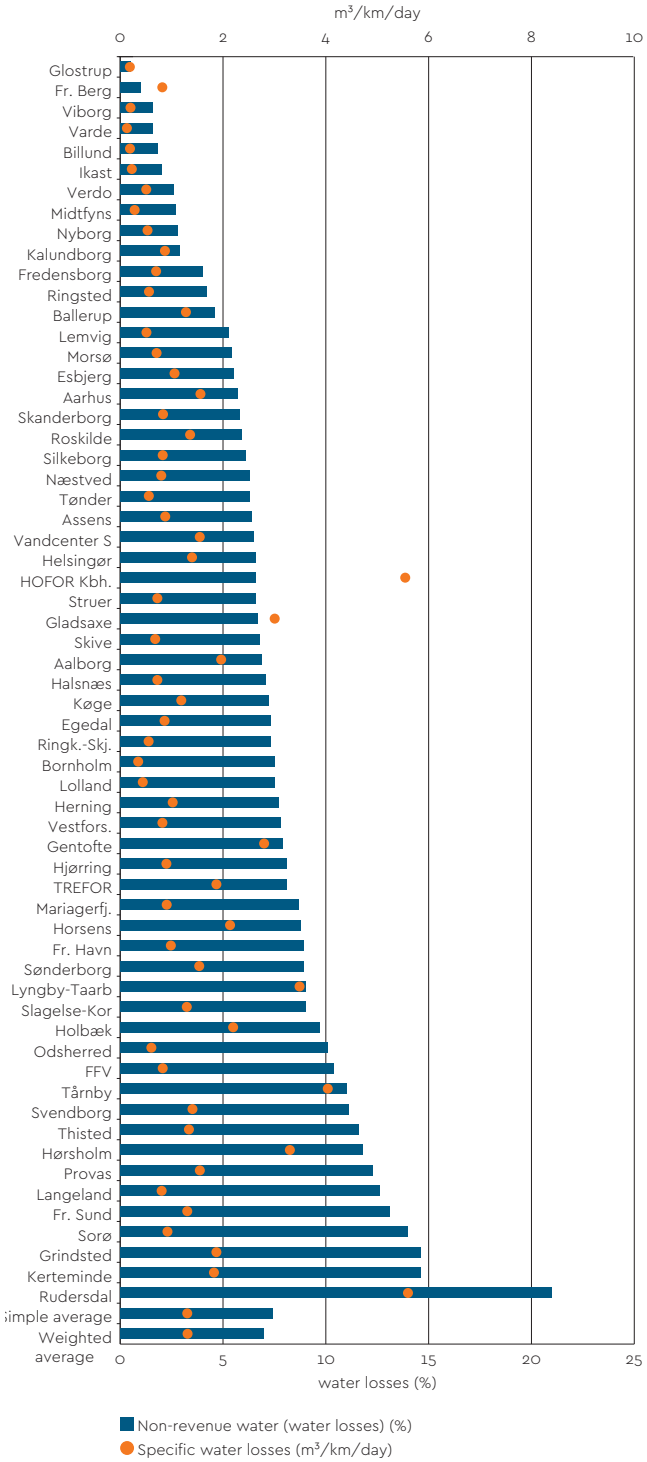
SHARE OF REMOTE METER READING

provides a significantly better basis of data for tracking of leaks, for example, in connection with an analysis of flow rate measurements.

Non-revenue water

The drinking water companies' calculation of "non-revenue water," also known as "water loss" in ordinary language, shows significant differences from one company to another as well as depending on whether the comparison is based on a percentage or on a specific loss of water as calculated in m^3/day. Companies with a large pipeline network, but with only a small consumption of water have better results in the comparison by specific water losses, whereas companies with large consumption of water from a smaller pipeline network are best in the percentage comparison. The actual calculation internally within the companies could show fewer fluctuations from one year to another, without any clear explanation, but, in particular, when the consumption meters or meters at the waterworks measuring pumped volume up are replaced, there could be fluctuations compared to previous years.

NON-REVENUE WATER (WATER LOSS), 2016



NOTE: The registration has not taken into account any post-adjustments of the company's water losses which could be due to a contamination/pollution process with large flushings of the pipeline network, where an exemption has been granted for the water used in relation to the calculation of penalty charges. This means that there may be minor differences in the water loss stated in the graph and the water losses declared by the companies themselves.

Infrastructure Leakage Index

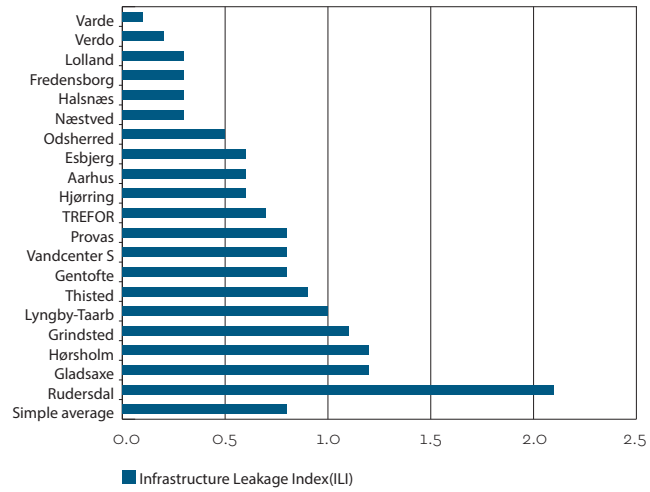
The loss of water can be calculated more accurately and compared with the calculations of the Infrastructure Leakage Index, referred to as the ILI. ILI is an international water loss performance indicator which has been developed by the International Water Association (IWA), which makes it possible to compare the actual physical water losses and the inevitable water loss between different companies with different framework conditions (size and design of the pipeline network, catchments, density, etc.) and comparisons across national borders. ILI is the relationship between actual physical water loss and "inevitable water loss."

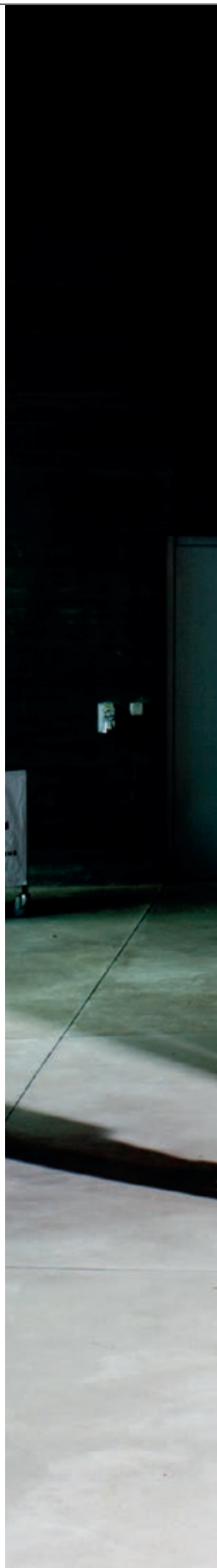
Actual physical water loss is calculated as the difference between the amount of water sold and the amount of water pumped, minus authorised non-billed consumption (for example, flushing of the pipeline network after repairs, water used for firefighting as well as unauthorised consumption (theft) and meter measurement uncertainties.

The "unavoidable real water loss" is a calculation which is based on an international formula that in turn is based on the size and water pressure of the pipeline network, presuming that it is a well-run healthy pipeline network of a recent date, which calculates the acceptable minimal, technically achievable water loss that is financially justifiable. Actual physical water loss, and thereby the ILI, can be reduced, for instance, by improving the speed and quality of repairs, introducing active leakage controls and incorporating asset management into the company's renovation planning. The ILI calculation is based partly on assumptions, for example, concerning the length of private water service laterals, the average pressure in the pipeline network as well as the calculation of water used for flushing. Meter uncertainty has not been incorporated into the Danish calculations.

There are calculations of ILIs from around the world on the website www.leakssuite.com under "Global ILIs/European ILIs."

INFRASTRUCTURE LEAKAGE INDEX (ILI), 2016



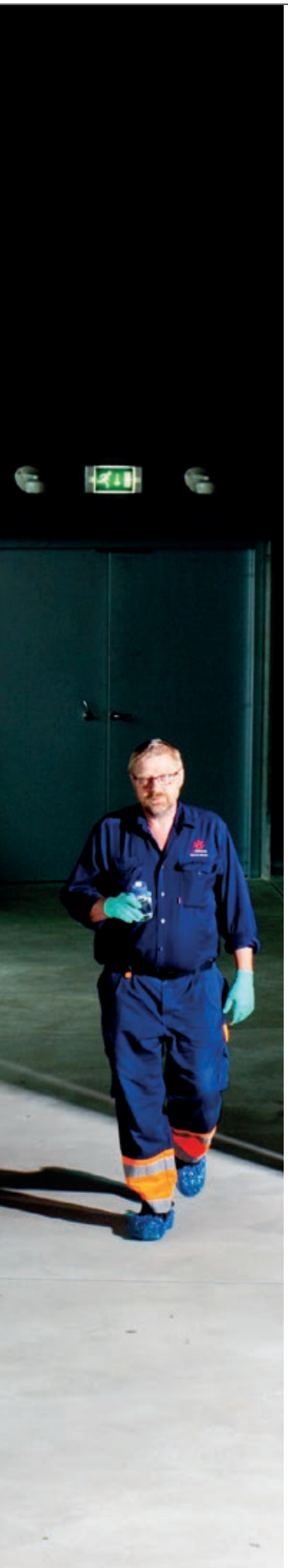


Danish water companies do not wastewater

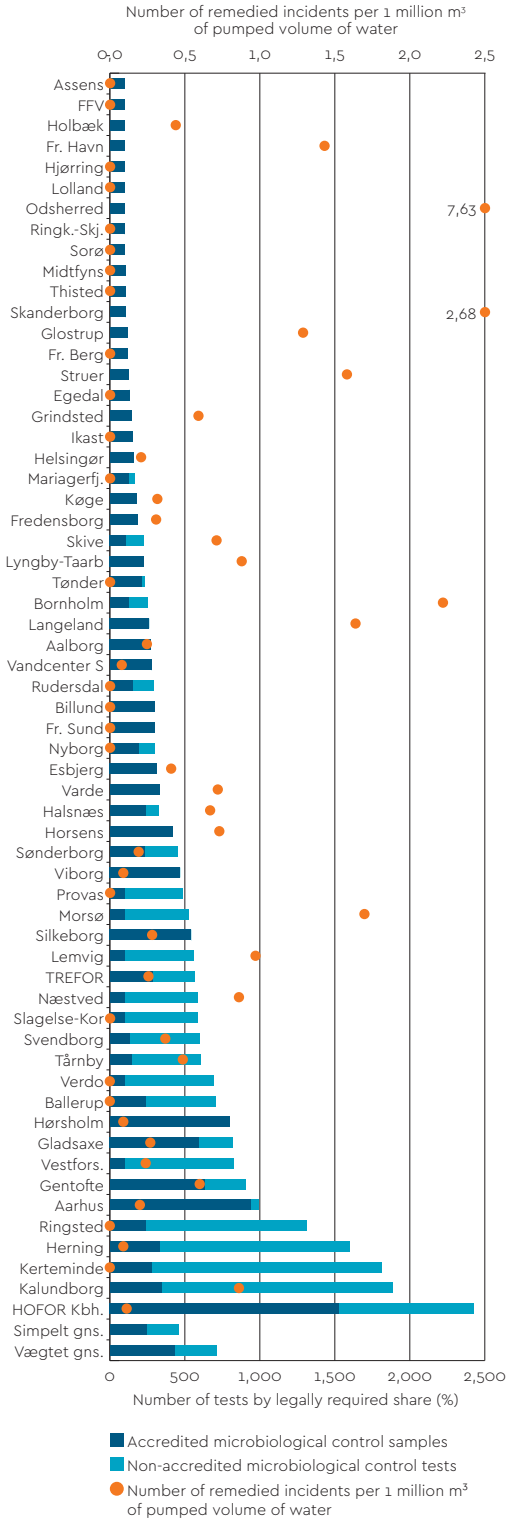
A comparison of drinking water companies in high-income countries prepared by www.leakssuite.com shows that Danish drinking water companies take great measures and succeed in reducing water loss of drinking water. Danish water companies come in second place among the12 high-income countries.

Country or Region	Percentage of supply included in the survey	Data year	Number of companies in the survey	Average ILI	% of companies with ILI >= 2%
The Netherlands	100%	2015	10	0.6	0%
Denmark	22%	2014	37	0.7	3%
Flanders (Belgium)	100%	2014	7	1.0	14%
Germany	0.7%	2011	44	1.0	25%
Austria	0.9%	2007/2011	50	1.0	36%
Australia	93%	2014/2015	65	1.1	21%
England/Wales	35%	2011/2012	9	1.7	22%
Georgia (USA)	100%	2011	107	1.8	44%
USA	0.5%	2011	25	2.4	64%
Portugal	11%	2013/2015	14	2.6	57%
Canada	100%	2003/2014	33	2.7	67%
Croatia	15%	2005/2014	23	4.5	80%

SOURCE: www.leakssuite.com/ili-overviews-by-country/ and DANVA



MICROBIOLOGICAL WATER QUALITY ANALYSES, 2016



Controlling drinking water quality

It is a statutory obligation to conduct inspections and controls of the drinking water before supplying it to the consumers. The inspections and controls consist of analyses for selected physical parameters such as iron and cadmium as well as microbiological parameters such as E-coli and bacterial count. Drinking water companies take samples from both the waterworks on the pipeline network and at the tap at the customers. A number of statutory inspection tests that are to be analysed at an accredited laboratory and carried out over the course of the year is determined together with the supervisory authority based on the size of the drinking water company.

It is up to each individual drinking water company to determine the scope and extent of any sampling beyond the statutorily required number of samples. Such sampling may include either more of the same type of samples as the 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 find the number of statutory tests to be sufficient, and other companies choose to expand their testing programme with many additional tests and controls, even though the more samples are taken, the more the risk of exceeding the established standards is increased.

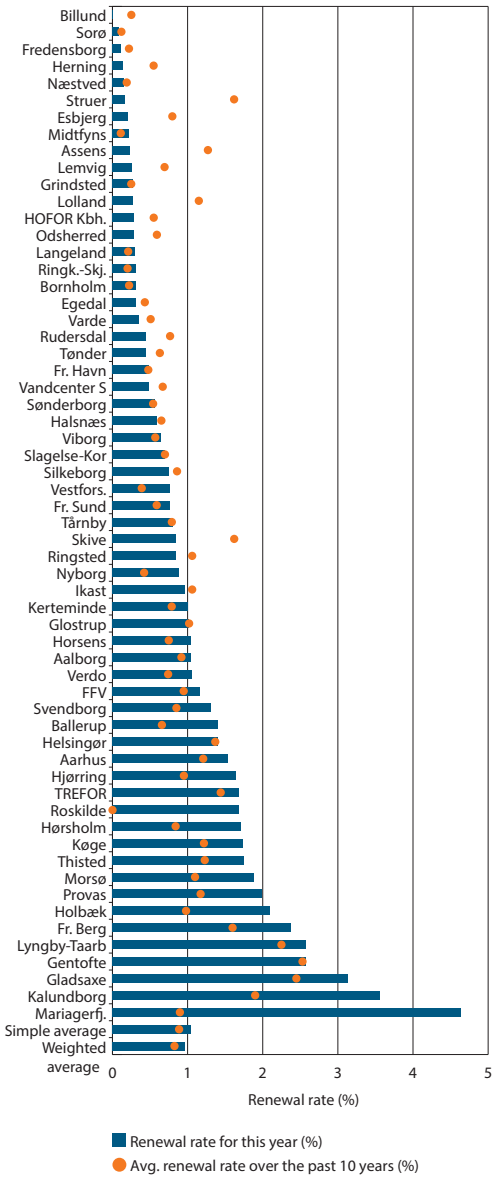
Over 2/3 of the 61 drinking water companies participating in DANVA's Statistics & Analysis and Benchmarking take more than twice as many samples than the regulatory authorities require in order to test for microbiological contamination.

The results from the accredited analyses show that, based on 12,815 samples, 98 per cent of the microbiological control samples taken fall within the threshold limits for all quality requirements. If only one analysis parameter for a water sample exceeds the quality threshold limit requirements, it is registered as an "incident," which, however, does not mean that the water is potentially harmful to health. Usually, it simply means there are conditions that need to be investigated further.

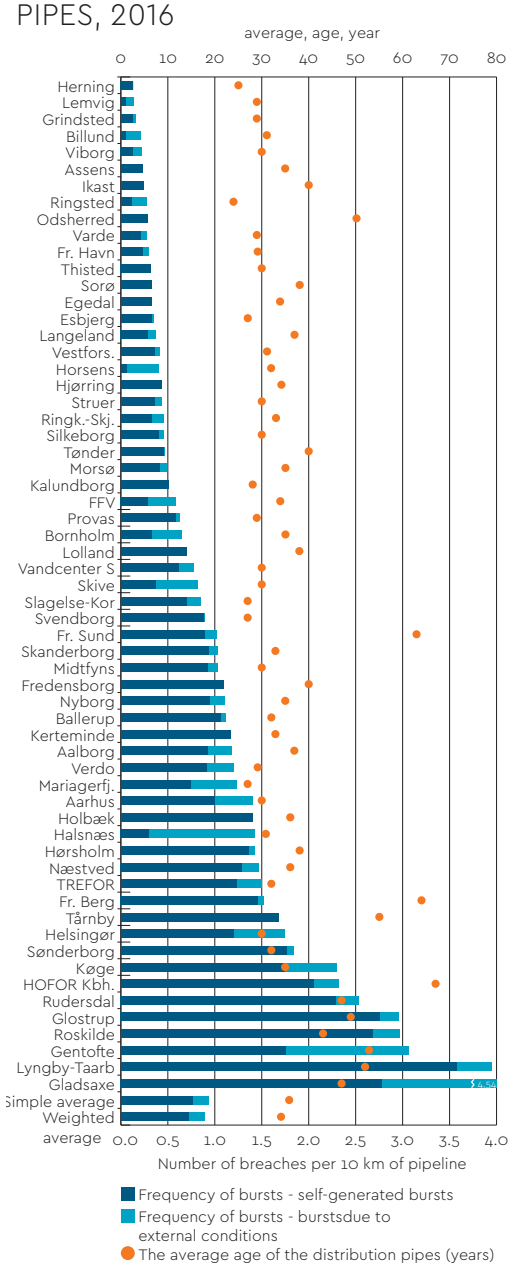
The key figure "Number of remedied incidents per 1 million m³ of pumped volume of water" is an expression for the number of incidents a company experiences per 1 million m³ of pumped water, which is corrected for the additional risk involved in taking more control samples than is statutorily required.

In 2016, two companies were forced to issue a recommendation to their customers to boil the water because the microbiological parameters were exceeded. The boiling recommendations involved a total of 3,232 households (water meters).

RATE OF RENEWAL OF DISTRIBUTIONS PIPES, 2016



FREQUENCY BURSTS TO DISTRIBUTION PIPES, 2016



Renewal of the pipeline distribution network

The pipeline supply network's renewal rate shows how much of the pipeline network was replaced the previous year (as a percentage), compared with the average per year for the past 10 years. There is a continuous renewal of the network, in order to maintain the high water quality, high security of supply and minimal water loss. There are a number of factors, such as, e.g. materials, geological conditions, surface loads and stresses and ages that affect when the pipeline network is renewed. Another important factor is also that many major infrastructure and facilities projects often mean that water companies must move their water distribution lines, even though they have not reached the end of their useful lives.

Large variation in the frequency of pipeline bursts

A burst in a pipeline network is one of the major operational tasks that drinking water companies need to maintain a focus on. A burst in the network most likely means that there will be consumers who will not have water in their taps, and naturally the companies will make attempts to reduce, to the extent possible, the number of bursts and the duration of such bursts.

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 2 categories:

- Self-generated 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 breach.
- Bursts due to external conditions, where the breach is often due to excavation damage caused by a contractor in connection with excavation work.

The graph shows self-generated bursts and bursts caused by external conditions on the mains and the pipeline network, calculated as number of bursts per 10 km of pipeline network. The bursts are distributed across the entire pipeline network, from the waterworks to the consumer's water meter. The main part of the pipeline network belongs to the water company, however, with the exception of the final metres from the property boundary and to the water meter, which are owned by the landowner, and which are often referred to as the water service lateral.

The 61 companies had more than 2,750 bursts in total, distributed among approximately as many bursts on the house/building connections as on the mains and pipeline network. Approximately 20 per cent of the bursts are caused by external conditions. In addition, 17 companies have registered bursts in private water service laterals. The companies experienced approx. 1,100 bursts in their own pipelines, but had knowledge of 300 bursts in private water service laterals. This figure may be significantly higher, as companies usually only become aware of the bursts when the landowner cannot find the shut-off stopcock in connection with the repair, or when they seek advice and guidance from the water company, or hope that the water company will pay for the repair.

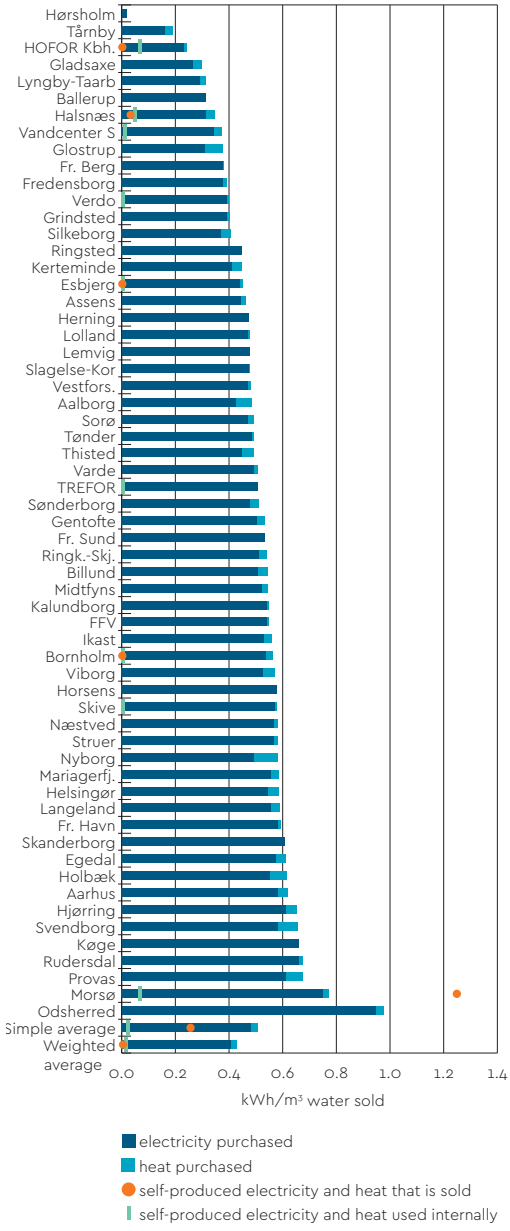
Energy consumption by drinking water companies

There is a significant difference between the amount of electricity and heating/energy consumption that Danish drinking water companies consume in order to supply 1 m³ of clean water to their consumers. Consumption of electricity (purchased electricity) is, on average, 0.41 KWh per sold m³, and the companies themselves produce approx. 0.2 per cent of the gross consumption. The average weighted gross energy consumption for drinking water is 0.45 kWh per sold m³. The gross and net energy consumption is the same for most drinking water companies, since only a minor fraction of the companies generate their own electricity, most often in the form of solar cells. However, the exception is Morsø Vand A/S, which has a substantial production of heat in connection with the water company and thus produces more energy than what is consumed in connection with the drinking water production.

The bulk of the consumption of energy in a drinking water company is electricity, which can be divided into consumption by the well-field and the waterworks, referred to as "production" and consumption of electricity used on the pipeline network from the waterworks to the customers, referred to as "distribution." 86 per cent of the consumed electricity is used in well fields (sources of water) and waterworks. However, what is very important for the calculations is whether the pumping 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.

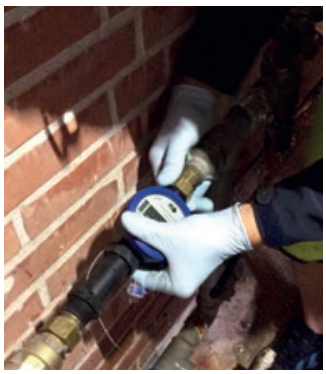
The difference in consumption of electricity can be explained partly by particularly energy-demanding deep drillings for water, imports of pre-treated water, topographic conditions of the pipeline network or a highly energy-inefficient distribution system. In the past few years, several water companies have commenced producing electricity using solar cells, which are part of the production and contribute to the water companies' objective to become CO_2-neutral in the long term. ■

ENERGY CONSUMPTION AND PRODUCTION OF DRINKING WATER COMPANIES, 2016



Good experience with **remote meter reading**




In TÅRNBY FORSYNING, the implementation of installing remotely read water meters has meant less efforts spent on administration, while a development project in Skanderborg Forsyning has resulted in more energy-efficient and careful abstraction.

These years quite a few water companies are choosing to replace their mechanical water meters with remotely read meters. This applies to Tårnby Forsyning, among others, where the replacement process is underway for a second year. So far, around half the approx. 10,000 mechanical meters controlled by the utility have been replaced with electronic meters, and there are already savings of administration and time, reports agronomist Jørn Leth-Espensen, who works in Tårnby Forsyning's engineering department.

"In the past, we needed to send out letters, and people would read their meters once a year themselves. There were many who simply didn't do it. So we needed to spend energy and incur postage expenses in order to send out letters out to all the consumers. Also some of them misread their meters and were thereby able to postpone receiving a bill for several years until they left or we replaced their meter, and this resulted in quite a bit of administration when we needed to subsequently collect the money. Now we can receive all the data one to two days after New Year, and this means that we can send out the bills much more quickly," he explains.

The remotely read meters have also meant that the company has begun to inform its customers about leaks.

"When we received the figures after New Year, we were able to see that about 20 consumers had not had one consecutive hour where their water consumption had been zero. This is a sign that there has been a leak, so we subsequently approached them and said that they should check their installations. A few of these customers actually found water loss of 2 to 5 cubic metres per day, and they were very grateful to us for bringing that to their attention – which is the very definition of good service," explains Jørn Leth-Espensen.

The expectation is that the utility's own water loss can also be reduced in the long term as it will be in a position where it can monitor water consumption much closer:

"We are working on making a sectioning, where we can see the consumption of water in the various areas. Then we will be able to measure how much water goes into an area and compare to the data we receive from the electronic meters. This will make things significantly more certain, as there will be some exact figures, figures which we can get our hands on much faster."

Energy savings

Skanderborg Forsyningsvirksomhed has gone one step further and and has used data from the remotely read meters in the Stilling area in a development project that has produced significant savings for their energy bill, comments Carsten Vigen Hansen, a water specialist at Skanderborg Forsyningsvirksomhed.

"Typically, waterworks are pre-programmed to do a particular thing at particular per-determined times. What is traditionally done is that if you have a water tank with four metres of water, and you have delivered one metre of water to the customers, then you fill it up again. And all of this runs completely automatically. We have now introduced real-time controlled operating optimisation, which means that we make forecasts of expected water consumption on the basis of hourly meter data from the consumers and then calculate what the extraction and water treatment should be," he explains.

Based on the required production output,

TEXT: ASSIA AWAD / **PHOTO CREDITS:** KASPER JENSEN, TÅRNBY FORSYNING

A technician from Tårnby Forsyning in the process of replacing a mechanical meter with a remotely read meter.

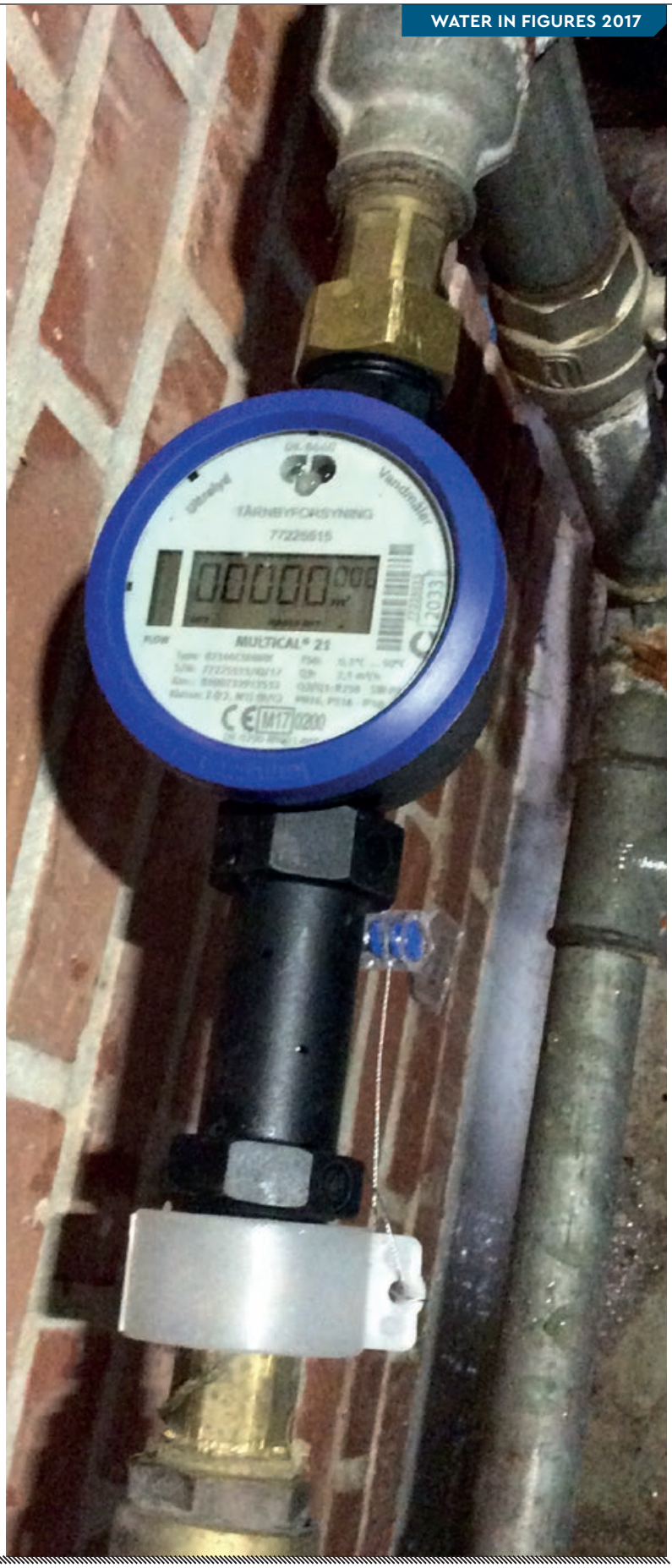
it is calculated which of the utility's frequency-controlled wells is most energy-efficient to use at any given time. This results in a more energy-efficient and gentle extraction, something that is also of benefit to the environment, plus it also saves the utility a significant amount of money.

"We anticipate energy savings of 15 per cent. Even though this is a small part of our area, I have calculated that we save about DKK 50,000 per year," comments Carsten Vigen Hansen.

The project, which was carried out in collaboration with Kamstrup, EnviDan and the Danish Hydraulic Institute, and supported by the Environmental Technology Development and Demonstration Program (MUDP) was completed in 2014, but the forecasts are still being used to control the production at the waterworks, and the system is planned to eventually be expanded to the rest of the utility.

They are also contemplating using the electronic meters to offer new services to their customers.

"We could perhaps be able to provide certain additional services to the companies so that they can monitor their own consumption. This could concern, for example, a warehouse that is empty. If a leak suddenly occurs, and the customer does not supervise the warehouse, we will be able to alert them," he explains. ■



The Americans have been inspired by our way of doing things, comments Claus Homann (in the middle), who is responsible for production and is Strategic manager at Aarhus Vand.

DANISH water – and wastewater treatment is among the best in the world

Large parts of the world are facing severe challenges with drinking water and wastewater treatment. This has caused interest in Danish water technology and the Danish water model to grow, which has led to increasing international cooperation in the water sector. Seen from Danish perspective, this means increased employment in Denmark and lower prices for the customers. Among other things, this has contributed to Aarhus Vand lowering its tariffs in 2017 due to lower energy consumption.

In particular, large Danish water companies such as VandCenter Syd in the city of Odense and Aarhus Vand are engaged in international partnerships and sell, in this connection, a large number of water technology products and solutions from Danish manufacturers to public authorities and utility companies all over the world. Many have apparently apparently discovered that Danish water companies and producers have something extra and a bit special to offer.

A report in World Energy Outlook in 2016 highlights the Danish water sector as being especially energy-efficient. The report specifically mentions Marselisborg Renseanlæg as a good example, which proves that wastewater treatment can become energy-neutral. A good number of Danish wastewater plants are already or on their way of becoming energy-neutral. Aarhus Vand has has started to generate energy with its plant in Marselisborg. The transition to a circular economy is an opportunity not only to recycle water but also a possibility to accelerate innovation that promotes greater efficiency and a higher degree of sustainability in the sector.

Marselisborg creates significant attention having en energy efficiency of 153 per cent on electricity alone. Expectations in Aarhus are so high that Marselisborg wastewater treatment plant is called "Marselisborg ReWater", and furthermore in the future Aarhus Vand will use employ the concept of "Marselisborg resource plant". In a few years, Danish wastewater companies will be able to produce so much energy that it will cover energy consumed in the entire water sector. This will have a significant effect on energy consumption in Denmark.

Many ongoing projects

VandCenter Syd (VCS) in Odense has extensive experience with international projects. Some primarily concern an exchange of experience, while others are commercial projects. The company engages in collaborative efforts with and contributes to projects in many countries, such as Burma, Malaysia, Indonesia, the United States and Zambia. VCS also works together with Aarhus Vand, along with HOFOR and BIOFOS (based in Copenhagen), under the common name 3VAND, with the aim to support the export of Danish water technology and Danish solutions.

VCS has assumed a leading role in a project in Zambia, where the company provides, together with Aarhus Vand and HOFOR, a significant input to Krüger A/S, a Danish consulting and construction company which specialises in

design, project planning and supply of water and wastewater solutions. 3VAND has extensive knowledge concerning the operations and maintenance of the type of facilities supplied by Krüger. When the water companies become involved in international commercial projects, it takes place on market terms and conditions.

Zambia is experiencing economic growth and population growth in cities. It is therefore crucial that the security of supply of water and treatment of wastewater is improved and made significantly more efficient. The project concerns the renovation of a district in the city of Ndola, while contributing to improving overall health. It also ensures better utilisation of resources, as the loss of water and the number of times they experience flooding is sharply reduced.

"The project in Zambia puts a major emphasis on providing sustainable solutions. It is absolutely decisive for the success of the project that at the same time as equipment deliveries takes place, a significant amount of training is provided and that knowledge about the operation and maintenance of the new solutions is transferred," comments Henrik Werchmeister, Head of Area at VCS.

Another good example of what Danish know-how and Danish technology can deliver is the Billund BioRefinery.

"This shows how the interaction between water companies, consultants and producers ensures value for Danish water customers and export markets. The project supports the water industry's "Water Vision," which has the goal of creating 4,000 new jobs in the industry and a doubling of water technology exports within 10 years," comments DANVA's Managing Director Carl-Emil Larsen, who is also chairman of The Foundation for Development of Technology in the Danish Water Sector (VTU-Fonden).

Billund Vand has developed Billund BioRefinery in joint collaboration with Krüger A/S. Two projects inspired by Billund BioRefinery have already been sold to South Korea.

The door is open to the market in the United States

In the United States, Aarhus Vand is working together in joint cooperation with the state of California and the city of Chicago in the field of water and wastewater. This cooperation has come to being within the framework of the Danish-US cooperation, Water Technology Alliance, which receives funding from The Danish Industry Foundation (Industriens Fond), among other sources. Chicago's water utility works together with Danish water technology producers, Aarhus Vand, and Eksportrådet/The Danish Trade Council. The expectation is that the invested money will come back many times over in the form of orders worth millions of kroner, along with new Danish jobs. Thus a future treatment plant in Chicago will be a full-scale model highlighting what can be offered by Danish water technology.

"The Americans have been inspired by our way of doing things. They have been very impressed that the wastewater treatment plant in Marselisborg produces 53 per cent more electricity than it consumes," reports Claus Homann, who is responsible for production, and strategic manager at Aarhus Vand.

In order to support Danish exports and WTA, Aarhus Vand has one employee posted in Chicago and another one in San Francisco. The intention is to function as a neutral bridgehead between Danish water technology and the US market and use this approach as a means to open doors.

Aarhus Vand's international efforts are based on 3 legs: In the United States, it has the role of a kind of water ambassador, while the company as a water innovator in partnership with HOFOR and VCS is part of a global network. Finally, its is also a supplier of knowledge and manpower. In addition to the WTA cooperation in the United States, Aarhus Vand has projects, e.g. in cooperation with the Municipality of Aarhus, in India and South Africa, where they sell know-how while collaborating with Krüger A/S on several projects in Zambia.

Danish water companies themselves benefit from the international joint collaboration. As Claus Homann comments:

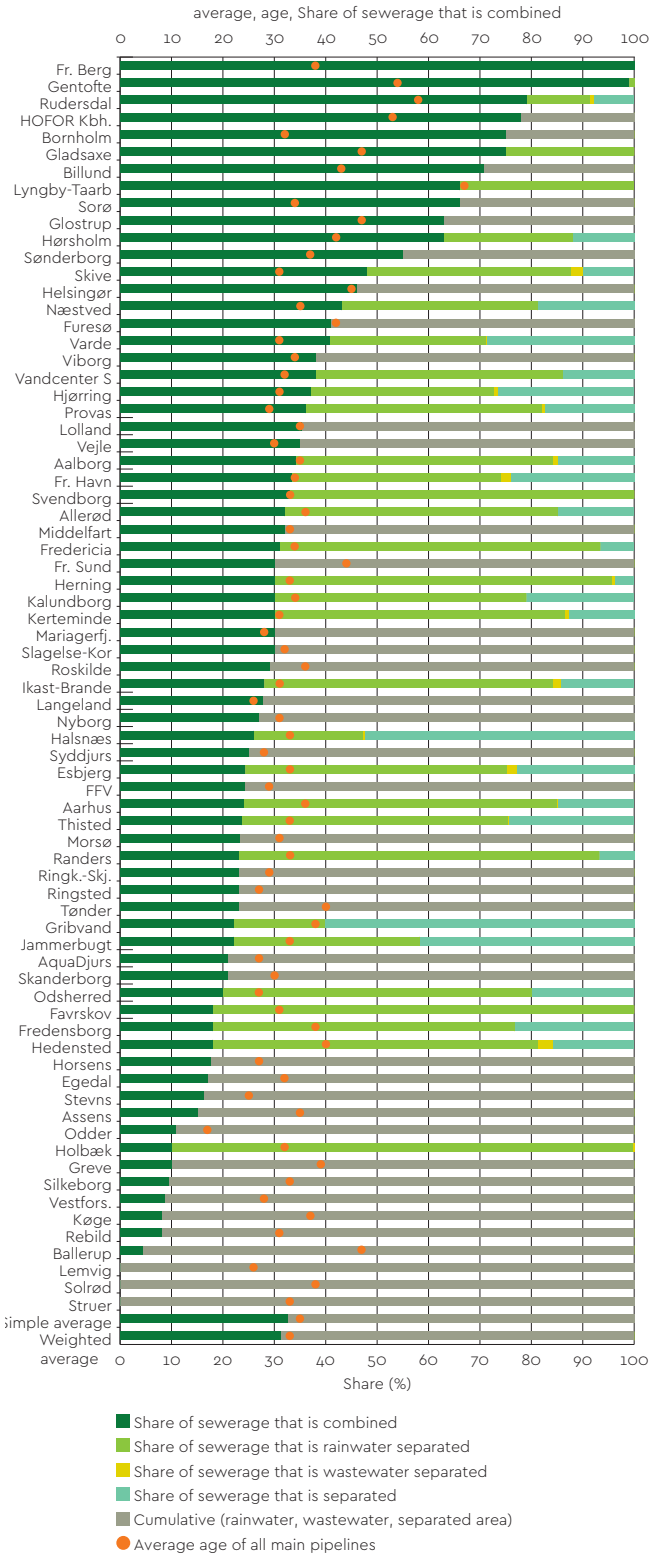
"We want to support the Danish water vision. We are not a private company, and our involvement in international activities must also generate some benefits to us. The joint collaboration furthers our ongoing development, which will ultimately be of benefit to our customers in Aarhus, in the form of better services and a higher level of service." ■

Praise for the Danish water sector

The report World Energy Outlook in 2016 highlights the Danish water sector as being especially energy-efficient. It specifically mentions Marselisborg Renseanlæg in Aarhus as an example that shows that wastewater treatment can become energy neutral. However, they are not alone, as many Danish wastewater plants are moving in the same direction.

Water Project in Zambia. VandCenter Syd and 3Vand cooperate with Krüger A/S on the provision of technology and know-how. Zambia is experiencing economic growth, and its cities are growing rapidly. It is therefore crucial that the security of supply of water and treatment of wastewater is improved and made significantly more efficient.

AREA ALLOCATION BETWEEN COMBINED AND SEPARATE SEWERAGE, 2016



THE WASTEWATER COMPANIES' SEWER NETWORKS ARE CHALLENGED

Companies face major challanges due to increased rainfall in recent years.

We experience several substantial cloudbursts flooding roads, rail lines, basements and shops. This is something that is very expensive for the community-at-large and affects, in particular, homeowners who, for example, may be so unfortunate to get untreated wastewater in their basement.

Separate sewerage

Wastewater companies can choose to expand their existing common sewer network with larger pipes and wastewater basins so as to handle increased volumes of rain, but the most effective, yet also the most expensive way to avoid water from sewer systems in basements is to separate the rainwater from the wastewater and establish a 2-strand sewer system: Traditional separate sewerage. Alternatively, the rainwater can be disconnected from the existing combined system and led to discharge locally on private grounds (Local Rainwater Harvesting, LRH).

Traditional separate sewerage is typically far more expensive than the other two, as it often requires excavation by both the utility and the residents. The LRH method is designed to provide a coordination with cloudburst (torrential downpour) protection and flooding from surface runoff, thereby solving multiple issues at once. This method makes it possible for residents to take advantage of easier/less expensive solutions and take joint responsibility for climate change adaptation by establishing rainbeds or fascines for percolation of rainwater, where possible. The LRH solutions are the first to break through as a method and make the most sense when it comes to management of cloudbursts or new residential areas. The biggest advantage of the expansion of the sewer system is that this does not require action from/involvement of residents, but at the same time, this method does not provide a 100 per cent guarantee that the residents will not continue to experience flooding in the event of a cloudburst.

The increase in the spread of separate sewerage is a consequence of an intensification of reconstruction work and prevention of basement flooding resulting from the many instances of torrential rain. At the same time, it is also one of the reasons why it has become more expensive in recent years for Danish consumers to have wastewater drained off.

In areas that are less densely populated, there are other arguments for separation. Here the focus is on removing extraneous water (groundwater and drainage water), minimising the transport of rainwater (pumping) and ensuring a more even flow to the wastewater treatment plants. These are the most important drivers for separation, along with the need for renovation.

Share of combined and separate sewerage

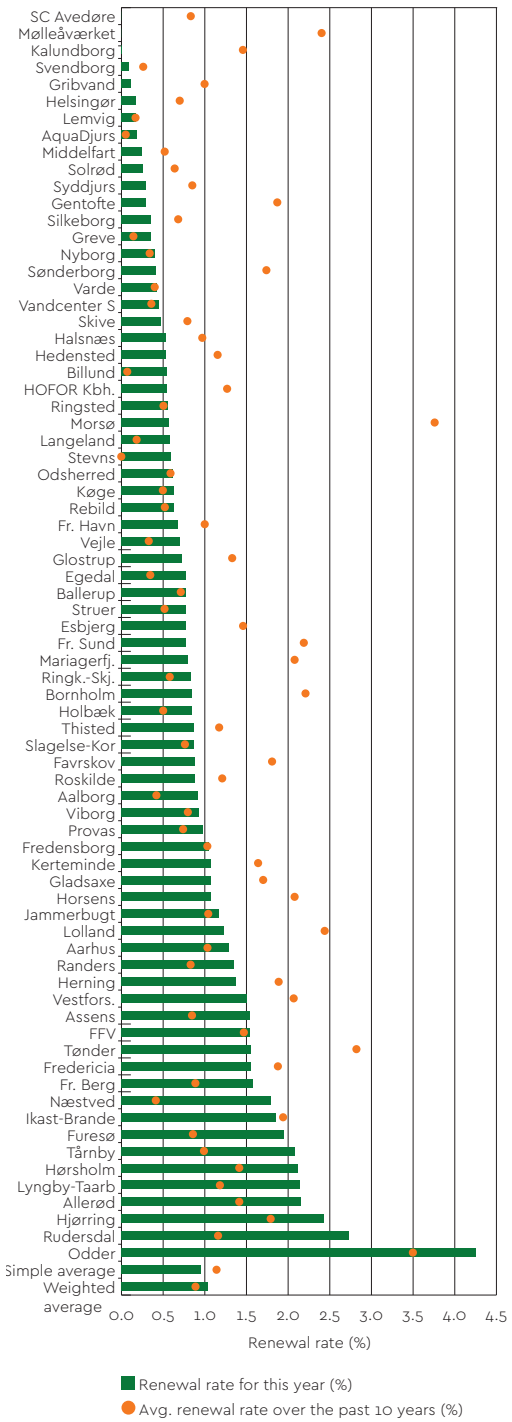
There is a very substantial difference in the degree of separate sewerage among the benchmarked wastewater companies. Some companies have almost only joint sewer systems, while others primarily have separated wastewater and rainwater in separate sewer systems. This is associated with the fact that the replacement of previously established combined sewer systems with separate systems requires a massive investment, since the vast majority of the wastewater companies' assets consist of the pipeline network. The prices of the replacement of the combined pipelines also vary quite a bit. For combined sewerage areas in large cities and, in particular, in densely populated city centres, where the construction of facilities is particularly difficult, the prices of the separation of the supply and residents are very high.

Renewal of the sewer network

The rate of renewal of the sewer network shows how much of the pipeline (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 of more than 1 per cent, which perfectly fits in with the investments in the sewer network in recent years. There are a wide variety of factors that influence when the sewer system should be renewed, such as materials, dimensions, leaks and breaches, geological conditions, surface load and age. Another factor of significance is that many large infrastructure and construction projects often require wastewater companies to move their sewer lines, even if they have not reached the end of their useful life.

RATE OF RENEWAL OF SEWER PIPES, 2016



Focus on extraneous water

Extraneous water is present, to varying degrees, among the various utility companies. Circumstances and conditions such as groundwater, soil conditions, rainfall and the condition of the sewer network are parameters that affect the volume of extraneous water that is discharged to the wastewater treatment plants.

Extraneous water comprises, among other things:

- Seeping groundwater in areas where the sewerage pipes are below the groundwater level.
- Faulty connections of rainwater drainage pipelines to wastewater systems.
- Drainage water connected to wastewater systems.
- Previously piped waterways, which over time have turned into sewerage systems without disconnecting the watercourses.

When the calculation of the amount of extraneous water is determined, it is compared with the expected amount of wastewater that the treatment plant should receive. This corresponds, to a large extent, to the amount of drinking water sold. The calculation shows that the volume varies between an inflow factor of 1.5 to 4.5. A factor of three corresponds to the treatment plant receiving 3 m^3 every time 1 m^3 of drinking water is sold in the treatment plant's catchment area. Since the wastewater companies' revenues are based, to a large extent, on the charge on the amount of water sold, this means that revenues cannot be obtained for the handling, pumping, treatment and payment of the discharge tax for the unrelated volumes of extraneous water.

It would be natural to ask: Why don't companies simply "just remove" the extraneous water? This is because it can be very difficult and extremely costly to locate exactly where the water is entering the systems. When the water volumes are successfully localised, it can turn out that there is less inflow supply to the sewerage system, but over very long distances. It can therefore be very expensive to establish close sewer lines, and the only commercially viable strategy is the long-term one, where a dense sewer network is established in connection with the general rehabilitation of the sewer system. In other cases, it can turn out that there are relatively few instances but a relatively large inflow supply, which can significantly reduce the extraneous water with a minimal effort.

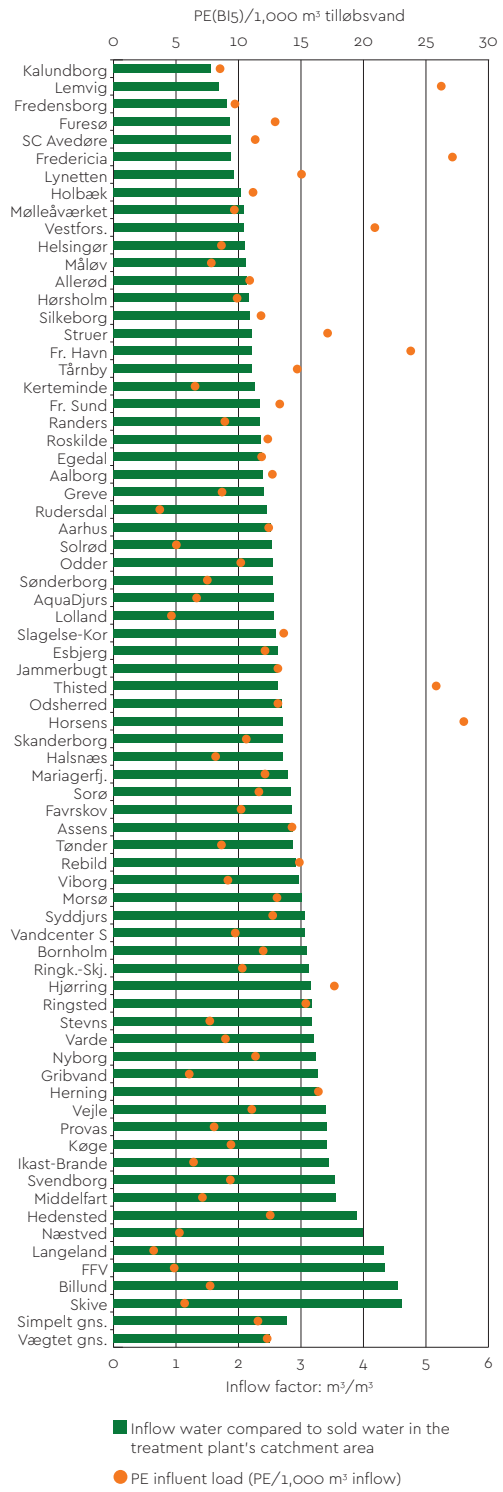
The utilities have their focus on reducing the amount of extraneous water, as here there are possible operational savings in the form of:

- Minimising the discharge tax paid to the government, a tax which is imposed on the amount of treated wastewater that is discharged from the treatment plants. Savings in the consumption of electricity that would be used for pumping.

Additionally, there are also environmental benefits in minimising the volume of extraneous water. These include:

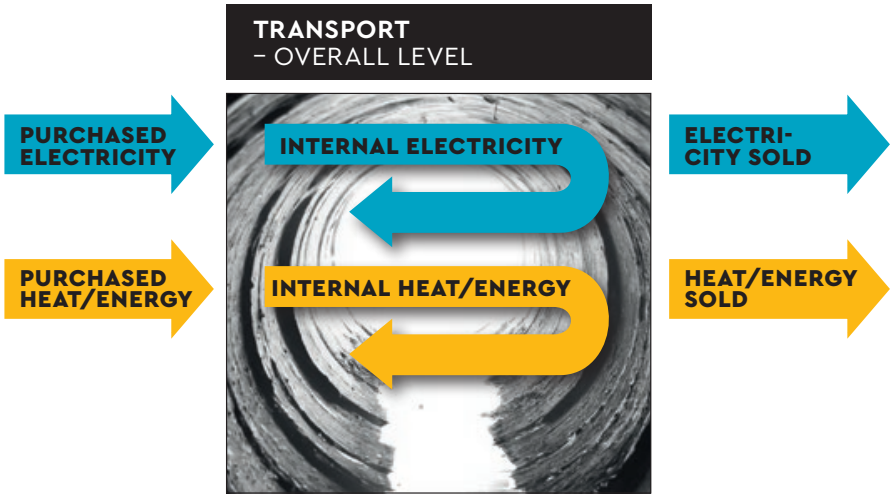
- Discharge of fewer nutrients from the treatment plants.
- Fewer instances of overflow in the event of heavy rains.
- Reduced CO_2 emissions (as a consequence of the reduction of electricity consumption).

INFLOW FACTOR AND INFLUENT LOAD TO THE TREATMENT PLANTS, 2016

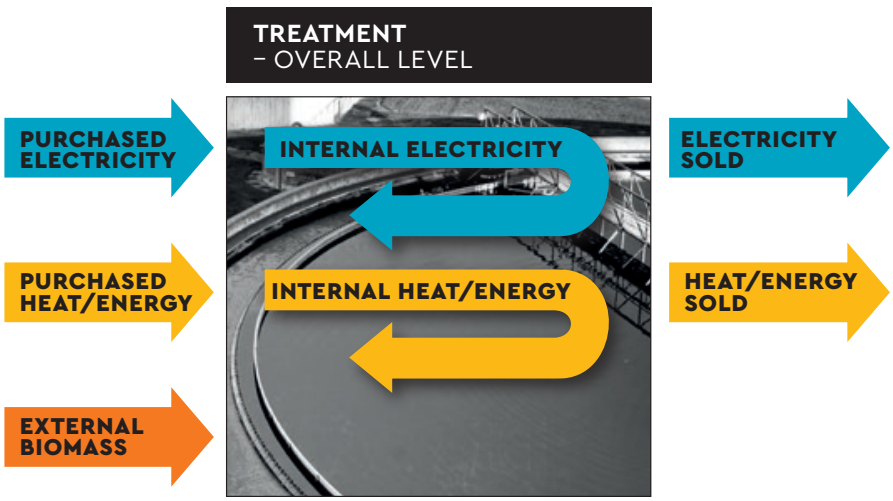


Influent loads at the treatment plants

There is a very substantial difference between the contents of the wastewater that flows into the wastewater treatment plants. Some wastewater can be "thick," if there are large companies in the catchment area, such as slaughterhouses or breweries, which discharge large amounts of organic matter. If the treatment plant primarily receives only wastewater from residential areas, the wastewater is defined as "thin." The load can be calculated in person equivalents referred to as PE(Bl5), which is a unit of measurement that represents what an adult individual contributes in terms of organic biodegradable material per day. 1 PE(Bl5) corresponds to 60 g Bl5/day.



Energy charges for the transport network. It is primarily purchased electricity and heat that is included in the calculations, as there is currently substantial energy production in the transport network.



Calculation of energy charges for wastewater treatment plant(s) – overall level. It is the net energy production and the degree of self-sufficiency in energy production that is the particularly interesting data and key figures.

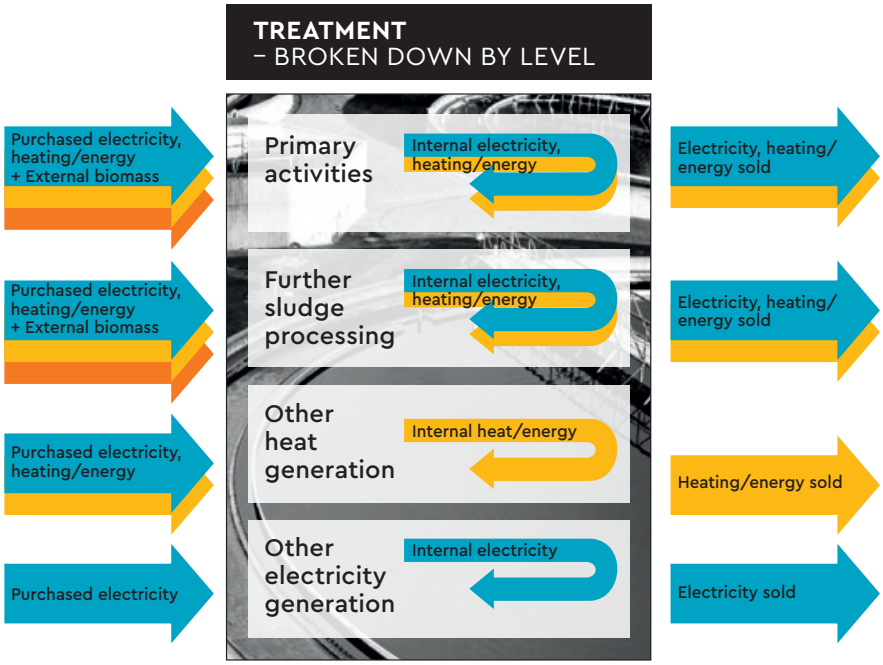
Calculation of energy consumption

For many years, the Danish wastewater treatment plants have had a considerable focus on reducing their consumption of energy, and the optimisation of energy production in recent years has made it possible for the treatment plants to transform from large consumers of energy to energy producers themselves in the long term. Several plants in Denmark have gradually gained this status.

Based on several workshops and meetings DANVA has prepared, in collaboration with the Danish Environmental Protection Agency, a common energy calculation method that provides a degree of uniformity in order to enable the comparison of energy consumption and energy production at the overall level for the companies' transport networks and the companies' wastewater treatment plants. DANVA has further differentiated the calculation method in order to cover the entire company, overall for transport and treatment plants, the individual treatment plants, and further down to 4 subdivisions: Primary activities (pre-treatment, biological tanks, final settling and "normal" sludge treatment and buildings, etc.), further sludge treatment (sludge incineration and sludge drying), other heat production (heat pumps and solar heat) and other generation of electricity (solar cells, turbines and wind turbines).

The calculation method is based on 3 main streams: Energy in (purchased), self-produced energy used internally, and energy out (sold). Energy comprises electricity, district heating, fuels (oil, gas, wood), heat production from incineration of biogas and sludge, external biomass, biogas sold, all of which is converted to kWh.

The calculation method makes it possible to prepare a number of different key figures for the entire wastewater company, for the two primary areas Transport and Treatment, the



Energy calculations for wastewater treatment plant(s) – broken down by level. The breakdown provides an overview of the various elements of energy generation that is included in the treatment plants, along with the option to prepare key figures for the primary activities that are included in traditional wastewater treatment.

individual plant, and the primary activities of the individual plant. Key overall figures:

- Net energy consumption: The difference between energy purchased and energy sold – kWh/m³
- Gross energy consumption: Total energy purchased and self-produced energy which is used internally – kWh/m³
- Degree of internal self-supply (degree of self-sufficiency): Percentage of energy sold in relation to energy purchased, per cent
- Production rate: Percentage of energy sold and self-generated energy used internally in relation to purchased energy and self-generated energy used internally, per cent

As a rule, the volume of water sold in the sewer catchments is used for the key figures for transport and volume of water sold in the wastewater treatment plants' catchments for purification.

Net and gross energy consumption, calculated based on transport and treatment as kWh/m³ is included in the forthcoming performance benchmarking, which will become mandatory in 2018 for all water companies subject to the Water Sector Act.

The key figures are an indication of the amount of energy used to transport wastewater through the sewer system and through the treatment plant, when a consumer buys 1 m³.

Energy consumption in 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 is done in order to be able to produce an appropriate comparable key figure such as kWh/sold m³, as too many companies differ in how many sold m³ of water are sold in the sewerage catchment area compared to the m³ of water sold in the treatment facility's catchment area. The key figures are an expression of how much energy the wastewater company uses to transport 1 m³ of purchased water down to the treatment plant and how much energy the treatment plant uses to purify/treat it before it is discharged.

The graphs show the companies' net and gross consumption of energy in the sewer system, which is stated collectively for all the company's wastewater treatment plants.

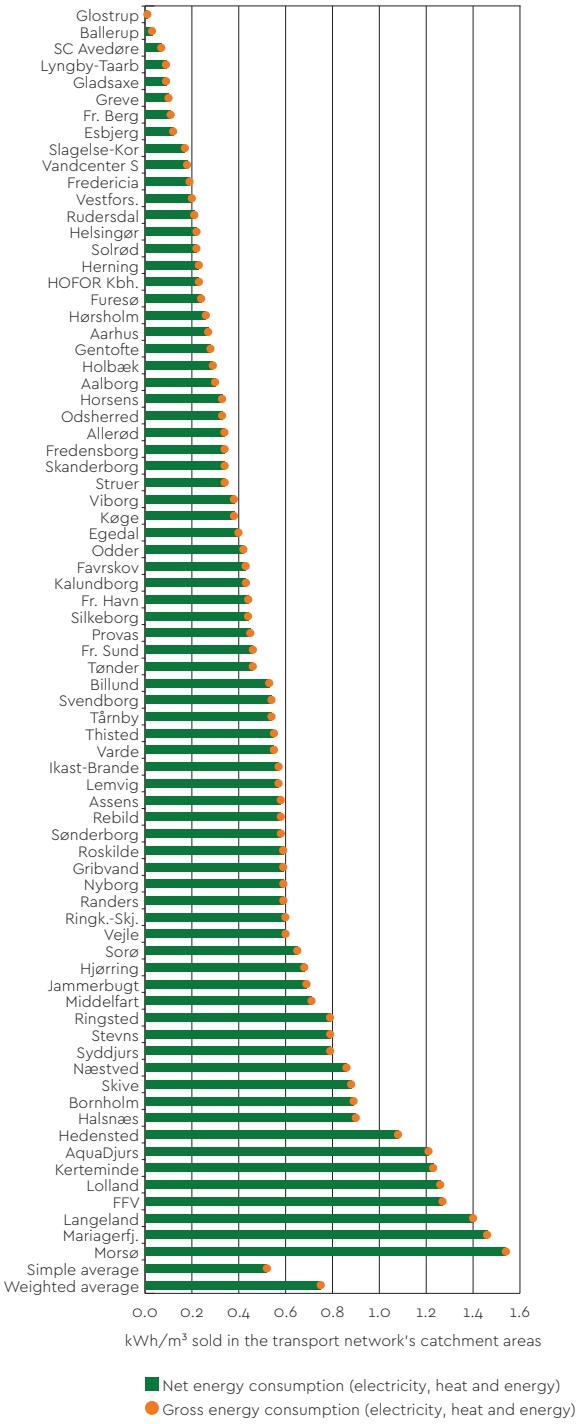
In the sewer system, the net and gross energy ratio is the same for the vast majority of companies, as there are only a few companies that have very little generation of energy, such that is insufficient to make a difference in the graph.

However for wastewater companies, there is a distinct difference between net and gross energy consumption, 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 have sludge incineration or heat pumps that extract energy out of the lukewarm wastewater. Other companies are too small for the production of biogas, and these often have net or even gross energy consumption.

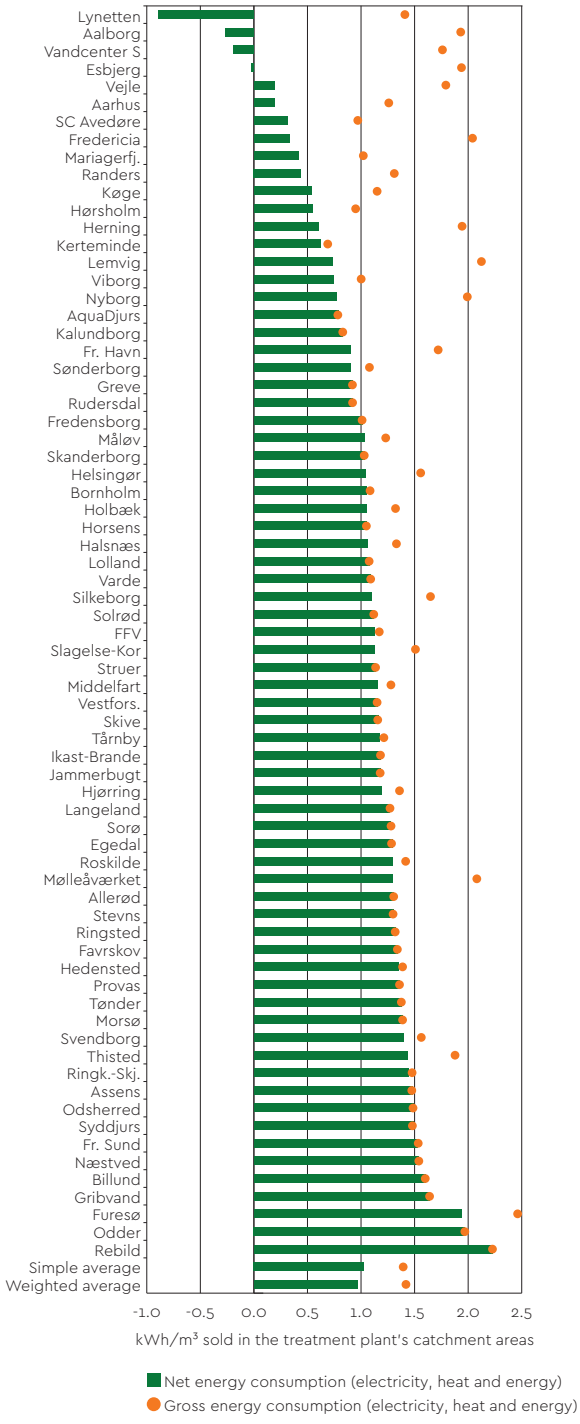
Overall, this results in a consumption of purchased electricity amounting to 1.45 kWh/m³ and net consumption of electricity of 1.22 kWh for the participating companies.

The 34 wastewater companies which produce their own electricity collectively produce a full 30 per cent of their own consumption of electricity.

WASTEWATER COMPANIES NET AND GROSS CONSUMPTION OF ENERGY – TRANSPORT, 2016



WASTEWATER COMPANIES NET AND GROSS CONSUMPTION OF ENERGY – TREATMENT, 2016



Wastewater companies' treatment of sludge

Once the wastewater of the Danish households arrives at a purification/treatment plant, the treatment of the wastewater commences. Once the wastewater has been treated/purified and discharged to a recipient, the companies are left with a residual product (sludge).

The figure on the right illustrates how the various companies deal with their surplus sludge before final disposal. The surplus sludge is divided into 3 groups. The categories are established by the regulation.

- Sludge that only undergoes ordinary drainage before disposal (normal treatment).
- Sludge that is used for the production of biogas and is subsequently drained.
- Sludge that is run directly on a drying bed for sludge mineralisation.

For those companies that transfer part of their surplus sludge into a biogas plant, the figure further illustrates how much biogas is produced per tonne of dry surplus sludge (excluding industrial sludge). There is a relatively big difference in how much biogas the various companies derive from their surplus sludge. This is because, among other reasons, there is a difference in how good the wastewater sludge is for the production of biogas, and if the companies introduce substances other than sewer sludge to their biogas plants, for example, industrial waste.

Wastewater companies' disposal of sludge

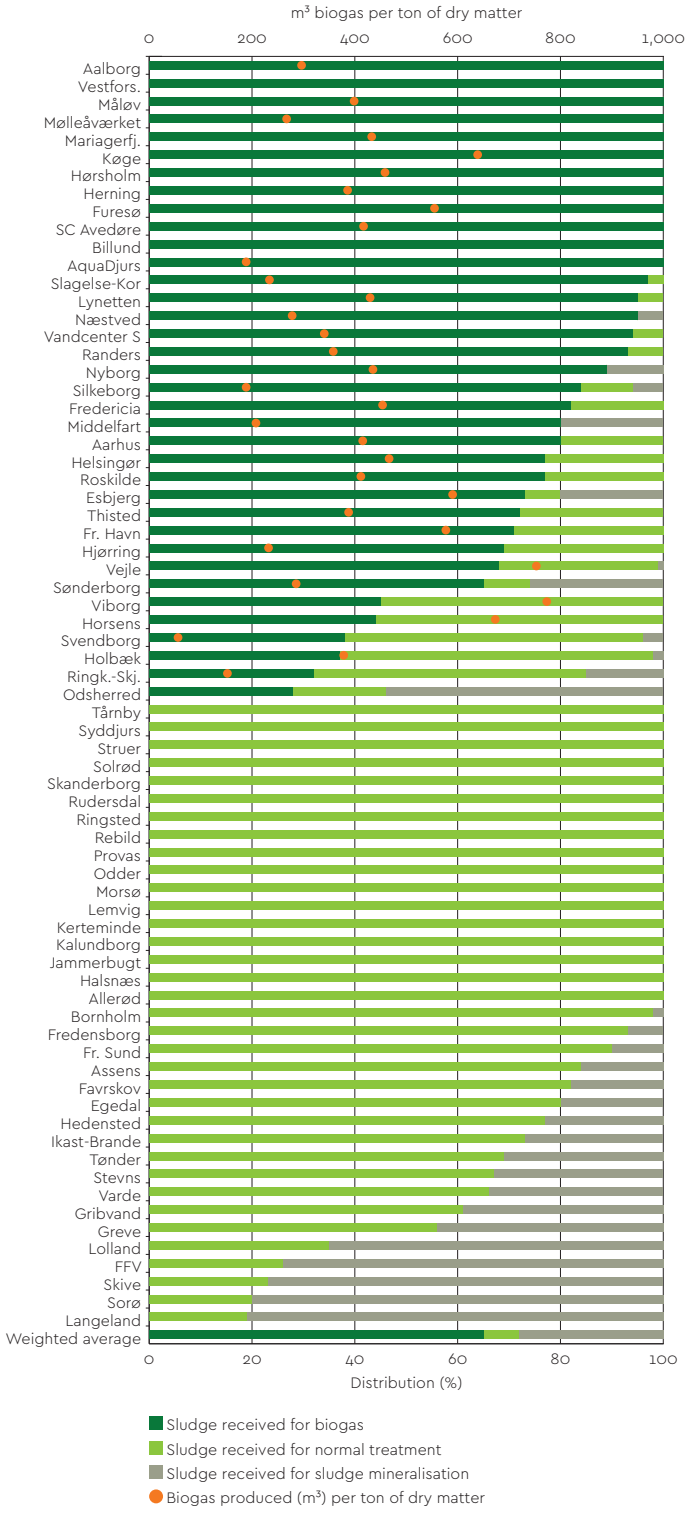
As a rule, drained sludge is disposed of in one of three categories:

- A Sludge: Wastewater sludge that can be spread on agricultural farmland.
- B Sludge: Wastewater sludge that is be processed before use, for instance, in connection with composting before reuse. The reason for this is usually an excessive amount of pesticides, which can be reduced, in connection with, e.g. composting.
- C Sludge: Wastewater sludge that is landfilled or incinerated. This can be due to an excessively high 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. For instance, a company could have the strategy of incinerating all sludge if the company does not want the sludge to be spread out on agricultural farmland.

In 2016, wastewater companies subject to the provisions of the Danish Water Sector Act had a total volume of sludge amounting to 138,967 tonnes of dry matter, and the expenses for the disposal of sludge stood, on average, at approx. 13 per cent of the wastewater companies' total operating expenses at the treatment plants. ■

WASTEWATER COMPANIES' SLUDGE TREATMENT, 2016



The hunt for **extraneous water** has started

Trailers with CTTV inspection equipment, old maps and mathematical models are just some of the weapons utilised by Morsø Forsyning and Herning Vand in the battle to prevent extraneous water from entering wastewater treatment plants.

Extraneous water in the treatment plant is a problem that all wastewater companies struggle with, to a greater or lesser extent. Infiltration of groundwater and rainwater via leaks in the sewer system, incorrectly connected drains, rain gutters and road gutters and excess seepage from rainwater pipes to wastewater pipes costs wastewater companies a large amount of money every year. There is therefore a lot of money to save if the company can specifically locate and prevent the extraneous water from ending up as wastewater.

Morsø Forsyning receives two to three times as much wastewater at the treatment plant as they get paid to treat. Here, the utility's pumping systems are used as a starting point for a hunt for the extraneous water, remarks Managing Director Jan Snæver Andersen.

"Most of our wastewater is being pumped at one point or another; so we can see what comes in in relation to what we have calculated. If a pumping station runs significantly more than anticipated, we look at the weather and particular season. If we have had a big rainfall, then it is a faulty connection we need to look for. If the pump runs significantly more in November to February than it does in the summer months, which is the time when groundwater is at its highest, then it is infiltration that we need to look at," he explains.

Own equipment for CCTV inspection

In 2016, a car with CTTV inspection equipment was purchased and an employee was hired to help locate sources of extraneous water.

"We have trained an employee to work with this, and when there is heavy rain, at the end of it, we drive out with the CTTV equipment to see where the extraneous water is penetrating," explains Jan Snæver Andersen.

So far, we have discovered some incorrectly performed couplings as well as double drains with rainwater at the top and wastewater at the bottom, where the rainwater was running into the wastewater, even if the drains had been lined up precisely in order to prevent this.

"We have removed a few of the drains, and the result has been that less water finds its way into the piping systems in question. But once we figure out how much extraneous water we have, there is still a long way to go," points out the pipeline manager.

There are a whole lot of ways in which extraneous water can penetrate into the system, and nine months ago, we became aware that there is also salt water that penetrates, explains the CEO of Morsø Forsyning, Gitte Guldberg.

"It ruins the processes at the treatment plant, and the chemicals do not work properly when there is saltwater penetration. We have been able to trace its precise location to a point in the city of Nykøbing, but we lack certain old maps. We are looking to find them in order to see if there is something connected that we do not know about. We have one-way/shut-off valves that close when the water rises in the fjord so that the water cannot run back into the pipeline network, and we have checked these and they work," she explains.

They have not yet set specific goals for how much they expect to be able to reduce the extraneous water by, as they are still in the investigation phase, but Jan Snæver Andersen has high hopes:

"The inflow intake to the treatment plant was reduced by almost one million cubic metres in 2016, which corresponds to 25 to 30 per cent, where the precipitation rate was 25 per cent less than what it was the year before, and we definitely aim to be able to reduce the inflow supply by a figure in that range."

Separation and refurbishment

Herning Vand sold approx. 4 million cubic metres of clean water to its customers in 2014, but received approx.15 million cubic metres of water at its treatment plants. Of the 11 million cubic metres of extraneous water, about 4 million cubic metres were rainwater, due to the fact that not all of the utility's catchment areas are separated. "In order to make use of some of this water, we have launched the planning of extensive refurbishment and separation of the sewerage system," explains Benny Nielsen, Head of "Plan and Project" at Herning Vand.

"We have about 7 million cubic metres of extraneous water, but we don't think there is a way we can get rid of all of it; that's unrealistic. But if we could even only get rid of half of it, then that's 3½ million cubic metres, equivalent to at least DKK 7 million per year in operating

What is extraneous water?

Extraneous water is the term for all water that does not directly belong to a wastewater system. For example, it could enter via leaks in the sewer system when the groundwater level is higher than the pipelines. In the event of heavy rainfall, rainwater could enter directly into the drainage system on its way down in the ground or can come from water from drainage systems that are connected to the drainage system. In areas with separated sewer systems the water could leak from rainwater pipeline into the wastewater pipeline, or the rainwater pipeline could mistakenly be connected to the wastewater pipeline.

expenses and wastewater environmental taxes. On top of that, comes the rainwater, which we have to separate. We typically renovate the old common systems first, which is also how we will get rid of some of the rainwater. This will make a further contribution, hopefully of the same size," explains Benny Nielsen.

Detailed review

In Herning, they have almost finished producing a detailed review of the sewer system in all 500 main catchments. The pumping and groundwater data have also been reviewed, and they will extrapolate conditions using mathematical models in order to "harvest the low-hanging fruits" first.

"Once we have done that, will have to see where we get the most value for our money. Where is it that we need to make the efforts to get rid of the extraneous water, because there is a whole lot of money involved in this. The relationship between the water that is produced and the wastewater we receive from the individual main catchments is between a factor of 1 and up to a factor of 25. In the situations where we do not know how much extraneous water is coming from a larger area, we have looked at where in the area it could potentially be coming from, including whether there could be faulty connections. There are some conditions that must be present before the water can seep into our pipelines: they must be in a poor condition and the groundwater must be at a high level," he points out.

In a few months, the review will be complete, producing a map that will demonstrate the order in which the different parts of the sewerage system should be refurbished when the costs of the extraneous water and other risks are balanced. In addition to the fact that the search for extraneous water would likely reduce the utility's operating expenses, it is also a means of future-proofing the pipeline network.

"We believe that the groundwater table is rising, and that the sewer pipes that are currently at the edge of the groundwater table won't make it in 20 or 50 years. We have no figures about this, but this is part of what we're trying to find out," explains Benny Nielsen. ■

Efficiency concerning operations, facilities and overall finances

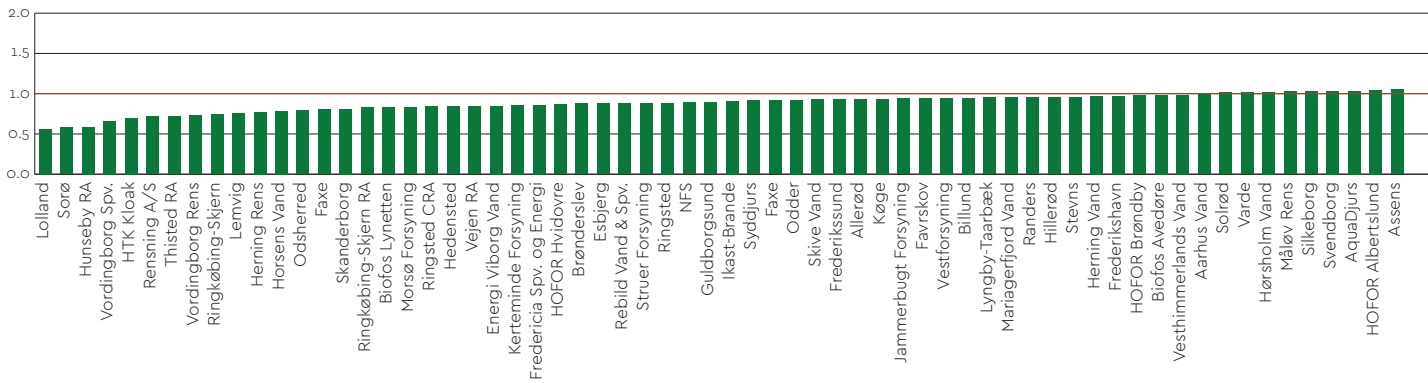
The natural "monopoly" situation for water and wastewater companies has resulted in an ongoing financial regulation of the companies. This regulation entails the issuance of one year or multi-year revenue frameworks, which is a maximum limit for how much the companies may charge their customers.

The determination of these revenue frameworks contains a benchmarking of the companies' total finances, i.e. both the companies' operating and facilities expenses. This benchmarking is conducted by the Secretariat for water supply. In 2017, only benchmarking of wastewater companies will be conducted, as in 2016 the drinking water companies were already notified of their revenue frameworks for 2017 and 2018. The future benchmarking will take place every two years, staggered for each type of utility.

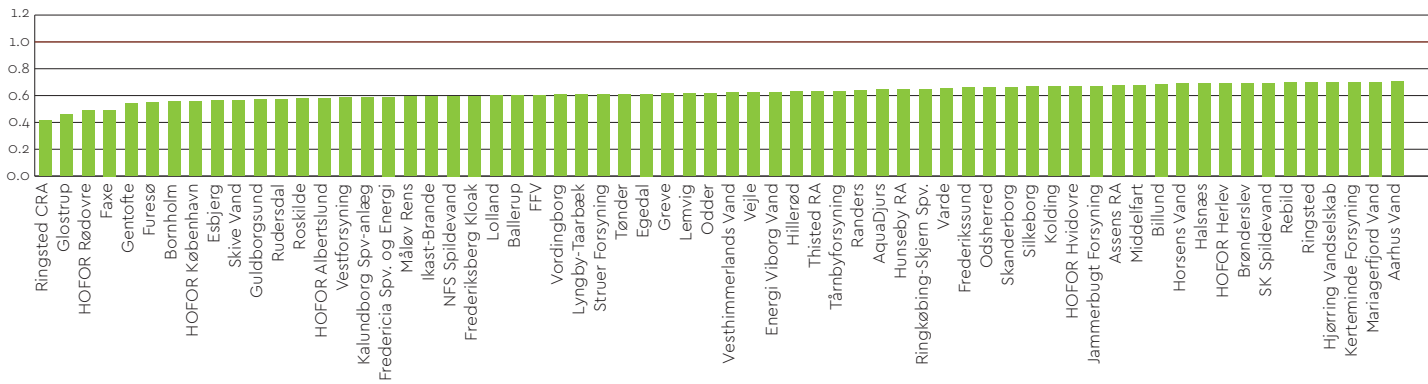
In order to compare the companies' operating and facilities' expenses with each other, it is naturally necessary to have a common benchmark. This is owing to the fact that companies differ by size, type, framework conditions, number of customers, etc. This basis of comparison is called net volume and consists of a number of standard expenses for operations and facilities, divided into different categories, also referred to as cost drivers. For example, the standard cost of the annual operation of one kilometre of wastewater pipeline located in a rural area is DKK 2,328. Correspondingly, the standard cost of a wastewater pool is DKK 6.12 per m^3 volume in the pool. This makes it possible to calculate a standardised level of total annual operating expenses for each company based on the company's portfolio of assets.

The same calculation is conducted for the facilities' expenses. For each asset, there is a

ACTAUL OPERATING COSTS COMPARED TO THE OPERATING COST NET VOLUME TARGET (OPEX)



REGULATORY DEPRECIATION COMPARED TO THE CAPITAL COSTS NET VOLUME TARGET (CAPEX)



standard depreciation, which in the Secretariat for water supply's benchmarking is defined as the replacement cost price in relation to the useful life, both from the price and useful life catalogue (POLKA). By putting all standard expenses together, it is possible to determine a standardised level for the company's anticipated annual replacement expenses.

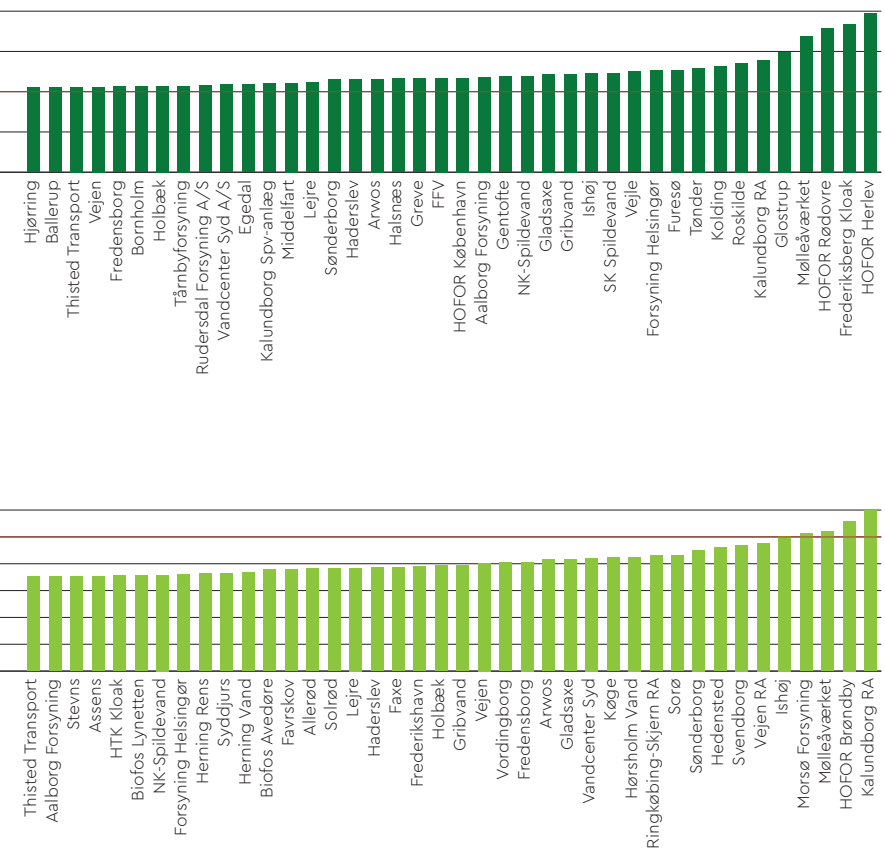
By comparing the annual actual operating and facilities expenses incurred (depreciation) with the corresponding net volume targets, we find a simplified key figure for the company's relative efficiency according to the Secretariat for water supply's benchmarking model. The lower the expenses a company has in relation to the net volume target, the more efficient the company is.

If the actual expenses in relation to the net volume target are below 1, which can be defined as a balance point, the company has lower expenses than the model anticipates. Conversely, a key figure above 1 indicates that the company has higher expenses than anticipated by the model. ■

TOTEX

OPEX | CAPEX

Net volume targets represent the expected annual costs for either operations (operating expenses – OPEX) or investments (capital expenditures – CAPEX). This is based on the number of assets the company has as well as the type, size, location and age of the assets.



Calculation of depreciation

When a company has carried out depreciation in accordance with net volume, this indicates that the company is efficient in relation to the benchmarking. However, it should be mentioned in this context that all depreciation carried out for investments made prior to 2009 is based on standard prices and not on actual cost. In addition, the date of acquisition has a major effect on the level of depreciation. This is because depreciation prior to 2009 consists of 50 per cent of the standard replacement cost in 2009 and 50 per cent of a standard cost price at the date of acquisition. Due to inflation, this means that companies with old assets carry out significantly less depreciation. In addition, net volume is determined as the replacement cost, which means that most companies are below the balance point of 1.

DRINKING WATER COMPANIES WHICH PARTICIPATED IN STATISTICS AND BENCHMARKING 2017 (DATA FOR 2016)

	MAIN DATA					
Company	Inhabitants in supply area	Total water volume sold	Boreholes (water abstraction-area)	Waterworks	Water hardness	Pipeline network (supply lines)
	persons	m³/year	number	Number of	dH	km
Assens Vandværk A/S	8,400	607,042	8	2	19.0	128
Billund Drikkevand A/S	7,021	724,464	9	2	7.8	191
Bornholms Energi & Forsyning A/S	20,000	1,332,053	27	4	15.0	779
Egedal Vandforsyning A/S	16,480	604,104	9	1	22.0	152
Energi Viborg Vand A/S	53,300	2,349,627	12	4	8.0	540
Esbjerg Vand A/S	96,500	6,618,827	64	6	7.5	1,000
FFV Vand A/S	9,481	626,410	8	2	18.5	239
Fors Vand Holbæk A/S	28,752	1,594,295	14	2	14.0	214
Fors Vand Roskilde A/S	55,000	3,168,028	20	3	19.0	385
Forsyning Helsingør Vand A/S	58,000	2,761,118	26	4	15.0	382
Fredensborg Vand A/S	38,706	1,689,631	13	2	15.0	275
Frederiksberg Vand A/S	105,000	5,297,479	5	1	30.0	178
Frederikshavn Vand A/S	53,000	4,450,738	100	5	8.0	1,207
Frederikssund Vand A/S	27,000	1,243,315	19	5	20.0	392
Glostrup Vand A/S	22,528	1,315,809	13	3	25.0	98
Grindsted Vandværk A.m.b.a.	12,032	1,019,755	11	2	6.6	256
Halsnæs Vand A/S	10,400	578,771	12	3	17.0	169
Herning Vand A/S	50,500	3,123,090	20	3	9.0	694
Hjørring Vandselskab A/S	34,000	3,142,162	48	5	14.0	843
HOFOR Vand København A/S	591,481	52,001,662	435	7	20.0	1,077
Horsens Vand A/S	50,564	3,986,467	24	4	14.0	481
Hørsholm Vand ApS	24,965	1,261,129			16.2	140
Ikast Vandforsyning A.m.b.A	16,000	890,205	11	2	8.5	208
Kalundborg Vandforsyning A/S	14,200	3,309,990	24	5	15.0	315
Kerteminde Forsyning – Vand A/S	17,000	886,276	9	2	24.0	214
Køge Vand A/S	32,600	1,599,013	14	3	23.0	287
Langeland Vand ApS	9,200	788,462	25	4	21.4	379
Lemvig Vand og Spildevand A/S	17,399	1,943,471	17	6		581
Lolland Vand A/S	38,511	1,623,643	30	4	18.0	809
Lyngby-Taarbæk Vand A/S	55,240	2,733,015	8	2	18.0	213
Mariagerfjord Vand a/s	15,000	1,293,197	13	7	8.8	323

PROCESS BENCHMARKING (KEY PERFORMANCE INDICATORS)						TARIFFS AND COSTS 2017 (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 waterworks	Operating costs related to distribution compared to sold water in own supply area	Operating costs on customer service by water meter	Opertating costs realted to general administration compared to sold water	Actual investment and renovations	Fixed annual contribution, incl. VAT	Variable water contribution, incl. VAT and taxes	Costs for consumption of 100 m³/ year
DKK/m³ sold	DKK/m³ sold	DKK/m³ sold	DKK/water meters	DKK/m³ sold	DKK/m³ sold	DKK	DKK/m³	DKK
6.06					3.58	618	17.66	2,384
1.72					26.83	706	13.64	2,070
6.90	2.78	1.26	55.67	2.25	8.19	1,249	17.30	2,979
6.43					3.75	375	15.95	1,970
4.85					7.22	850	13.81	2,231
3.36	1.75	0.71	168.10	0.12	2.43	828	13.88	2,216
8.02					7.06	875	19.95	2,870
5.20	1.22	1.85	83.72	1.19	6.04	313	16.26	1,939
5.33	1.36	3.73	67.76	0.00	5.31	375	20.93	2,468
5.51					15.34	576	20.47	2,623
2.56	1.32	0.85	63.81	0.52	3.86	254	16.56	1,910
4.58	2.17	2.63	832.99	0.15	6.36	370	18.89	2,259
5.62					10.52	1,313	15.33	2,846
7.10					8.72	850	19.55	2,805
5.38					6.71	283	21.00	2,383
4.39	1.55	1.05	58.85	1.26	3.19	729	10.82	1,811
6.99	0.61	3.36	63.40	2.37	8.30	838	23.01	3,139
4.01	1.74	1.90	39.80	0.00	3.55	740	11.51	1,891
6.80	3.81	1.15	49.11	1.20	3.52	1,339	15.19	2,858
3.17					2.47	480	18.23	2,303
3.01					2.73	984	12.72	2,256
3.99		3.41	102.37	0.00	5.51	0	25.49	2,549
4.93					5.13	594	14.38	2,032
2.92	2.85	0.62	185.85	0.54	7.77	0	18.79	1,879
6.69	2.54	3.18	159.78	0.57	3.33	630	16.75	2,305
5.89	2.63	1.76	75.97	0.73	16.72	236	20.91	2,327
4.99					6.91	675	13.56	2,031
3.05					4.56	892	14.69	2,361
6.97	2.10	3.33	17.55	1.21	6.95	945	23.57	3,302
3.59	2.27	1.86	84.84	0.38	10.14	0	22.37	2,237
3.98					6.93	633	12.71	1,904

DRINKING WATER COMPANIES WHICH PARTICIPATED IN STATISTICS AND BENCHMARKING 2017 (DATA FOR 2016)

	MAIN DATA					
	Inhabitants in supply area	Total water volume sold	Boreholes (water abstraction-area)	Waterworks	Water hardness	Pipeline network (supply lines)
Company	persons	m³/year	number	Number of	dH	km
Midtfyns Vandforsyning A.m.b.a.	16,000	1,603,530	13	5	17.0	435
Morsø Vand A/S	9,271	556,576	9	2	13.0	122
NFS A/S	18,475	1,209,974	18	2	18.8	180
NK-Forsyning A/S	40,000	2,159,868	20	3	17.0	502
Nordvand (Gentofte Vand A/S)	75,578	3,609,849	22	1	19.0	302
Nordvand (Gladsaxe Vand A/S)	68,345	3,442,649	9	2	19.0	227
Odsherred Vand A/S	5,200	353,100	15	3	17.0	179
Provas	33,000	1,594,037	16	3	10.6	394
Ringkøbing – Skjern Vand A/S	35,957	3,337,042	36	8	7.4	1,211
Ringsted Vand A/S	26,926	1,752,147	12	4	19.0	376
Rudersdal Forsyning A/S	33,000	1,574,212	13	3	20.0	205
Silkeborg Vand A/S	53,000	2,436,312	11	3	4.0	521
SK Vand A/S	69,200	3,422,127	51	5	18.0	716
Skanderborg Forsyningsvirksomhed A/S	18,620	1,002,390	19	5	13.5	205
Skive Vand A/S	33,500	2,435,328	31	10	10.0	710
Sorø Vand A/S	10,000	503,657	8	1	19.0	245
Struer Forsyning Vand A/S	13,960	945,715	9	2	5.3	251
Svendborg Vand A/S	38,495	1,864,702	27	6	20.0	457
Sønderborg Vandforsyning A/S	41,000	2,125,780	19	6	15.0	369
Thisted Vand	32,375	3,117,073	34	8	13.0	835
TREFOR Vand A/S	147,000	11,192,041	78	10	13.0	1,436
Tønder Vand A/S	24,370	1,690,899	13	4	11.0	553
TÅRNBYFORSYNING Vand A/S	42,947	2,593,537	10	1	28.0	191
Vand Ballerup A/S	54,000	3,163,617	11	5	20.0	322
Vandcenter Syd as	168,000	8,666,037	46	5	16.6	1,010
Varde Vandforsyning A/S	22,300	1,657,765	16	2	7.0	572
Verdo Vand A/S	49,200	2,357,156	21	5	12.5	341
Vestforsyning Vand A/S	48,832	3,848,847	29	6	11.5	1,087
Aalborg Vand A/S	118,990	6,751,983	51	11	17.0	694
Aarhus Vand A/S	274,535	13,894,911	85	8	16.0	1,487

PROCESS BENCHMARKING (KEY PERFORMANCE INDICATORS)						TARIFFS AND COSTS 2017 (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 waterworks	Operating costs related to distribution compared to sold water in own supply area	Operating costs on customer service by water meter	Opertating costs realted to general administration compared to sold water	Actual investment and renovations	Fixed annual contribution, incl. VAT	Variable water contribution, incl. VAT and taxes	Costs for consumption of 100 m³/ year
DKK/m³ sold	DKK/m³ sold	DKK/m³ sold	DKK/water meters	DKK/m³ sold	DKK/m³ sold	DKK	DKK/m³	DKK
4.34					1.90	550	11.56	1,706
4.23	1.77	1.62	77.24	0.15	9.82	699	13.72	2,071
4.92					10.58	625	16.18	2,243
6.81	2.27	2.06	140.86	1.38	6.22	889	17.18	2,607
5.15	1.54	3.07	136.76	0.00	7.51	0	22.85	2,285
4.24	2.35	2.43	194.56	0.00	5.90	0	22.05	2,205
10.10	2.86	2.14	113.68	2.97	10.36	1,393	15.55	2,948
5.41	1.50	2.96	80.09	0.16	7.50	875	18.50	2,725
4.25					6.39	1,321	15.03	2,824
4.25					5.20	186	20.38	2,224
5.23	1.37	2.09	42.31	1.17	3.61	445	17.94	2,239
4.18					4.97	788	13.99	2,187
5.98					3.99	1,299	14.83	2,782
4.56					5.75	738	15.32	2,270
3.80	1.32	1.11	56.91	0.94	5.53	750	15.82	2,332
4.83					11.85	537	18.35	2,372
					3.18	893	13.45	2,238
5.61	1.88	2.22	48.26	0.90	11.37	800	19.82	2,782
4.31					17.56	555	16.15	2,170
3.04	1.00	1.60	9.48	0.26	4.46	734	14.09	2,143
4.72	1.14	0.91	271.18	1.40	15.29	1,250	15.31	2,781
4.94					5.88	1,047	15.04	2,551
1.52	1.80	0.97	20.33	0.08	6.52	256	17.54	2,010
4.15					7.58	0	20.49	2,049
5.78	2.92	1.91	147.55		5.34	600	19.69	2,569
4.57	2.67	0.64	328.99	0.00	1.66	1,164	13.90	2,554
4.55	0.87	1.43	77.17	1.85	3.96	694	13.34	2,028
3.87	1.02	1.60	40.58	0.98	3.41	766	14.95	2,261
3.63					3.79	1,250	14.19	2,669
5.77	2.13	1.82	81.25	1.24	9.40	688	18.40	2,528

WASTEWATER COMPANIES WHICH PARTICIPATED IN STATISTICS AND BENCHMARKING 2017 (DATA FOR 2016)

	MAIN DATA					
Company	Inhabitants in catchment area	Sewer system (wastewater and rainwater)	Total water volume sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
	persons	km	m³/year	number	m³/year	PE, person equivalents
Afløb Ballerup A/S	48,107	359	2,755,312			
Allerød Spildevand A/S	23,538	287	1,132,242	3	2,415,620	26,309
AquaDjurs A/S (Spildevand)	16,150	1,045	1,673,387	3	5,184,400	34,600
Assens Spildevand A/S	34,915	1,036	1,749,967	8	5,193,373	74,051
Billund Spildevand A/S	22,936	420	1,286,739	5	5,873,266	45,454
BIOFOS Lynettefællesskabet A/S			46,965,151	2	89,980,000	1,350,000
BIOFOS Spildevandscenter Avedøre A/S	242,159	55	13,294,305	1	25,010,000	283,000
Bornholms Energi & Forsyning A/S	30,000	815	1,788,849	8	5,721,705	68,493
Egedal Spildevand A/S	41,258	534	1,531,686	3	2,735,071	32,446
Energi Viborg Spildevand A/S	96,479	1,577	3,982,947	19	11,844,351	108,521
Esbjerg Spildevand A/S	107,173	1,283	6,118,311	10	16,382,527	198,459
Favrskov Forsyning A/S	42,000	877	1,798,158	7	4,840,479	49,531
FFV Spildevand A/S	50,953	1,281	2,165,882	8	9,424,130	45,848
Fors Spildevand Holbæk A/S	57,861	1,070	2,919,662	8	5,942,163	66,173
Fors Spildevand Roskilde A/S	68,381	910	3,903,298	5	9,203,992	113,464
Forsyning Helsingør Spildevand A/S	61,400	570	2,898,193	3	6,103,823	52,446
Fredensborg Spildevand A/S	40,230	455	1,715,702	3	2,611,248	25,369
Fredericia Spildevand og Energi A/S	50,868	851	5,009,000	1	9,419,258	255,409
Frederiksberg Kloak A/S	105,037	146	4,928,636			
Frederikshavn Spildevand A/S	51,709	877	3,830,609	9	11,009,047	261,852
Frederikssund Spildevand A/S	39,200	640	1,932,912	6	4,533,236	60,212
Furesø Spildevand A/S	40,202	324	1,646,228	1	1,617,509	21,000
Glostrup Spildevand A/S	22,461	156	1,326,361			
Greve Spildevand A/S	49,516	580	2,156,876	1	5,383,283	46,616
Gribvand Spildevand A/S	41,082	873	1,832,501	9	5,958,479	35,925
Halsnæs Spildevand A/S	28,337	569	1,327,328	4	3,612,638	29,380
Hedensted Spildevand A/S	32,955	964	1,778,100	5	6,943,191	87,114
Herning Vand A/S	70,000	1,176	4,027,673	14	13,260,265	217,364
Hjørring Vandselskab A/S	52,000	1,087	3,114,153	9	9,840,085	174,089
HOFOR Spildevand København A/S	591,481	1,083	31,180,754			
Horsens Vand A/S	80,926	1,225	4,695,784	3	12,556,405	352,256
Hørsholm Vand ApS	24,812	167	1,209,351	1	3,727,730	36,927

PROCESS BENCHMARKING (KEY PERFORMANCE INDICATORS)						TARIFFS AND COSTS 2017 (Level 1)		
Actual operating costs for transportation, treatment, customer management and general administration compared to sold volume of water	Operating costs related to sewer system compared to the amount of water sold in the sewerage catchment area	Operating costs related to treatment compared to the amount of water sold in the treatment plant's catchment area	Operating costs related to customer management compared to the number of water meters	Operating costs related to general administration compared to the amount of sold water	Actual investments and renovations	Fixed annual contribution, incl. VAT	Variable contribution incl. VAT and taxes	Costs for consumption of 100 m³/ year
DKK/m³ sold	DKK/m³	DKK/m³	DKK/ meter	DKK/m³ sold	DKK/m³ sold	DKK	DKK/m³	DKK
3.61					8.09	0	24.16	2,416
12.36	3.56	6.73	38.70	1.90	31.53	0	48.75	4,875
13.62					16.46	741	32.50	3,991
17.66					23.07	733	55.73	6,306
12.24					46.12	741	41.20	4,861
2.69		2.30		0.39	3.32			
4.07	0.16	3.38		0.53	5.11			
15.98	2.87	7.99	39.36	4.47	14.09	671	39.63	4,634
13.78					33.18	0	46.25	4,625
11.41					23.88	0	46.05	4,605
8.46	2.41	5.21	101.31	0.20	8.03	740	29.33	3,673
13.42	4.88	8.20	76.98	0.16	33.23	700	42.00	4,900
17.41					47.15	741	49.25	5,666
12.49	4.58	4.50	95.05	2.70	16.87	625	34.11	4,036
14.37	6.37	7.54	67.86	0.06	16.30	0	38.00	3,800
13.57					17.62	665	34.44	4,109
9.60	3.54	4.30	58.30	1.83	15.03	0	39.38	3,938
8.31	2.06	4.67	76.26	1.32	14.28	438	33.75	3,813
3.84	2.98		407.97	0.31	5.76	0	15.89	1,589
14.09	3.32	6.62	39.03	1.00	19.48	740	42.75	5,015
16.50					32.84	745	44.35	5,180
11.86					28.04	0	43.75	4,375
4.68					13.86	0	33.25	3,325
10.54	4.96	3.84	64.41	1.16	17.81	0	27.50	2,750
18.35	6.05	10.44	137.08	0.00	32.77	703	55.85	6,288
18.78	5.47	7.11	34.82	5.83	6.59	688	49.50	5,638
17.17	6.80	8.93	124.67	0.31	26.97	740	41.25	4,865
10.81	4.66	5.76	40.94	0.00	17.97	740	30.63	3,803
13.60	4.24	6.48	60.18	2.25	19.04	738	45.79	5,317
2.79					4.92	0	20.30	2,030
10.74					14.31	741	36.53	4,394
11.13	2.65	5.34	57.67	0.51	27.41	0	37.21	3,721

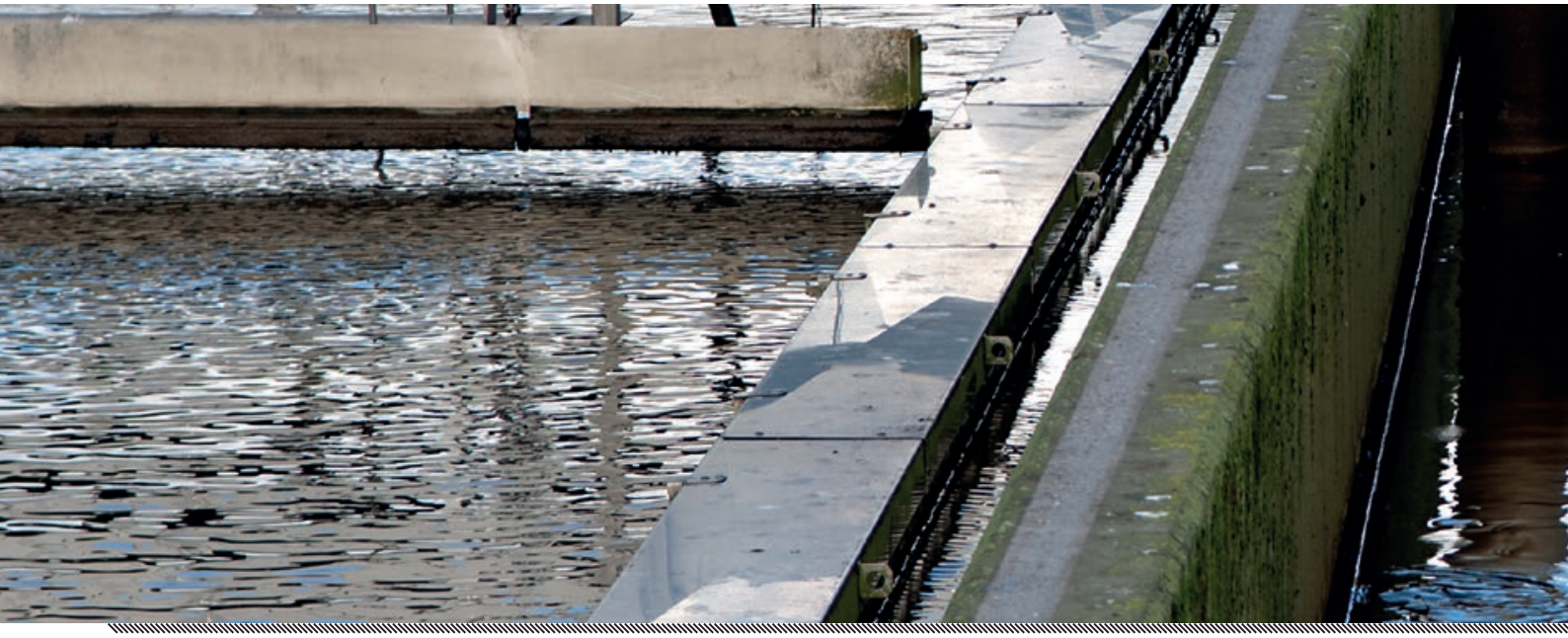
WASTEWATER COMPANIES WHICH PARTICIPATED IN STATISTICS AND BENCHMARKING 2017 (DATA FOR 2016)

	MAIN DATA					
	Inhabitants in catchment area	Sewer system (wastewater and rainwater)	Total water volume sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
Company	persons	km	m³/year	number	m³/year	PE, person equivalents
Ikast-Brande Spildevand A/S	35,700	638	1,790,511	3	6,182,282	39,591
Jammerbugt Forsyning A/S	45,600	817	1,768,825	4	4,715,642	61,930
Kalundborg Spildevandsanlæg A/S	48,725	807	5,676,573	9	8,861,026	75,452
Kerteminde Forsyning – Spildevand A/S	22,177	373	1,049,800	5	2,448,661	15,943
Køge Afløb A/S	56,300	863	2,563,000	4	8,371,920	78,594
Langeland Spildevand ApS	9,079	470	599,009	8	2,592,859	8,314
Lemvig Vand og Spildevand A/S	19,200	574	1,280,811	3	2,243,633	58,859
Lolland Spildevand A/S	23,205	1,142	1,683,539	51	4,319,165	20,133
Lyngby-Taarbæk Spildevand A/S	55,240	339	2,741,131		0	0
Mariagerfjord Spildevand A/S	30,000	876	1,945,671	3	5,400,000	65,481
Middelfart Spildevand A/S	38,093	674	1,557,241	6	5,539,995	39,467
Morsø Spildevand A/S	14,654	562	862,684	3	2,593,444	33,900
Mølleåværket A/S		7	5,177,149	1	10,783,974	104,572
Måløv Rens A/S			1,995,813	1	4,254,883	33,264
NFS A/S	36,187	571	1,552,810	4	5,815,825	66,030
NK-Forsyning A/S	71,500	1,098	2,939,402	10	11,757,472	61,522
Nordvand (Gentofte Spildevand A/S)	75,578	379	3,618,515			
Nordvand (Gladsaxe Spildevand A/S)	68,345	289	3,369,364			
Odder Spildevand A/S	7,908	265	870,630	3	2,231,194	22,616
Odsherred Spildevand A/S	25,700	643	1,169,318	11	3,157,202	41,415
Provas	50,503	1,034	2,400,718	13	8,192,386	65,831
Randers Spildevand A/S	92,591	1,477	4,151,985	6	10,954,416	97,759
Rebild Vand & Spildevand A/S	21,800	575	1,147,166	11	845,000	12,600
Ringkøbing – Skjern Spildevand A/S	40,700	1,041	2,583,973	16	8,085,016	83,378
Ringsted Spildevand A/S	28,463	566	1,893,251	3	6,006,000	92,457
Rudersdal Forsyning A/S	55,700	458	2,648,752	3	3,878,000	14,500
Silkeborg Spildevand A/S	80,700	1,432	3,691,148	15	8,035,898	94,662
SK Spildevand A/S	57,250	1,146	3,227,380	20	8,400,514	114,209
Skanderborg Forsyningsvirksomhed A/S	53,750	1,231	2,431,069	6	6,358,512	67,666
Skive Vand A/S	15,796	846	1,790,427	5	8,246,305	47,120
Solrød Spildevand A/S	22,147	274	894,321	1	2,270,108	11,403
Sorø Spildevand A/S	21,000	526	1,021,959	12	2,900,686	33,807

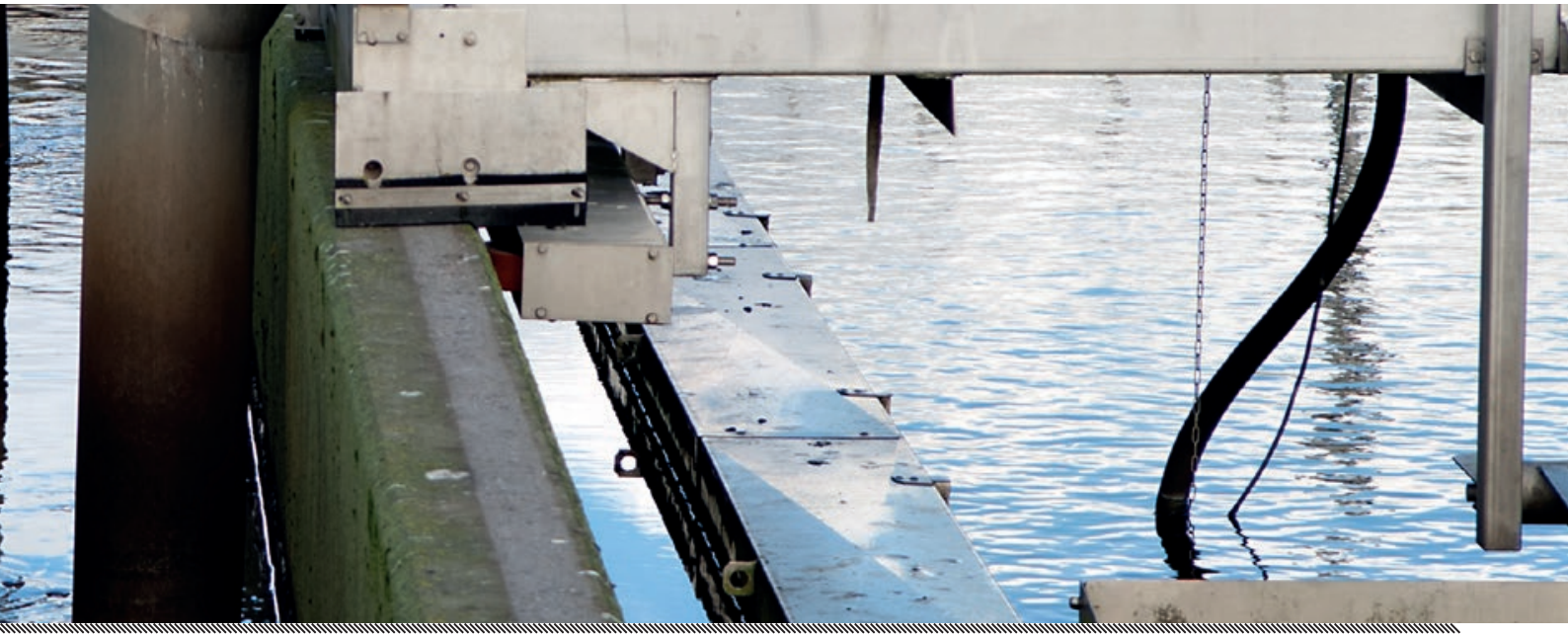
PROCESS BENCHMARKING (KEY PERFORMANCE INDICATORS)						TARIFFS AND COSTS 2017 (Level 1)		
Actual operating costs for transportation, treatment, customer management and general administration compared to sold volume of water	Operating costs related to sewer system compared to the amount of water sold in the sewerage catchment area	Operating costs related to treatment compared to the amount of water sold in the treatment plant's catchment area	Operating costs related to customer management compared to the number of water meters	Operating costs related to general administration compared to the amount of sold water	Actual investments and renovations	Fixed annual contribution, incl. VAT	Variable contribution incl. VAT and taxes	Costs for consumption of 100 m³/ year
DKK/m³ sold	DKK/m³	DKK/m³	DKK/ meter	DKK/m³ sold	DKK/m³ sold	DKK	DKK/m³	DKK
10.77	3.67	6.35	46.45	0.35	16.94	740	35.41	4,281
12.50	3.99	7.53	64.70	0.00	21.25	741	26.25	3,366
6.62	6.95	3.68	117.67	0.43	8.19	0	52.79	5,279
9.70	6.25	0.87	58.95	0.25	20.82	740	29.75	3,715
10.87	2.91	7.04	41.48	1.10	46.87	0	46.70	4,670
21.36					49.42	740	38.80	4,620
12.76					31.29	731	35.74	4,305
12.70	5.34	6.73	36.13	0.15	26.11	741	56.25	6,366
3.09	2.24		22.32	0.76	19.02	0	29.86	2,986
13.05					17.95	633	35.95	4,228
15.68	4.24	8.51	65.64	2.31	24.86	0	55.65	5,565
18.28					51.81	741	46.25	5,366
6.00		4.93		0.99	5.82			
5.16					3.23			
14.86					14.69	625	42.50	4,875
15.10	6.46	6.19	159.67	1.09	39.49	741	51.25	5,866
5.14	4.67		108.58	0.00	8.73	0	39.05	3,905
4.66	4.13		151.32	0.00	10.49	0	25.00	2,500
12.09					58.00	781	35.63	4,344
16.65	3.72	9.26	163.73	1.90	24.93	740	51.60	5,900
13.33	5.45	6.93	96.38	0.20	40.77	726	50.88	5,814
10.32	3.08	4.33	77.58	1.88	24.78	718	34.32	4,150
9.07					37.81	683	31.81	3,864
11.19					25.74	739	44.63	5,202
12.62					36.45	0	53.91	5,391
7.34	2.55	5.77	40.96	1.12	17.18	0	30.63	3,063
11.24					18.52	656	30.00	3,656
16.35					26.33	709	50.63	5,772
10.91					37.35	688	35.15	4,203
13.58	5.89	4.84	54.85	2.33	36.15	725	38.44	4,569
11.66	2.18	5.84	82.18	3.00	27.76	0	32.50	3,250
13.49					69.73	608	54.95	6,103

WASTEWATER COMPANIES WHICH PARTICIPATED IN STATISTICS AND BENCHMARKING 2017 (DATA FOR 2016)

	MAIN DATA					
	Inhabitants in catchment area	Sewer system (wastewater and rainwater)	Total water volume sold in catchment area	Treatment plant over 30 PE	Inflow volume to treatment plants	Total influent organic load
Company	persons	km	m³/year	number	m³/year	PE, person equivalents
Stevns Spildevand A/S	18,581	451	796,874	5	2,537,018	19,577
Struer Forsyning Spildevand A/S	18,863	401	912,489	3	2,014,032	34,552
Svendborg Spildevand A/S	57,327	870	2,659,785	6	9,433,444	88,241
Syddjurs Spildevand A/S	34,523	790	1,578,734	11	3,578,505	45,520
Sønderborg Spildevandsforsyning A/S	74,737	1,355	3,221,768	5	8,202,483	61,484
Thisted Vand	51,505	803	2,505,241	5	6,615,305	170,930
Tønder Spildevand A/S	29,060	770	1,797,771	17	5,171,840	44,891
TÅRNBYFORSYNING Spildevand A/S	43,010	194	2,259,114	1	5,020,967	73,785
Vandcenter Syd as	225,000	2,324	10,994,122	14	33,703,981	328,624
Varde Kloak & Spildevand A/S	61,528	849	2,223,733	8	7,060,979	63,347
Vejle Spildevand A/S	96,748	1,853	5,024,970	9	17,060,448	188,725
Vestforsyning Spildevand A/S	51,460	999	3,486,374	6	7,235,948	151,361
Aalborg Kloak A/S	204,877	2,025	10,450,454	2	27,166,631	344,626
Aarhus Vand A/S	335,685	2,798	14,922,423	4	37,206,925	460,428



PROCESS BENCHMARKING (KEY PERFORMANCE INDICATORS)						TARIFFS AND COSTS 2017 (Level 1)		
Actual operating costs for transportation, treatment, customer management and general administration compared to sold volume of water	Operating costs related to sewer system compared to the amount of water sold in the sewerage catchment area	Operating costs related to treatment compared to the amount of water sold in the treatment plant's catchment area	Operating costs related to customer management compared to the number of water meters	Operating costs related to general administration compared to the amount of sold water	Actual investments and renovations	Fixed annual contribution, incl. VAT	Variable contribution incl. VAT and taxes	Costs for consumption of 100 m³/ year
DKK/m³ sold	DKK/m³	DKK/m³	DKK/ meter	DKK/m³ sold	DKK/m³ sold	DKK	DKK/m³	DKK
18.18	5.91	7.21	140.41	3.49	52.53	754	62.00	6,954
13.78					12.97	0	27.50	2,750
11.86	4.08	6.60	33.17	0.92	16.41	740	38.75	4,615
15.10					32.34	741	47.92	5,533
12.61					28.34	0	44.88	4,488
12.44	5.02	6.90	2.67	0.51	15.37	741	35.78	4,319
16.27					21.83	595	42.50	4,845
8.94	3.55	4.91	54.82	0.24	16.65	0	31.54	3,154
10.72	3.34	5.55	230.16	0.23	26.72	738	39.25	4,663
11.58	4.19	4.91	141.79	0.73	12.78	620	32.20	3,840
13.47					25.61	753	37.50	4,503
12.14	3.69	5.61	85.22	2.36	15.92	735	31.11	3,846
9.51	4.29	3.32	137.32	0.94	22.56	740	26.96	3,436
7.50	2.07	3.82	43.70	1.44	27.34	625	28.61	3,486



DANVA

DANVA, Danish Water and Wastewater Association, is a national industry and stakeholder organisation for Denmark's drinking water and wastewater utilities.

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All company data from the tables can be downloaded from www.bessy.dk

KEY FIGURES

- One litre of water costs on average € 0.009.
- Consumption of water in Danish households is 104 litres per person/per day on average.
- The actual operating expenses of drinking water companies are, on average, € 0.58 per m^3, and the implemented investments amount to € 0.81 per m^3.
- The actual operating expenses of wastewater companies are € 1.42 per m^3 on average, and the implemented investments amount to € 2.84 per m^3.
- Electricity consumption (purchased electricity) for 1,000 litres of water pumped from the ground, delivered to the consumer and taken from the tap amounts to an average of 0.41 kWh. Transport, purification/treatment and discharge of water to the recipient use an average of 1.45 kWh. Collectively, this results in purchased consumption of electricity of 1.86 kWh. If the electricity which the companies produce themselves is offset, the net consumption of electricity amounts to 1.63 kWh per 1,000 l.

(Data for 2016)