Efficiency potential of the water sector, 2020-2030

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Summary

The water sector consists of natural monopolies. This means that water and waste water companies are not exposed to competition. Therefore, they are not at risk of losing their customers to competitors with better quality or lower prices. Lack of competition often leads to lower quality and higher prices as the company is not forced to be cautious about staying in the market or capturing market shares.

An efficiency potential up until 2030 consists of two elements. *Firstly,* a backlog that needs to be recovered. *Secondly,* a continued expectation of future productivity development, where monopolistic companies also have to keep up. If the water companies do not live up to these potentials, their customers –households and undertakings – will have to pay more for their water.

In this analysis, the efficiency potential in the water sector has been estimated at around DKK 3.9 billion overall for the period 2020-2030. This covers an efficiency potential of approx. DKK 3.1 billion in the waste water sector and approx. DKK 0.75 billion in the drinking water sector. The overall estimated efficiency potential is an uncertain, but conservative estimate, as a number of possible contributions to the potential for further efficiency improvement have been omitted, one reason being lack of data. In addition, a number of prudent considerations have been made, for example regarding how quickly companies invest in new technology or consolidate.

The estimated efficiency potential is close to what has previously been identified.[1] In 2013, a potential between DKK 1.8-5.0 billion was estimated.[2] On this basis, political agreement was reached to recover *minimum* DKK 1.3 billion in 2020. In 2016, an efficiency potential of DKK 2.5-3.0 billion was estimated[3], and, on this basis, a broad political majority decided to recover DKK 2.5 billion in 2025. This analysis adopts a slightly different approach to that of previous analyses and looks at the efficiency potential up until 2030 for the first time. The potential corresponds to a cost reduction of around 3 per cent per year on average.

This analysis identifies the efficiency potential through five sources: (1) the inefficient water companies' current efficiency potential from the benchmarking (sector internal backlog), (2) increased consolidation, (3) lower wages corresponding to the competition-exposed level (4) investments in less expensive and more efficient existing technology and (5) the expected productivity development in a comparable part of the competition-exposed Danish economy up until 2030, which the water sector must keep up with and exploit opportunities from.

[1] See an overview of previous analyses of the efficiency potential in the Danish water sector in Box 2.2 on page 13.

[2] Deloitte (2013) *Evaluering af vandsektorloven* (Evaluation of the Danish Water Sector Act). Deloitte did not estimate the efficiency potential of investments, but found an operating potential of around DKK 1.1-1.4 billion and a consolidation potential of between DKK 0.7-3.6 billion depending on how ambitious a consolidation was desired.

[3] McKinsey & Struensee (2016) *Forsyningssektorens effektiviseringspotentiale* (Efficiency potential of the utilities sector).

Efficiency requirements for the companies' costs are not an obstacle to the companies' ability to handle new challenges, such as reducing greenhouse gas emissions and engaging in climate adaptation. In contrast, the efficiency requirements contribute to the water sector's ability to perform new tasks without unnecessary increases in water bills for households and the business sector. In addition, several of the mentioned sources of efficiency improvement can make it possible to provide a higher security of supply, better and more sustainable quality and bigger reductions of carbon emissions than today. Overall, there is also ample capital and good financing opportunities in the sector. The assessment concludes that the potential can be completed with full consideration for the green transition, continued high security of supply, high customer service and continued technological development.

At a completely overall level, there are two ways to recover the backlog and meet the ongoing potential: Utilisation of new technologies and better organisation of the work. Technological development includes, for example, better utilisation of IT and data, as well as purchases of more efficient assets when existing assets are replaced. Better organisation includes consolidation, improved processes and work organisation.

The current regulation is expected to make it possible to recover around DKK 3.0 billion in the period 2020-2030. This corresponds to 78 per cent of the identified potential. The implementation of the 2018 voting agreement on new elements in the economic regulation – including flexible revenue caps and rate of return caps – can strengthen the possibility of recovering the potential. However, this presupposes that the future model for flexible revenue caps is structured in such a way that the risk of overinvestments is countered. In addition, the future regulation should be implemented so that the incentive to generate as significant (regulatory) profits as today, are removed. . The new elements are expected to enter into force in 2022.

The analysis concludes with four recommendations for new regulation aimed at realising the full efficiency potential to the benefit of Danish consumers' room for manoeuvre and the competitiveness of water-consuming companies.

The analysis has been prepared at the request of the Minister for Climate, Energy and Utilities. The request was received in January 2020.[4]

[4] See request here: https://www.kfst.dk/vandtilsyn/analyser/

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Why is there an efficiency potential in the water sector?

Box 1.1

Chapter 1 – Why is there an efficiency potential in the water sector?

» Natural monopolies do not have sufficiently strong incentives to be efficient because consumers cannot switch suppliers and competitors cannot enter the relevant markets/fields of utilities.

» The efficiency potential in the water sector consists of both a historical backlog and of the future productivity development. The backlog must be seen in regards to the fact that the companies do not have a strong incentive to focus on cost-effectiveness in comparison to companies that exist in a well-functioning market with effective competition.

» Effective regulation can support technology development and innovation by stimulating the water companies' demand for the development of new sustainable and cost-effective solutions by private suppliers and consultants. This gives them a good framework for growth, development and may contribute to strengthening the Danish suppliers' position in international markets.

» Overall, the water sector has good opportunities for investing in sustainability and green transition. The revenue caps are generally adequate, and there are ample opportunities for receiving supplements for new green projects. In addition, the sector has easier access to capital than the private sector.

1.1 How does an efficiency potential arise?

The efficiency potential consists of two parts.

The first part of the efficiency potential reflects an estimated historical backlog in relation to the development of the competition-exposed part of the Danish economy. In other words, new technology, better organisation and increased resource utilisation could be used to achieve efficient operations to an even greater extent than what has been the case.

The second part of the efficiency potential consists of the future opportunities that will arise for the water sector. New digital solutions are constantly being developed as well as more efficient and durable assets, new post training and educational opportunities and new organisational structures. This makes it possible to provide a high level of security of supply, quality, reduction of carbon emissions, improved services, etc. even more cost effectively. In this way, the Danes get as clean water and nature as possible for the money. Therefore, there is a There a potential for the water sector, that includes companies constantly improving and exploiting the opportunities that arise up to 2030.

Ultimately, there are only consumers – households and undertakings – to foot the bill if the water companies do not both recovering the backlog and exploiting new opportunities in the future.

1.2 Why is there an efficiency potential in the water sector?

The economically regulated water sector in Denmark consists of 110 waste water companies and 225 water companies (2019).[5] Some of these are municipally owned, while others are owned by consumers. They all share the common characteristic of being a natural monopoly. A monopoly is natural if, from a socio-economic perspective, it is more expensive to produce the service in question with several companies in the same field of utilities than with a monopoly.[6] The reason for this is that the large overheads connected with having to lay competing underground pipes, establishing competing plants, etc. are not commensurate with the gains from the increased competition. For consumers, this means that they only have one possible supplier of water and waste water.

A characteristic feature of natural monopolies is that the lack of competition weakens their incentive to make themselves attractive to consumers by ensuring a high quality and low prices.[7] The natural monopolies are therefore not forced to constantly work to retain their market shares.

When assessing the efficiency potential in the water sector, it must also be considered that Danish water companies have only faced efficiency requirements for just under 10 years. For most of this period, requirements have only been made for operating costs and not for total costs. In addition, the efficiency requirements are made based on very large prudent considerations. In addition, there is a difference in the extent to which the municipal owners exert an influence on the municipal companies' operational decisions in relation to efficient operations.

1.3 Efficiency potentials in monopolies can be achieved through regulation

The purpose of the economic regulation of the water sector is to simulate the competitive pressure to which the companies would have been exposed, if the market has been subject to competition as a well-functioning market. Given that water and waste water companies provide services of vital importance to society under different production conditions and with statutory requirements for quality. These considerations in the economic regulation protect water consumers and encourage the companies to deliver as cost-effective services as possible.

Economic regulation requires the companies to recover a historical backlog and to keep up with the current development. Two different types of efficiency requirements are therefore also imposed on the companies. One efficiency requirement is aimed at recovering part of the backlog, and the size of the requirement depends on how well the water companies perform relative to the other companies in the industry. This puts pressure on the less efficient companies to become better and gradually catch up with the most efficient companies. The second efficiency requirement is to ensure that the sector keeps up with the productivity development in competition-exposed industries, and all companies are therefore subject to the requirement.

[5] In addition, there are approximately 2000 water utilities outside the economic regulation.

[6] Baumol, W. (1977) *On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry*. The American Economic Review, 67(5), 809-822.

[7] Tirole, Jean (2017) *Economics for the Common Good*. Princeton University Press

1.4 Efficiency requirements promote innovation and technology development

When requirements are made for monopolistic companies, they strengthen the incentive for them to use new technologies and innovative solutions if it helps them meet the requirements. This applies to environmental, health and economic requirements.[8]

In relation to technological development and innovation, the role of water companies is first and foremost to demand better and more efficient solutions from private companies. The water companies' main task is to operate and continuously invest in the infrastructure needed to supply clean water and discharge as clean water as possible back into nature. The State stimulates research and development, including through research grants and various forms of subsidy for private research and development.

Nevertheless, the companies can play a role in technological development and the development of brand-new innovative solutions. For example by making facilities available for production companies and consultants for the testing and demonstration of new technologies, or by contributing knowledge about the technical side of the operations to universities, among others. The companies can also themselves develop within the revenue caps, and they can apply for funds on an equal footing with others, for example through the Danish Green Investment Fund and MUDP (the Environmental Technology Development and Demonstration Programme). The funds received in such a context are not subject to efficiency requirements. Competition for such funds supports that the projects chosen are of a good quality and can provide a societal return.

Effective regulation that encourages focus on cost-effectiveness supports technologicaldevelopment and innovation in two ways: *Firstly,* the economic regulation aims to make companies more aware of the consequences of their decisions. In other words, the regulation must provide the companies with an incentive to demand both sustainable and cost-effective solutions from suppliers and consultants.[9] If the companies choose to participate in the development of new technology, regulation must contribute to the selection of projects with the greatest expected gain.

Secondly, the water companies' demand leads to a focus among suppliers and consultants on developing and selling even better solutions – that are more environmentally sustainable, more energy efficient, but also more cost effective. This provides a good framework for suppliers and consultants to be competitive in the international markets.

1.5 There is money for sustainability and green transition

The core tasks of the water sector are to ensure clean drinking water and to discharge treated waste water back into nature. Overall, the water companies today have sufficient funds in their revenue caps to perform their core tasks.[10] The companies' total equity was around DKK

[8] Motta (2004). *Competition Policy: Theory and Practice.* Cambridge University Press and Arrow (1962) *Economic Welfare and the Allocation of Resources for Inventions* In *The Rate and Direction of Inventive Activity*, ed. R. Nelson, Princeton University Press

[9] Tirole, Jean (2017) *Economics for the Common Good*. Princeton University Press

[10] In addition, the companies have a low average debt to assets ratio of around 13 per cent (in 2019) as well as access to favourable loans, including through Kommunekredit. Finally, in 2018, the sector had total provisions of around DKK 2.3 billion that were not tied to existing investments. These are funds that the companies have collected from consumers but have not paid as costs. Added to this is a significant regulatory profit in the sector – see Table 2.1 in Chapter 2.

142 billion in 2014 and, seen as a whole, the sector has a very low debt ratio relative to private companies.

In addition, the current regulation gives companies good opportunities to finance the new tasks imposed on them to, for example, increase security of supply and achieve better protection of the environment, nature and climate. This is done by allowing companies to receive a supplement to their revenue cap corresponding to the costs when new tasks are imposed on them. In the period 2011-2019, supplements totaling just under DKK 1 billion were granted for financing of new tasks. [11]

Thus the water sector has good opportunities for financing and operating the companies and for financing projects that support cleaner drinking water, a better aquatic environment and more sustainable production methods, etc. Furthermore, the sector also has good economic opportunities to contribute towards the overall climate goals.[12] The waste water sector emits around 0.1 million tonnes of CO_2e (out of the expected Danish net emissions in 2020 of around 47 million tonnes CO_2e[13]), equal to 0.2 per cent of the estimated Danish emissions.

[11] Read more about supplements and the other developments in the water sector's economy in Konkurrence- og Forbrugerstyrelsen (2019) *"Udviklingen i den danske vandsektors økonomi, 2010-2019"* (Danish Competition and Consumer Authority (2019) Development in the economy of the Danish water sector, 2010-2019), https://www.kfst.dk/media/55569/udviklingen-i-den-danske-vandsektors-oekonomiske-rammer_final.pdf

[12] Agreement on Climate Act of 6 December 2019

[13] Klimarådet (2020) *Kendte veje og nye spor til 70 procents reduktion – Retning og tiltag for de næste ti års klimaindsats i Danmark* (Danish Council on Climate Change (2020) Known paths and new tracks to 70 per cent reduction – Direction and measures for the next 10 years climate action in Denmark)

Chapter 2
Efficiency potential of the Danish water sector up to 2030

Box 2.1
Main conclusions

Chapter 2 – Efficiency potential of the Danish water sector

» The potential in the water sector is conservatively estimated at around DKK 3.9 billion in the period 2020-2030. This includes a potential of approx. DKK 3.1 billion in the waste water sector and approx. DKK 0.75 billion in the drinking water sector.

» The potential has been identified based on (1) the inefficient water companies' current efficiency potential from the benchmarking, (2) increased consolidation, (3) pay reduction to the competitive level, (4) increased use of better existing technology regarding assets and (5) the expected productivity development up to 2030.

» The estimated potential is uncertain, but not exhaustive, as a number of reasons for the backlog in efficiency have not been included, due to a lack of data. In addition, the small companies under 800,000 m^3 are typically not included in the analysis.

2.1 Efficiency potential of the water sector up to 2030

The total efficiency potential in the Danish water sector is estimated to be around DKK 3.9 billion in the period 2020-2030, see Table 2.1. The potential consists of DKK 3.1 billion in the waste water sector and DKK 0.75 billion in the drinking water sector. The estimated potential is conservative, because several potentially significant sources of more efficient operations have not been included – primarily due to a lack of data. However, the estimate of the efficiency potential is also connected with considerable uncertainty.

The efficiency potential must be seen as possible reductions in the companies' annual costs. This means that if the efficiency potential is achieved, this will result in an annual saving for consumers, as the lower costs entail lower water prices. If the entire potential is achieved by 2030, this means subsequent lower annual costs of DKK 3.9 billion for Danish consumers.

Table 2.1 **Efficiency potential of the Danish water sector 2020-2030**

	Waste water *In DKK million*	**Drinking water** *In DKK million*	**The total water sector** *In DKK million*
Backward-looking potential (backlog)			
Backlog in non-efficient companies (benchmarking)	900	250	1,150
Potential of consolidation	650	100	750
Pay down to competitive level	50	(*)	50
Forward-looking potential			
Potential of existing technology development in assets	250	50	300
Productivity development up to 2030	1,250	350	1,600
Overall efficiency potential	**3,100**	**750**	**3,850**
Regulatory profit in 2018	1,300	(**)	1,300

Note (*): One in six underlying models is not statistically significant. Against this background, it is assessed that the uncertainty of pay premiums in the drinking water sector is too high to include them in the analysis. In addition, much voluntary labour is also used in this part of the sector.

Note (**): The regulatory profit has not been calculated for the drinking water sector.

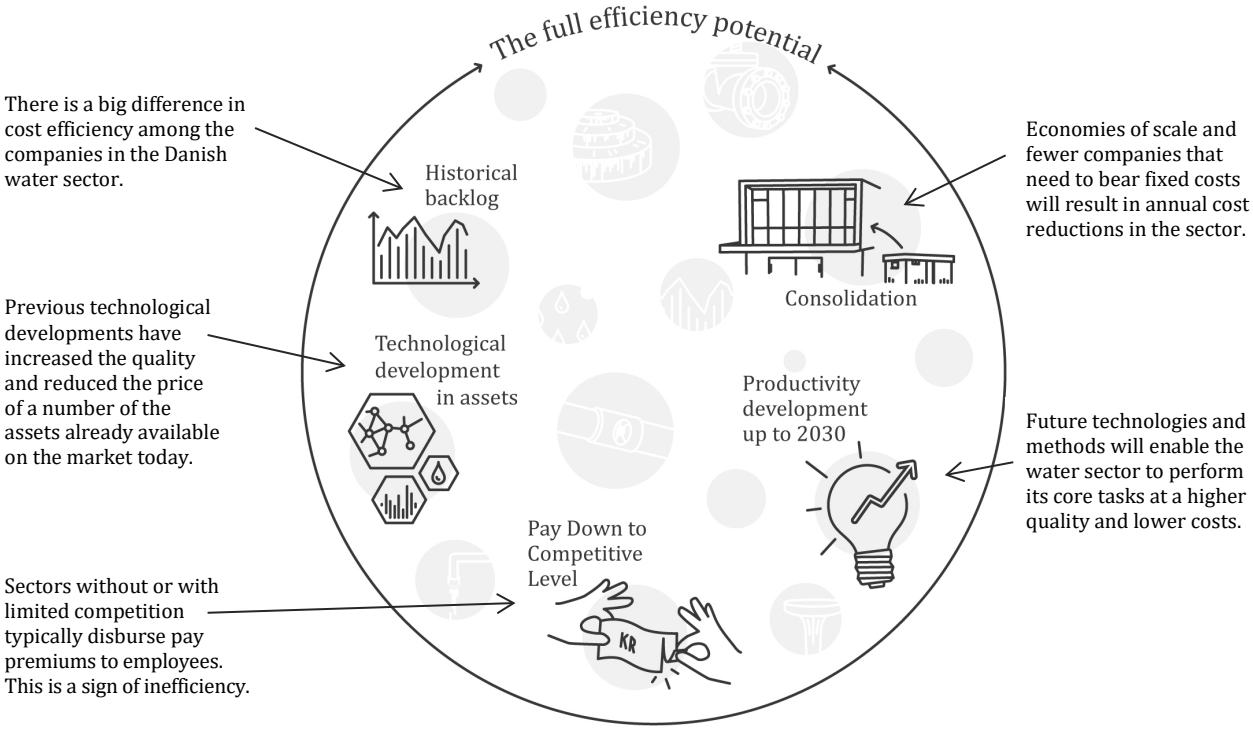
Note: The table summarises the results presented in this chapter. The regulatory profit in the waste water companies in 2018 shows that the companies' revenue caps are higher than their actual total costs.

Source: Own calculations

The efficiency potential has been calculated from five sources that, overall, show a potential in the use of better existing technology as well as better organisation of and in the companies. The five sources are: (1) the inefficient water companies' current efficiency potential from benchmarking (sector internal backlog), (2) increased consolidation, (3) pay reduction corresponding to the competitive level, (4) increased use of better existing technology regarding assets and (5) productivity development up to 2030.

The first three sources of efficiency potential (1-3) recover the historical backlog (the so-called *catch-up* potential). The latter two sources (4-5) represent a forward-looking potential towards 2030 which arises continuously as new opportunities arise for the water companies. The five sub-potentials are shown in Figure 2.1.

Figure 2.1 **The total potential is greater than the sum of the identified areas**



Note: Five sub-potentials have been estimated, but the sum total of these potentials probably do not cover the overall efficiency potential of the water sector

Source: Own production

In addition to the efficiency potential displayed above, there is also a significant so-called regulatory profit in the water sector. In 2018, the waste water companies generated revenues that exceeded their costs by about DKK 1.3 billion. This regulatory profit has occurred because, under the current regulation, the companies may charge water tariffs that guarantee them revenues that exceed their actual costs. The profit can be accumulated and transferred to the reserve fund without restrictions, despite the self-sustaining breakeven principle. If the waste water companies' unutilised revenue caps (i.e. a profit that is permitted, but not collected) is included, the profit totals DKK 1.7 billion. This total profit is not included in the efficiency potential and is therefore often characterised as a 'leeway' in the revenue caps because the profit shows that, further costs can be incurred without raising tariffs. It should be noted that the figure is a snapshot from 2018 and that some of the regulatory profit may, for example, have been allocated to cover deferred costs.[14] No comparable figure has been calculated for the drinking water sector, but it is likely to be lower than in the waste water sector.

The analysis of the water sector's efficiency potential is based on sub-analyses of five significant sources of efficiency potential. These sub-potentials are not an exhaustive list of sources

[14] https://www.kfst.dk/media/55574/20191017-metode-for-opgoerelse-af-effektiviseringskrav.pdf

of efficiency potential. Box 2.2 describes a number of reasons why the efficiency potential for the period 2020-2030 is likely to be higher than estimated. Conversely, there may be a certain overlap between some of the estimated sub-potentials. Overall, it is assessed that the efficiency potential calculated in this analysis is a conservative, but uncertain, estimate.

Box 2.2
Additional sources of potential not included in the analysis

Not all water companies are included in the analysis.

In most cases, the analysis has focused on the larger companies with a charged water volume above 800,000 m^3 per year. These companies constitute by far the main part of the sector and charge by far the main volumes of both drinking water and waste water.[15] The remaining companies are currently subject to either self-sustaining breakeven regulation (for charged water volumes below 200,000 m^3) or a simple framework regulation without benchmarking (for charged water volumes between 200,000 m^3 and 800,000 m^3). As a general rule, the efficiency potential of these companies are not included in the overall estimated efficiency potential, but there is also a potential to be realised in these companies. The latter are not included because they have the option of withdrawing from the regulation with effect from 2021.

Digital solutions offer new opportunities for increasing efficiency potential.

The opportunities offered by digital solutions include automation of processes and use of data from, for example, sensors to optimise operational tasks and utilisation of the water companies' assets.[16] Increasing demand for digital solutions and products in the Danish water sector has been reported in, for example, monitoring of water through optical sensors, data mining and intelligent pattern recognition. Technical University of Denmark (DTU) has also prepared 16 examples of specific digital initiatives that can contribute to making the water sector more economically efficient or improve the water quality.[17]

Global Water Intelligence (2016) estimates the global potential of increased use of digital solutions at 8-15 per cent for capital costs and 3-18 per cent for operating costs.[18] When these calculations are compared with the capital and operating costs in the Danish water sector, there is an efficiency potential from digital solutions of around DKK 0.3 billion in the drinking water sector and of around DKK 1 billion in the waste water sector. Global Water Intelligence uses interviews with water sector players and stakeholders worldwide. It is therefore uncertain to what extent the estimated cost reductions give a true and fair view of the Danish water sector. It is assessed that interviews to map the potential of digital solutions have both a backward-

looking element and a forward-looking element. The reason for this is that a potential is probably identified from the digital backlog in the water sectors, but also in the future opportunities offered by new digital technology.

[15] 94 per cent of the waste water companies and 33 per cent of the water companies charge over 800,000 m^3, and these large companies are responsible for 99 per cent of the waste water and 81 per cent of the drinking water, respectively.

[16] Digital solutions are defined as solutions "containing one or more of the following elements: digital data collection, data transmission, data processing/analysis, presentation of data (processed and/or raw data). Solutions can include both software and hardware (e.g. sensors)." Call Copenhagen (2019), *Smart Water – Digitalisering i vandsektoren* (Smart Water – Digitalisation in the water sector).

[17] Danmarks Tekniske Universitet (2019a) *Sektorudviklingsrapport – Lad vand og data strømme* (DTU (2019a) Sector development report – Let water and data flow)

[18] Potential OPEX reduction from digital solutions in: Treatment of drinking water (18 per cent); transport of drinking water (12 per cent); treatment of waste water (15 per cent); transport of waste water (17 per cent) and administration (3 per cent). Global Water Intelligence (2016) *Water's Digital Future*.

Efficiency potential in the absence of cross-subsidisation.

The Danish Water Sector Act (*Vandsektorloven*)[19] and the Danish Stop Act (*Stoploven*)[20] lay down a number of requirements for water companies' financial transactions in order to avoid cross-subsidisation. They do this by ensuring separation between tax-funded activities and tariff-financed activities, separation of financing of different types of supply, for example in multi-supply groups, and that water companies' agreements are generally entered into on arm's length terms. The possibilities for effective supervision of this are, however, limited. This follows from the scope of the current supervisory powers and from the fact that existing supervisory obligations are distributed on different authorities. There are, in other words, not the best opportunities for ensuring that the money consumers and undertakings pay for water is not used for other purposes.

Especially in large supply groups, internal transactions may be extensive and relatively complicated. To avoid that too high costs are not highlighted due to cross-subsidisation, it is expedient if one and the same authority has the necessary supervisory powers and resources to ensure, on behalf of the consumers, that the rules on separation and marketability are complied with. This includes that the supervisory authority has sufficient access to obtain necessary information about the transactions conducted by water companies – both with other companies internally in a group and with owner municipalities. Therefore, it cannot be ruled out that there is today a potential for lower costs hidden in cross-subsidisation and too high purchase prices. The potential of this has thus not been included due to a lack of data.

2.2 Significant efficiency potentials have previously been found in the water sector

The efficiency potential of DKK 3.9 billion in the period 2020-2030 must be seen in the light of the sector's total impactable costs amounting to approx. DKK 11.5 billion.[21] The delimited potential thus corresponds to an average cost saving of just under 3 per cent per year.

The analyses in this survey find efficiency potentials of about the same size as the earlier studies, see Box 2.3. This should be seen in the light of the fact that efficiency requirements have been imposed on the Danish water companies for less than 10 years – and for most of this period only for operating costs and not the total costs, and that the requirements are very conservative.

This analysis applies for both previously used and new methods that determine the efficiency potential of the water sector. For example, this analysis also uses benchmarking models and is inspired by Deloitte (2013) in relation to estimating the consolidation potential in the sector. Pay premiums in the water sector have previously been analysed in Copenhagen Economics (2017). However, this is the first time that an analysis of the efficiency potential of existing technological progress has been conducted. This part of the analysis makes use of a new technology catalogue with input prices.[22]

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[19] Consolidation Act of 23 January 2020 on the organisation and financial conditions of the water sector (*Lovbekendtgørelse om vandsektorens organisering og økonomiske forhold af 23. januar 2020*)

[20] Consolidation Act of 23 August 2019 on municipalities' sale of water companies (*Lovbekendtgørelse om kommuners afståelse af vandselskaber af 23. august 2019*)

[21] Today, the companies have non-impactable costs of around DKK 3 billion (e.g. taxes, compensations, etc.)

[22] The technology catalogue for drinking water technologies (2020) can be found here https://www.kfst.dk/vandtilsyn/analyser/ A corresponding technology for waste water technologies follows.

Box 2.3
Existing analyses find significant potentials in the water sector

A joint feature of existing analyses of the efficiency potential in the water sector is that they identify significant potentials. Different methods have been used across the analyses to identify the potentials.

- **Konkurrencestyrelsen (2003)**, *Konkurrenceredegørelse* (**Danish Competition Authority (2003)**, *Competition Report*). Finds a total efficiency potential of DKK 1.3 billion in the sector, of which DKK 426 million is in the water supply area (only operating costs) and DKK 849 million for the waste water treatment plants (total costs). The analysis uses DEA benchmarking to estimate the potential.
- **De Økonomiske Råd (2004)**, *Dansk Økonomi, Efterår 2004 (**Danish Economic Councils (2004)**, Danish Economy, Autumn 2004).* Finds a potential of DKK 304 million in lower production costs per year in the municipal water supplies. The results are based on a regression analysis.
- **COWI (2005),** *Benchmark af kloakområdet* (*Benchmarking of the sewerage area)*. Finds an efficiency potential in the sewerage system of around DKK 330 million per year (only operating costs). The analysis comprises transport of waste water (i.e., for example, the sewerage system as well as overflow facilities and pumping stations). It therefore supplements the mapping of the efficiency potential made by the Danish Competition Authority (2003) by determining the potential in the rest of the waste water sector. The analysis uses DEA benchmarking to estimate the potential.
- **Peter Bogetoft (2012),** *Strukturanalyse af den danske vandsektor* (Structural analysis of the Danish water sector). Pure synergies through local collaborations are, in many cases, estimated to result in cost reductions of between 10-20 per cent for both water and waste water companies. The analysis primarily uses DEA benchmarking to estimate the potential.
- **Deloitte (2013)**, *Evaluering af vandsektorloven* (Evaluation of the Danish Water Sector Act). Finds an efficiency potential of DKK 1,090-1,360 million (DKK 270-330 million for municipally owned utility companies, DKK 90-110 million for consumer-owned utility companies and DKK 730-930 million for waste water companies). Added to this is a consolidation potential of DKK 0.6-2.9 billion in the waste water sector and DKK 0.1-0.7 billion in the drinking water sector.
- **PwC (2014),** *Vurderinger af potentialer ved samarbejde mellem tolv forsyninger* (Assessments of potentials in collaboration between twelve utilities). It is estimated that a joint holding company between the utilities can create synergies of just under DKK 200 million, two thirds of which concern operations.
- **McKinsey (2016)**, *Forsyningssektorens effektiviseringspotentiale* (Efficiency potential of the utilities sector). Finds a total efficiency potential of around DKK 1.9 billion in the sector, DKK 770 million of which is in the drinking water sector and DKK 1,145 million in the waste water sector. Added to this is a consolidation potential of DKK 205-463 million among the water companies and DKK 296-978 million among the waste water companies.
- **Copenhagen Economics (2017),** *Lønniveau i forsyningssektoren* (Pay level in the utilities sector). Finds a significant pay premium in water supply, sewerage services, waste management, etc. of around DKK 3-6 (2-3 per cent) an hour, including pension.[23] The analysis uses two regression models (*random effects* and *fixed effects)* to estimate pay premiums for hourly pay (including pension) for employees from 2009 to 2015.

2.3 Backlog in the water sector

Part of the efficiency potential consists in that the less efficient companies can become just as efficient as those that are the most efficient and have fairly comparable conditions, etc.. This

[23] Copenhagen Economics (2017) *Lønniveau i forsyningssektoren (*Pay level in the utilities sector)

backlog among the less efficient companies is estimated at DKK 1.1 billion in the period 2020-2030. This covers an efficiency potential of DKK 900 million for the waste water companies and DKK 250 million for the water companies. In other words, there is a significant difference in the companies' efficiency, which creates this sector-internal backlog.

The latest benchmarking results are used to determine the backlog. The water companies were most recently benchmarked in 2018, while waste water companies' backlog was most recently calculated in 2019. Here, annual efficiency potentials of DKK 82 million and DKK 24 million were estimated for the waste water companies and the water companies, respectively.[24] The calculation of the overall efficiency potential has been based on the annual efficiency potentials for the whole period 2020-2030 being of the same size as calculated in the most recent benchmarking. The reason for this is that, historically, there are no signs that the backlog is reduced.[25]

The benchmarking models determine the potential by comparing all companies with the most efficient companies in the sector. The challenge of the benchmarking models is that the most efficient companies in the Danish water sector are not necessarily as efficient as they could potentially be – or as they would have been if they had been exposed to competition. Therefore, the benchmarking models do not identify the overall potential.

2.4 Consolidation

Consolidation can be both a technical amalgamation of plant, equipment and infrastructure with a view to, for example, better utilisation of capacity, an organisational merger of companies with resulting joint ownership or several companies' establishment of a joint company for procurement and administration, etc. Consolidation can thus lead to economies of scale with reductions in the companies' unit costs.

In this analysis, consolidation includes both administrative and technical amalgamations. The estimated consolidation potential includes both the technical and administrative potential of increased consolidation. However, it is assessed that the consolidation potential may be even higher in the longer term, as investments are gradually made in larger, better and more cost-effective plants.

Significant consolidation potentials have previously been identified in the water sector. In 2013, the consolidation potential was estimated at DKK 0.6-2.9 billion for waste water and DKK 0.1-0.7 billion for drinking water.[26] A fairly recent analysis from 2016, which took into greater account the importance of the companies' geographical position in relation to consolidation, estimated a consolidation potential of DKK 296-978 million for waste water and DKK 205-463 million for drinking water.[27] The present analysis is based on the methodology used in Deloitte (2013), but with a number of modifications to take into greater account the companies' internal differences when estimating the consolidation potential. For example, the companies' benchmarking scores are checked in the consolidation analysis for waste water companies, which reduces the risk of overlap between the consolidation potential and the sub-po-

[24] In the most recent benchmarking, the backlog was calculated at DKK 659 million for the waste water companies and DKK 188 million for the water companies. The annual efficiency potentials have been calculated based on a realisation rate of eight years.

[25] The reason for this is that the most efficient companies are likely to constantly implement new measures that make them more efficient, thus increasing the backlog for the less efficient companies.

[26] Deloitte (2013) *Evaluering af vandsektorloven* (Evaluation of the Danish Water Sector Act)

[27] McKinsey (2016) *Forsyningssektorens effektiviseringspotentiale* (Efficiency potential of the utilities sector)

tential identified through the benchmarking models. For the drinking water sector, the analysis also includes small companies that are not subject to economic regulation. These companies are not benchmarked, and, for a large share of the companies, there can therefore be no overlap with the potential identified through the benchmarking models. Furthermore, a number of the largest waste water companies have not been included in the consolidation analysis as they are only engaged in either transport or treatment of waste water and are consequently not directly comparable with the rest of the industry in relation to unit costs. For drinking water, the largest observation has been omitted (HOFOR Copenhagen) as an outlier.

The purpose of this analysis is not to identify which companies should consolidate. Furthermore, it is not assessed which companies consolidate in the calculation.

Consolidation potential in the waste water sector

Large companies have lower actual total costs per m^3 water charged, see Figure 2.2.[28] The total costs per m^3 charged water is around DKK 40 for a company that charges DKK 2.5 million m^3 water, while the costs are expected to be DKK 30 (i.e. 25 per cent lower) for a company that charges 8 million m^3 water.[29] The result remains significant when we check for a number of factors that could affect the outcome.[30] We use the results from the control variable model to determine the consolidation potential in the waste water sector.

[28] The method for estimating the consolidation potential is inspired by Deloitte (2013)

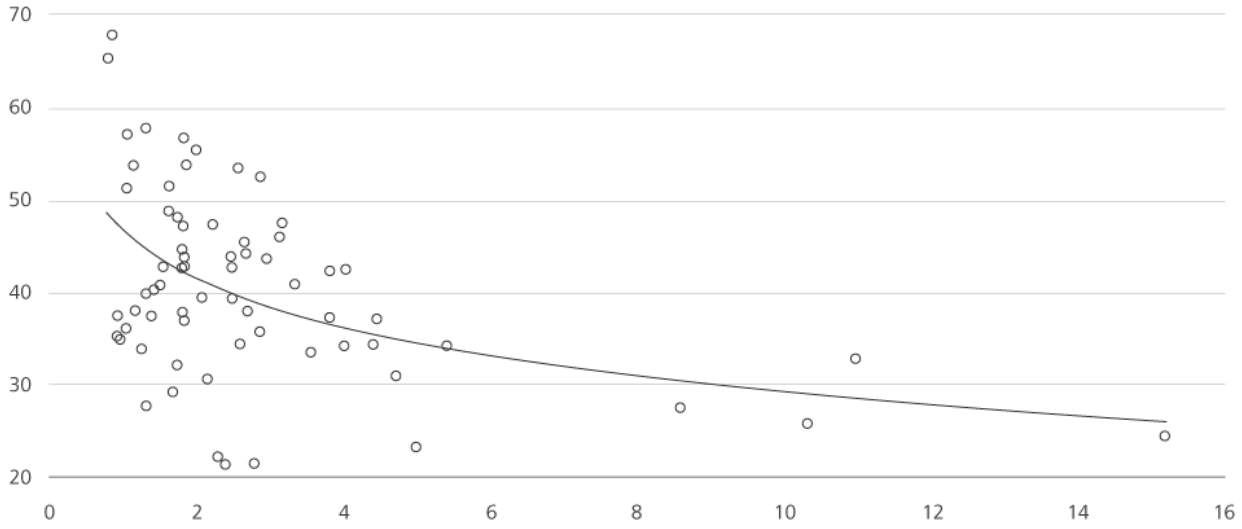
[29] The analysis does not include companies that are not engaged in both treatment and transport activities. This means that the two major companies in Copenhagen, HOFOR and Biofos, are not included in the waste water analysis. As a robustness analysis, we have included HOFOR and two thirds of Biofos as one single company. This does not change the overall picture. We have included two thirds of Biofos because HOFOR Spildevand Holding A/S owns 67.6 per cent of Biofos, see https://biofos.dk/om-os/ejerforhold/

[30] We have checked the age of the companies, the density of the companies' customers (measured as number of addresses per km of pipeline network) and the companies' *best-of-two* scores from the benchmarking. The inclusion of the last variable shows that the cost differences do not only reflect the companies' efficiency as identified through the benchmarking models. Size is still a statistically significant coefficient in the analysis.

Figure 2.2 **Large waste water companies have lower total unit costs**

Unit costs of waste water treatment depend on the charged water volume

Actual total cost per m^3, average between 2017 and 2018



Note: The figure shows the correlation between charged water volume and actual total costs measured as an average between 2017 and 2018. Companies that are exclusively engaged in treatment or transport of waste water have been excluded.

Source: Own calculations based on reported data

The consolidation potential in the waste water sector is DKK 650 million at 50 per cent consolidation, see Figure 2.3. Consolidation of 50 per cent means that the number of companies in the calculation has been reduced by 50 per cent (34 average companies) from the current 68 companies that are engaged in both treatment and transport activities. A 50 per cent consolidation means that the charged water volume per company is doubled. The potential increases with the degree of consolidation and is around DKK 1,300 million at 75 per cent consolidation.

Consolidation of the water sector is expected to take place gradually. 50 per cent consolidation over the period 2020-2030 is equal to about three fewer companies annually.[31] There are also indications of a CO_2 reduction potential in connection with technical consolidations of waste water treatment plants.[32]

The consolidation potentials for that part of the waste water companies which is not included in the regression analysis is estimated to be around DKK 200 million at 50 per cent consolidation, based on the calculation technical assumption that the correlations found in this regression also apply to them. This means that the total consolidation potential in the waste water sector is of up to DKK 850 million at 50 per cent consolidation. At 75 per cent consolidation,

[31] At least 27 companies consolidated to some extent in the period 2012-2018. This concerns the companies in HOFOR, Biofos, FORS, Din Forsyning, Novafos and Lolland/Hunseby.

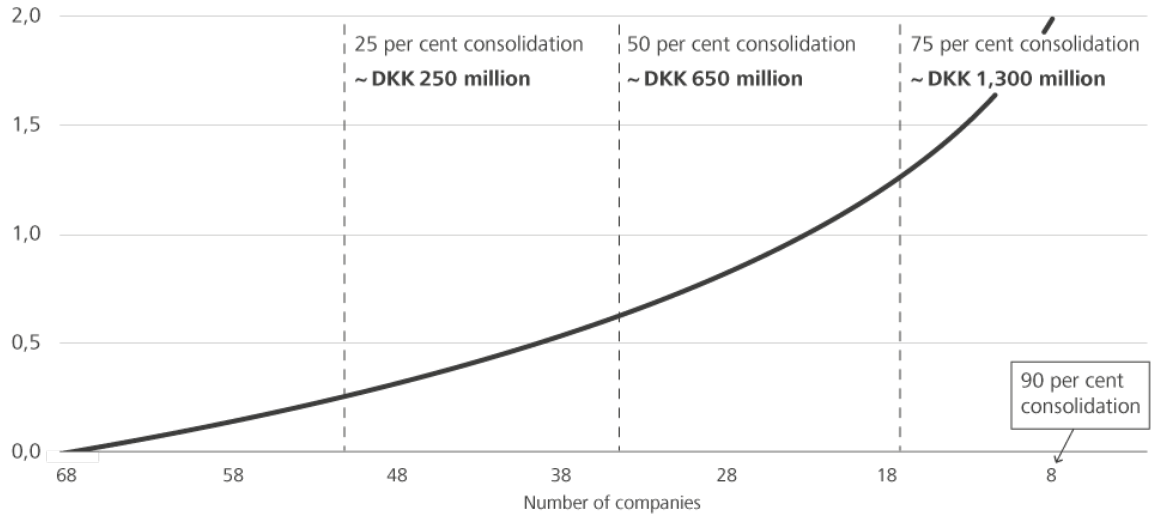
[32] The Government's climate partnerships – Waste and water, circular economy. Reporting, 16 March 2020.

the total consolidation potential is of around DKK 1,700 million. It should be noted that these estimates are connected with particular uncertainty. However, they support the existence of consolidation potential among the companies that are not included in the regression, which are mainly companies that are either exclusively engaged in transport or treatment of waste water. However, for reasons of prudence, this has not been included in the overall efficiency potential of the water sector.

Figure 2.3 **The consolidation potential in the waste water sector is DKK 650 million at 50 per cent consolidation**

Consolidation potential in the waste water sector at different levels of consolidation

Consolidation potential in DKK billion



Note: To calculate the efficiency potential from consolidation, we use the estimation coefficients from the model that checks for density, the company's age and *best-of-two* scores from the most recent benchmarking in 2019. All coefficients are statistically significant at a significance level of 1 per cent. When the companies consolidate, their average charged water volume will increase, pushing down unit costs. It is assumed that the average density, age and *best-of-two* cores will remain unchanged. From here, the annual consolidation potential has been estimated at all degrees of consolidation in the waste water sector.

Source: Own calculations based on data reported from the companies

There are also costs connected with consolidation. These costs include various one-off costs, for example linking of supply networks, conversion to shared IT systems and gathering of administration. It is important to note that these are one-off costs, whereas the consolidation potential is an annual saving for Danish consumers – year after year.

Part of the costs have implicitly been included in the analysis, as the large companies have made a number of investments, thereby reducing unit costs on average. These investment costs affect their unit costs and have therefore at least been partially included in the analysis.[33]

[33] Not all costs have been included in this way. The reason for this is that some of the large companies' investments may have been fully written off and are therefore no longer included in their costs. However, this may equally be the case for the small companies' costs. Therefore, it is not assessed to have a significant effect on the estimated consolidation potential.

Box 2.4
Method for determining the consolidation potential of the waste water sector

Waste water companies with higher charged water volumes have lower actual total unit costs on average. A simple econometric model has been created that reflects this context. In specific terms, the actual total costs per m^3 charged water as a function of (the logarithm) for the charged water volume and multiple control variables, see Table 2.2. The interpretation of the coefficient for charged water volume is that when the charged water volume increases by one per cent, the actual total cost per m^3 charged water decreases by just over DKK 0.05. The prefixes of the coefficients for customer density and the companies' benchmarking scores are as expected. A company will have lower total unit costs, the closer it is located to its customers and given that, it is more efficient in the benchmarking models. In addition, there is a small effect of older companies having lower total unit costs.

Table 2.2 **Regression output for waste water, average for 2017 and 2018**

	Actual total costs per m^3 water charged	
Log (charged water volume in million m^3)	-5.23	***
Density	-193.36	***
Best-of-two score	-35.48	***
Age of company	-0.93	***
Constant term	115.04	***
Adjusted R^2	0.51	
Number of observations	68	

Note: The table shows regression output for an OLS regression based on average observations for 2017 and 2018. ***, ** and * indicate significantly different from zero at 99 per cent, 95 per cent and 90 per cent confidence intervals. The table presents a level log regression. Another way to specify the regression is where the log (actual total costs per m^3 charged water) is used as explained variable. In this case, the coefficient for log (charged water volume in million m^3) is stated at -0.129. This specification of the model indicates that unit costs are reduced by 0.13 per cent when the charged water volume increases by 1 per cent.

Source: Own calculations

The data base is waste water companies that charge over 800,000 m^3 of water and are engaged in both treatment and transport activities. There are 68 companies in the observation set.

When the companies consolidate, the average charged water volume per company will increase. It is a calculation technical assumption that the companies which consolidate have an average charged water volume. The consolidation will consequently increase the charged water volume per company and thus reduce the estimated unit cost in the waste water sector. It is a calculation technical assumption that the average density, *best-of-two* score and age are unchanged in connection with consolidation.

No calculation technical assumptions are made about how the production is distributed when companies consolidate. The calculation is based on the average charged water volume per company. When there are fewer companies, the average charged water volume per company will increase. This will occur regardless of whether a given company is consolidated with a company of the same size or whether, for example, it is taken over by the large companies in the industry. Another way of putting this is that the regression model for the costs per m^3 (the unit costs), using the charged water volume as one explanatory variable, shows how much the unit costs decrease when the charged water volume increases marginally. This is equal to a large average company.

It is assumed in the calculation that the consolidating companies have an average size measured by their charged water volume.

To estimate the consolidation potential among the companies that are not included in the regression, the same percentage reduction in unit costs is used as for the 68 companies in the population. The consolidation potential in this part of the waste water sector is estimated at around DKK 200 million.

There have been some amalgamations of varying scope in the waste water sector. The actual operating costs in three years preceding and up to four years after the amalgamations are shown in Figure 2.4 below. These are five specific Danish amalgamations made in the period 2012-2017.[34] The overall picture is that the operating costs have fallen by an average of around 10 per cent. However, there are also examples of a short-term increase in the measured operating costs.[35] The figure indicates that, in most cases, cost reductions are realised immediately after the amalgamation and that they are sustained.[36]However, the analysis does not check for changes in operating costs as a result of other changes during the period, including whether new supplements have been made to the companies' revenue caps that result in increased operating costs.

[34] This concerns HOFOR in 2012, Biofos in 2013, FORS in 2016, Novafos in 2017 and DIN Forsyning in 2017. These are amalgamations that have occurred after the consolidation potential was analysed in Deloitte (2013) *Evaluering af vandsektorloven* (Evaluation of the Danish Water Sector Act). In addition, several of the mergers have taken place after the consolidation potential was analysed in 2016.

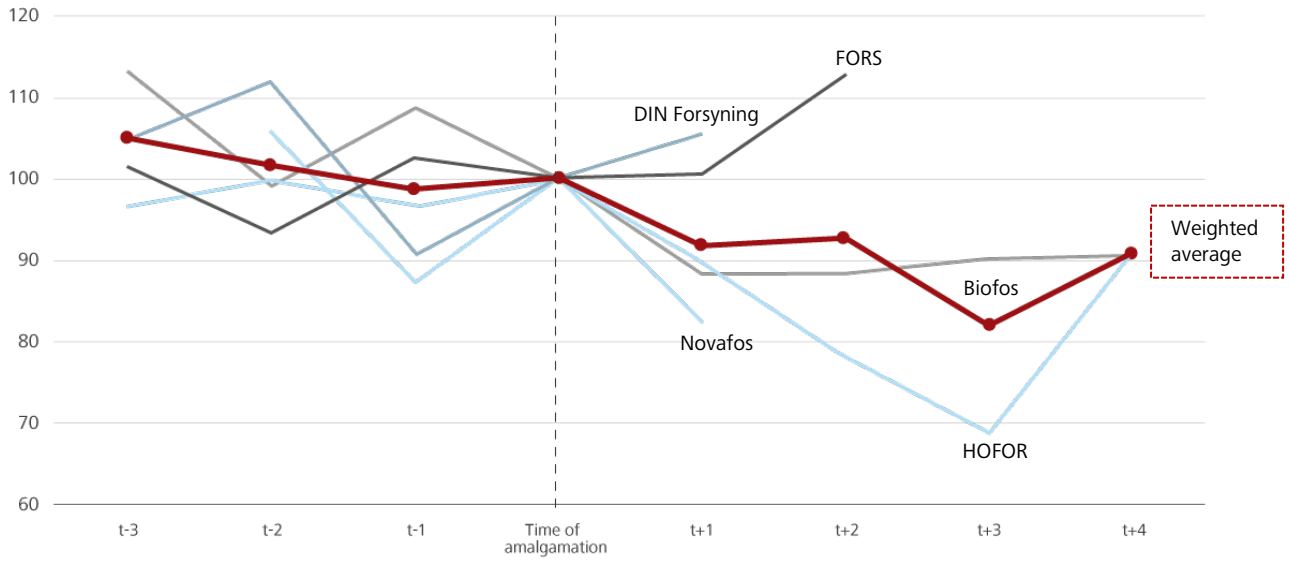
[35] The term 'amalgamations' has been widely used to describe a number of different forms of increased cooperation between the companies. It therefore covers both mergers and the establishment of joint companies. No distinction is made between different degrees of amalgamation in Figure 2.4.

[36] The conclusions in the figure are indicative. It has not been possible to find a control group for the five companies that provides a true and fair comparison and thus statistically examine whether the amalgamations are the direct reason for any cost reductions.

Figure 2.4 **Estimated cost reduction is around 10 per cent of operating costs in connection with amalgamations**

Actual operating costs of five companies amalgamated in the period 2012-2017

Index, amalgamation time = 100



Note: HOFOR includes the amalgamation of eight companies in 2012. There are no data for Dragør and Vallensbæk companies in 2016 (t+4). For these two companies, we have used data from 2017. In 2016 (t+4), the HOFOR companies were granted approval of supplements to their revenue cap totalling around DKK 42 million. Part of the increase seen in the figure for HOFOR in this period is expected to be due to these supplements.

Source: Own calculations based on reported data.

Consolidation potential in the drinking water sector

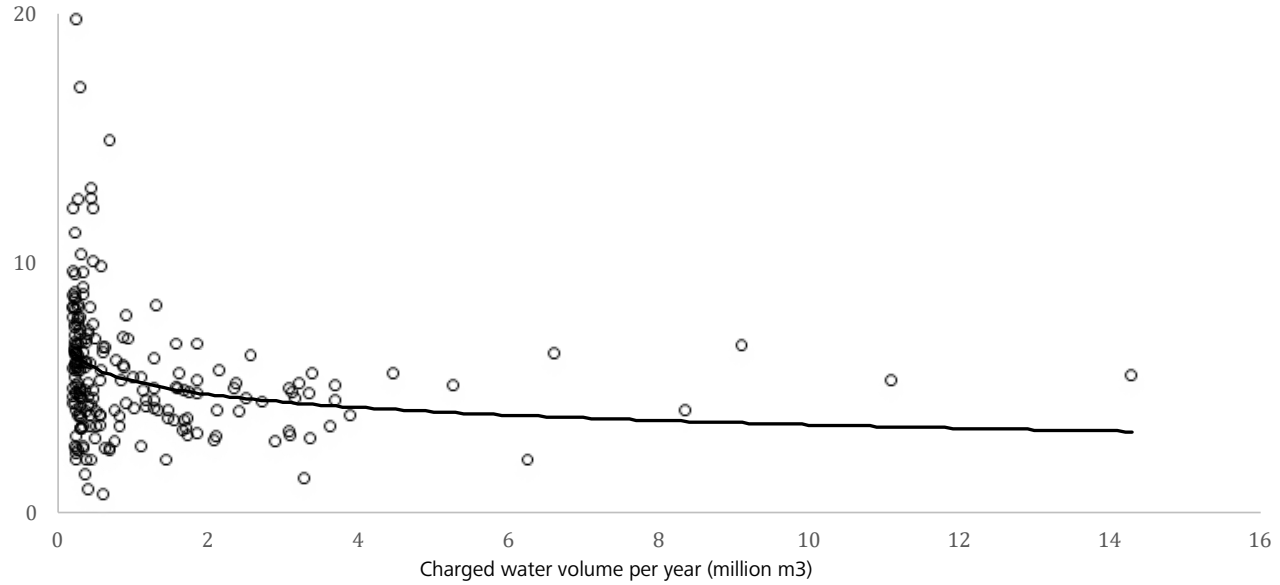
Large water companies also have lower actual operating costs per m³ charged water, see Figure 2.5.[37] A simple econometric model has also been created that highlights this correlation. This statement illustrates that operating costs are approximately 32 per cent lower per charged water volume for a company producing 3 million m³ charged water than for a company charging 0.2 million m³ water, see Figure 2.5.

[37] The consolidation potential in the drinking water sector focuses only on operating costs, as, due to the current regulation, we do not get data on the actual total costs of companies charging less than 800,000 m³ water per year. But as a large proportion of the water companies charge between 200,000 and 800,000 m³ water, it is important to include these companies. Water utilities below 200,000 m³ have not been included in the analysis of the consolidation potential of the drinking water sector due to a lack of data. In the waste water sector, the vast majority of companies charge more than 800,000 m³ water per year, and we therefore have data on actual total costs for most of the waste water sector.

Figure 2.5 **Large water companies have lower operating costs per m³ of water**

Operating costs per m³ of drinking water depends on charged water volume

Actual operating costs per m³, 2017



Note: The figure shows the correlation between charged water volume and actual operating costs for 2017. HOFOR Copenhagen has been excluded from the figure as an outlier.

Source: Own calculations based on reported data

The above model has then been used to calculate a stylised consolidation potential according to the same principles as for the waste water sector. On this basis, the consolidation potential of the drinking water sector's operating costs has been estimated at just over DKK 100 million in connection with a consolidation of 50 per cent, see Figure 2.6. According to the calculation, the potential increases with the degree of consolidation, and the potential is thus around DKK 250 million annually in connection with a consolidation of 75 per cent.[38] The actual potential is probably higher because the capital cost reductions have not been included due to a lack of data. Operating costs and capital costs each constitute about 50 per cent of the total costs in the water companies.

The consolidation potentials of the water companies that are not included in the regression are just under DKK 50 million in connection with consolidation of 50 per cent if the results from the regression analysis are also applied to them on a calculation technical basis. This means that the total consolidation potential in the waste water sector's operating costs is of up to DKK 150 million at a consolidation of 50 per cent. The total consolidation potential is around DKK 300 million at a consolidation of 75 per cent. In the same way as for the waste water sector, there is particular uncertainty about these estimates. It is thus estimated that

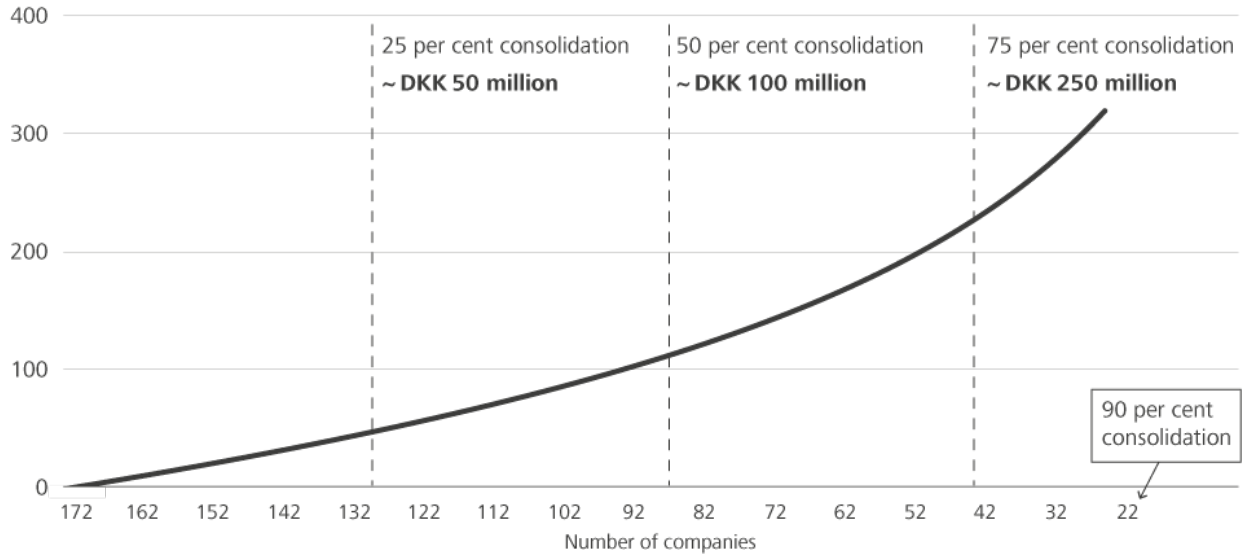
[38] 36 companies merged in the period 2011-2019. This is equal to four a year. However, mergers are only one of several ways of achieving economies of scale. The actual consolidation is probably higher if other methods of consolidation than mergers are considered, for example technical amalgamations or administrative collaborations

there is a potential in the remaining 38 companies that do not form part of the regression analysis, but this has not been included in the overall potential calculation.

Figure 2.6 **The consolidation potential in the drinking water sector is more than DKK 100 million a year at a consolidation of 50 per cent**

Annual consolidation potential for operating costs in the drinking water sector at different levels of consolidation

Consolidation potential in DKK million



Note: To calculate the efficiency potential from consolidation, we use the estimation coefficients from the model that checks for density. We do not check for the companies' age or the latest *best-of scores*, as this information is not available for the small water companies. The coefficient for the charged water volume is statistically significant at a significance level of 1 per cent, while the coefficient for density is not significant. When the companies consolidate, their average charged water volume will increase (lower operating costs per m^3 of water). It is assumed that the average density will remain unchanged. From here, the consolidation potential has been estimated at all degrees of consolidation in the drinking water sector. 38 companies have been excluded from the analysis due to a lack of data or because they are outliers.

Source: Own calculations based on data reported from the companies.

There are indications that large water companies have better opportunities to achieve higher a security of supply. Consolidation may therefore potentially also support increased security of supply. This must be seen in the context that the current environmental regulation imposes an obligation on large utility companies to test the quality of their drinking water more often than small companies.[39] Large utilities must also be assumed to have at their disposal greater specialist expertise in, for example, security of supply and greater opportunity for making cost-effective investments as they can exploit their economies of scale.

The water companies are limited to some extent in relation to technical consolidation, as the purity of the drinking water may deteriorate if the water is transported too far. However, this does not mean that the companies cannot consolidate and exploit both administrative and

[39] Executive Order on Water Quality and Supervision of Water Utility Plans (*Bekendtgørelse om vandkvalitet og tilsyn med vandforsyningsanlæg*), Appendix 5, Table 1: https://www.retsinformation.dk/Forms/R0710.aspx?id=210700#id407116a4-d444-4d3a-9812-837156a10068.

technical advantages. In the same way as for the waste water companies, consolidation will, to some extent, be connected with increased investments in the form of one-off costs. These costs must be converted into an annual expenditure during the life of the investment before they can be compared with the annual cost reduction that the consolidation secures and which is of a more permanent nature. In the same way as for the waste water sector, at least part of the costs of consolidation must implicitly be assumed to have been included in the analysis, as the costs of establishing large plants in the large companies have been included in these companies' unit costs.

Box 2.5
Method for determining the consolidation potential of the drinking water sector

Water companies with higher charged water volumes have lower actual total unit costs on operating activities on average, see Table 2.2. The analysis includes 172 water companies that charge over 200,000 m^3 of water per year. The interpretation of the coefficients is the same as for waste water, see Box 2.3.

Table 2.3 **Regression output for drinking water, 2017**

	Actual operating costs per m^3 water charged
Log (charged water volume in million m^3)	-0.79 ***
Density	-0.78
Constant term	5.52 ***
Adjusted R^2	0.08
Number of observations	172

Note: The table shows regression output for an OLS regression based on data for 2017. ***, ** and * indicate significantly different from zero at 99 per cent, 95 per cent and 90 per cent confidence intervals. The table presents a level log regression. Another way to specify the regression is where the log (actual operating costs per m^3 charged water) is used as explained variable. In this case, the coefficient for log (charged water volume in million m^3) is -0.121. This specification of the model indicates that unit costs are reduced by 0.12 per cent when the charged water volume increases by 1 per cent.

Source: Own calculations

When the companies consolidate, the average charged water volume will increase, which will reduce the estimated unit cost of operating activities in the drinking water sector. The data regarding the age of all the companies is not available. Furthermore, the companies under 800,000 m^3 charged water per year are not benchmarked and no *best-of-two* scores have consequently been given. Therefore, these two explanatory variables are not included in the drinking water analysis. It is assumed that the average density remains unchanged in connection with consolidation. The percentage reduction in unit costs is multiplied by the 172 companies' total actual operating costs, which are around DKK 1.1 billion.

To estimate the consolidation potential among the companies that are not included in the regression, the same percentage reduction in unit costs is used as for the 172 companies in the population. This cost reduction is compared with the approximately DKK 250 million that these companies have in actual operating costs.

2.5 Pay down to competitive level

Seen in isolation, a lack of competition leads to less incentive to ensure efficient operations and good service. One indication of weak competition – and of efficiency potential for the utilities sector – is earnings above normal, including excessive pay premiums. In other words, excessive pay premiums may be a sign that a market is not being run on a cost-effective basis.

A pay premium is the additional salary or wage paid when the composition of the labour force and its experience, level of training and education as well as other explanatory variables are taken into account. Some industries pay higher wages and salaries than others, but pay premiums only exist if the reason for the pay difference is that the job is in a specific industry and is *not* due to differences in the employees' competences.

According to the calculations, the pay premiums in the *waste water sector* are 5.0-7.6 per cent higher than in the furniture industry.[40] The furniture industry has been chosen as a reference industry because it is exposed to international competition and is therefore not assumed to have pay premiums that are connected with weak competition. A large number of characteristics, including gender, age, level of training and education and geographical location, have been taken into consideration in the analysis. In the period 2008-2018, waste water companies had average payroll costs of around DKK 980 million per year. The annual pay premium potential is 5.0-7.6 per cent of the annual payroll costs, which is equal to DKK 49-74 million.

If the pay premium is defined in relation to the median industry (i.e. the industry with a pay premium that is in the middle of all 128 industries), the pay premium is 1-5 per cent in the waste water sector, which results in an estimated potential of DKK 10-50 million.[41]

In summary, it is conservatively estimated on the basis of the above results that the potential from pay premiums in the waste water sector may be around DKK 50 million.

According to the calculations, the pay premiums are 1.5-7.7 per cent in the drinking water sector relative to the furniture industry.[42] The lower pay premium estimate (1.5 per cent) is not significant. One in six empirical models in the analysis does not find a significant pay premium in the drinking water sector. In the period 2008-2018, the water utilities had average payroll costs of around DKK 420 million per year. This means that the annual potential pay premium potential is DKK 6-32 million per year.

If the pay premium is defined in relation to the median industry, the pay premium is 1.0-1.6 per cent, resulting in an estimated potential of DKK 5-7 million.[43]

In summary, it is assessed that there is a potential from pay premiums in the drinking water sector, but, due to the uncertainties in the estimates, we do not include this in our overall assessment of the efficiency potential.[44]

[40] Konkurrence og Forbrugerstyrelsen (2019) *Konkurrencen på markedet for pension* (Danish Competition and Consumer Authority (2019), Competition in the pension market). This report includes an analysis of pay premiums across 117 different industries. Six different econometric approaches have been used. In our calculation of the efficiency potential in the water sector, we have leaned on models 3 and 5, one being an OLS model and the other a *fixed effects* model. The estimated pay premiums are statistically significant.

[41] The median industry is the middle industry if all industries were ranked according to their estimated pay premium.

[42] Konkurrence og Forbrugerstyrelsen (2019) *Konkurrencen på markedet for pension* (Danish Competition and Consumer Authority (2019), Competition in the pension market).

[43] It should be noted that the upper estimate of the pay premium relative to the median industry (1.6 per cent) is not significant.

[44] Copenhagen Economics (2017) has also estimated a significant pay premium in water supply, sewerage services, waste management, etc. of around DKK 3-6 (2-3 per cent) an hour, including pension. At the same time, however, it is concluded that, on average, this is lower than in electricity, gas and heating supply. Copenhagen Economics (2017) *Lønniveau i forsyningssektoren* (Pay level in the utilities sector).

2.6 Existing, documented technological development in the sector's assets

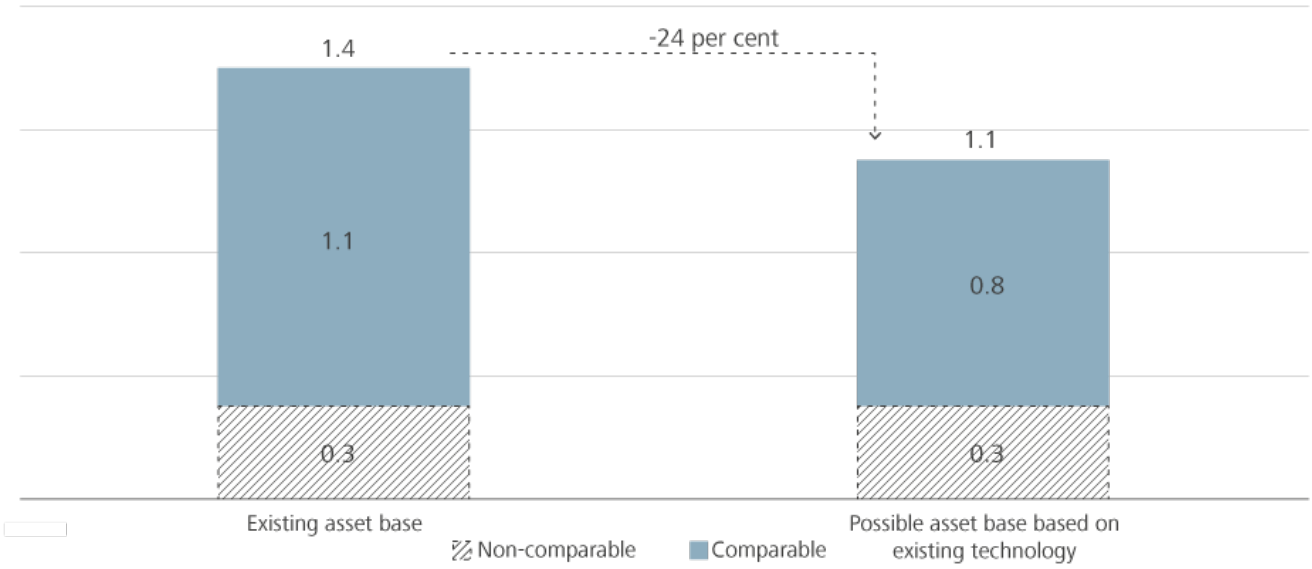
Technology is constantly developing. Methods that were previously state of the art are now widely used. In this process, purchase prices of new assets decrease due to productivity improvements in manufacturing, for example as a consequence of international division of labour and technological development.

With increased use of the technologies that are already available in the current market for water technologies, we find a potential in the drinking water sector of around DKK 300 million annually, see Figure 2.7. This is identified by comparing the costs of the companies' current asset base with the cost they would have incurred if the companies had the most efficient assets that are available today. This is equal to about 21 per cent of the annual depreciation of the water companies' assets, which amount to around DKK 1.4 billion. The method is described in Box 2.5.

Figure 2.7 **Annual cost reductions in the drinking water sector of around DKK 300 million through use of new technology in assets**

Annual depreciation of asset base with the companies' current assets and available assets

DKK billion, 2019 prices



Note: Rounded to the nearest hundred million. The left column shows the water companies' annual depreciation calculated by comparing the current assets of all large water companies. Estimated acquisition prices and expected useful lives have been taken from the price and useful life catalogue, see https://www.kfst.dk/vejledninger/kfst/dansk/2016/pris-og-levetidskatalog-for-vandforsyning-og-spildevand/. The annual depreciation of the total current assets is calculated on this basis. This is a measure of the companies' annual costs of their current assets. The right-hand column also shows the companies' current total assets, but where acquisition prices and expected useful lives have been estimated in the technology catalogue for drinking water.[45] The technology catalogue is 11 years more recent than the price and useful life catalogue and shows that technological development for 2009-2020 has led to lower prices of the companies' assets. Some assets have not been comparable across the price and useful life catalogue and the technology catalogue. This is the case for annual depreciations of a value of just under DKK 300 million.

Source: Own calculations based on the Price and Useful Life Catalogue (2009), the Technology Catalogue for Drinking Water (2020) and the companies' reports from 2019.

[45] Konkurrence- og Forbrugerstyrelsen (2020) *Teknologikatalog for drikkevand* (Danish Competition and Consumer Authority (2020) Technology catalogue for drinking water). Can be read here: https://www.kfst.dk/vandtilsyn/analyser/

Many assets still have a long useful life, and it is rarely optimal to replace assets prematurely. It is never optimal to replace all assets at once. This means that the full annual potential cannot be realised every year until 2030. The companies' annual reinvestments account for about 1.53 per cent of the total assets.[46] With this reinvestment rate, the efficiency potential of replacing assets with existing new technologies is of around DKK 50 million in the period 2020-2030.

Unlike for drinking water technology, the Danish Competition and Consumer Authority does not have a technology catalogue for waste water technologies. The efficiency potential from existing technology development in the waste water sector's assets is nevertheless estimated, although with greater uncertainty, to be DKK 250 million in the period 2020-2030. The efficiency potential from better utilisation of existing technology is thus expected to be higher for waste water companies as they have a larger asset base than water companies. In connection with the latest analysis, the waste water companies had about 5.5 times as high capital costs as water companies. The potential in the waste water sector has thus been calculated based on the possible cost reduction in the water companies and on the waste water companies having a somewhat larger asset base. This estimate is subject to considerable uncertainty.[47]

The potential cost reductions can be realised in line with the companies continuously replacing their assets. For the water companies, this includes the following assets:

» **Pipes:** In the past, eternit pipes and cast iron pipes have previously been used to transport drinking water. These pipes cost around DKK 1,400 per metre in replacement value, according to the price and useful life catalogue.[48] When these pipes are to be replaced, they are nearly always replaced with PE plastic pipes, which cost around DKK 440 per metre. This gives a cost reduction of around 68 per cent. In addition, PE plastic pipes have a longer expected useful life because they are more flexible in the joints instead of breaking.
» **Filter systems, open filters:** A filter system with a capacity of 200 m^3 water per hour cost around DKK 14,000 in 2009. Today, the price is down to just over DKK 8,000. This is a cost reduction of around 43 per cent.
» **Pumps:** The price for pumps was about DKK 2,300 per m^3 water per hour in connection with the price calculation in 2009, see the price and useful life catalogue.[49] Today, the price is around DKK 1,750 per m^3 water per hour. This is a cost reduction of around 25 per cent.

Due to a lack of data, the derived cost reductions on operation and maintenance of the new assets have not been included. Nor does the calculation include the cost reductions from technologies that make previous assets redundant.

New technology has not only made the water companies' assets less expensive. There has also been a quality improvement on a wide range of points to the benefit of the environment, health and general sustainability. For example, water pipes are today made of PE plastic, which has extended the useful life, reduced the risk of breakage, reduced the risk of penetration of foreign substances and resulted in cleaner combustion when discarded. Another example is the phasing-out of oxygenation stairs in favour of closed systems with a lower pollution risk.

[46] Konkurrence og Forbrugerstyrelsen (2018) *Totaløkonomisk benchmarking for drikkevandsselskaber* (Danish Competition and Consumer Authority (2018) Total economic benchmarking for water companies)
[47] The technology catalogue for waste water has not yet been prepared
[48] Calculated as the average of pipes with a diameter between 110 and 250 mm.
[49] Calculated as an average across four size ranges of pumps

Box 2.6
Method for determination of efficiency potential in ongoing replacement of asset base with more recent technology

The total possible cost reduction is calculated as the difference between the annual depreciation if all large water companies (with a charged water volume above 800,000 $m^{3)}$ replace their current assets with assets currently available on the market. Many of the assets used by water companies have today been overtaken by newer products, which are either less expensive or better or both. The efficiency potential of existing, documented technology development in the assets of the sector has been calculated based on the companies' ongoing reinvestment in new assets, by which the possible cost reduction is achieved on a continuous basis.

Based on the companies' reporting of assets in connection with the benchmarking in 2019, an overview has been created of the total asset base in the drinking water sector. We use this asset base as a basis for the analysis.

For each asset in the current asset base – as stated in accordance with the categories in the Price and Useful Life Catalogue (POLKA) – we have found the best alternative currently available. The technology catalogue for the drinking water sector is used as a basis. The technology catalogue provides an overview of the technologies currently available on the market and indicates both the acquisition price and the operating and maintenance costs of the different technologies. However, operating and maintenance costs are disregarded in this analysis, as this information is not available in POLKA.

We have calculated the difference in annual depreciation by switching to the latest technology for each asset. The annual depreciation is a measure of the companies' annual costs connected with having invested in the given asset base.

An annual cost reduction of DKK 0 has been assumed for those assets in POLKA for which there is no comparable asset in the technology catalogue. This may be because the type of assets is no longer installed, but is still used. This means that the annual depreciation is assumed to be unchanged. An example of such an asset is oxygenation stairs, which are no longer installed, but which are still used in the water companies. A cost reduction of DKK 0 has also been assumed for assets calculated in one unit in POLKA and a non-comparable unit in the technology catalogue. Both assets that are no longer installed and assets without comparable units are included in Figure 2.7 as non-comparable assets.

The annual depreciation of each asset in POLKA and the technology catalogue has been calculated by multiplying the companies' total quantity of the asset with the unit price of the asset and dividing it by the life of the asset.

The total efficiency potential for the period 2020-2030 is calculated based on the companies' expected annual reinvestment of 1.53 per cent of their total assets. This means that they realise 1.53 per cent of the total possible cost reductions each year.

2.7 Productivity development up to 2030

Towards 2030, there will be continued general productivity development in society. The development becomes visible in higher quality and/or lower prices on markets exposed to competition. Without economic regulation, monopolistic markets such as the Danish water sector where the companies operate, will probably not keep up with this development, and consumers and undertakings will therefore miss out on the benefits of the development in productivity.

It is assumed that the productivity development in the industry can be seen as a reasonably central indication of the productivity development that must be expected of an efficiently run water sector. We estimate that there will be an efficiency potential of around DKK 1.6 billion from the productivity development in the total water sector towards 2030. The potential is divided into around DKK 1,250 million in the waste water sector and DKK 350 million in the drinking water sector. The calculation includes that the companies' costs are expected to in-

crease as a result of new tasks, for example better groundwater protection, increased environmental requirements, extensions of supply areas, etc. New tasks are financed by supplements that increase the companies' revenue caps equal to the costs.[50]

The productivity development towards 2030 has been estimated based on the average development in the total factor productivity in the period 2007-2016, see Box 2.7.

Box 2.7
Method for determination of efficiency potential up to 2030

We use the period 2007-2016 as a basis for the assumed productivity development up to 2030. We have used the total factor productivity development in the industry as a basis.

The average total factor productivity development in the industry for the period 2007-2016 is around 1.4 per cent, while it is 1.7 per cent for the period 2006-2015.

The companies' actual total costs (excluding non-impactable costs of approx. DKK 3 billion) are around DKK 11.5 billion in 2018, and expected supplements in the period 2020-2030 are around DKK 1.5 billion. With an assumed productivity increase of 1.4 per cent, the potential from the productivity development is thus around DKK 1.6 billion. It is assumed here that, going forward, the development in supplements is equal to the course in the period 2011-2019. On average, the water companies received average supplements of DKK 44 million per year in this period, whereas the waste water companies received average supplements of DKK 69 million per year. It has also been taken into account that the other sub-potentials also reduce the expected cost base over the period 2020-2030.

[50] See Konkurrence- og Forbrugerstyrelsen (2019) *Udviklingen i den danske vandsektors økonomi, 2010-2019* (The Danish Competition and Consumer Authority (2019) Development in the economy of the Danish water sector, 2010-2019), where the supplement mechanism has been described and the development since 2010 has been analysed.

Chapter 3
The current regulation cannot achieve the full efficiency potential

Box 3.1
Main conclusions

Chapter 3 – The current regulation cannot recover the full efficiency potential

» The current regulation is expected to recover around DKK 3.0 billion in the period 2020-2030, which corresponds to about 78 per cent of the identified potential.

» The decided introduction of, among other measures, flexible revenue caps and rate of return caps from 2022 is expected to have a positive effect on the recovery of the potential. However, this will depend on the final models.

» Four new measures are recommended that can contribute to recovering the efficiency potential that cannot be recovered with either the current or future politically decided regulation.

3.1 The current regulation is likely to recover most of the potential

The current regulation is expected to recover DKK 3.0 billion in the period 2020-2030, see Table 3.1. This is equal to around 78 per cent of the total potential of DKK 3.9 billion. The remainder is not expected to be recovered with the current regulation. The method for calculating the recovery of the potential with the current regulation is described in Box 3.2.

If the general efficiency requirement is lower at a stable level in the future as a result of the new method for laying down the requirement, less than the 78 per cent will be recovered.

Table 3.1 **The current regulation will recover 78 per cent of the potential**

	Waste water *in DKK billion*	**Drinking water** *in DKK billion*	**The total water sector** *in DKK billion*
Total economic framework 2019	10.2	4.8	15.0
Expected efficiency requirements 2020-2030	2.3	0.7	3.0
Efficiency potential 2020-2030	3.1	0.75	3.85

Note: The table shows the current overall economic framework and efficiency potential for water and waste water companies (rounded to the nearest hundred million).

Source: Own calculations

Box 3.2
Recovery of the efficiency potential under the current regulation

The current regulation lays down two types of efficiency requirements for the companies: General and individual requirements.

Calculation of general efficiency requirements

The current method for fixing the general efficiency requirement differs across company sizes.

» *Small companies (200,000-800,000 m³ charged water annually):* The general efficiency requirement for these companies is 1.7 per cent of the financial revenue cap excluding non-impactable costs. Non-impactable costs are costs that the companies are not regarded as being able to influence and which are consequently not affected by efficiency improvements.
» *Large companies (over 800,000 m³ charged water annually):* The general efficiency requirement for these companies differs across the companies' operating costs and capital costs. For operating costs (OPEX), the general efficiency requirement is set at 2 per cent, while the efficiency requirement for the companies' capital costs (CAPEX) is set on the basis of a weighted five-year average of the hourly productivity development in the building and construction industry (weighted 70 per cent) and in the market economy (weighted 30 per cent).

When calculating the recovery of the efficiency potential, a general requirement is set for a CAPEX of 1.65 per cent per year for large companies. The requirement is based on a geometric average of the productivity development in the period 2009-2018. The estimated general requirements for the period 2020-2030 are subject to uncertainty as the future productivity development is unknown.

Calculation of individual efficiency requirements

The individual efficiency requirements are set by benchmarking analyses and they only apply to large companies (over 800,000 m³ charged water per year) until 2022. Individual requirements set for those companies that are less efficient than the most efficient companies or that have revenue caps that exceed their costs. Two methods are used to calculate the companies' relative efficiency: a DEA model and an SFA model. When laying down the individual requirements, the method that gives the companies the best score is used for each company. Other things being equal, this leads to lower requirements for the companies than if only one single model was used. This is consequently a prudence consideration.

The average individual efficiency requirements across the companies are 0.92 per cent for water companies and 0.85 per cent for waste water companies. This is calculated on the basis of benchmarking of the water companies in 2018 and the waste water companies in 2019. The average individual efficiency requirements take into account that the backlog estimated in the benchmarking models must be recovered over a period of eight years and that each company's annual individual efficiency requirement must not exceed 2 per cent.[51] The assumption is that the average individual efficiency requirements will be set throughout the period 2020-2030. The reason for this is that, historically, there is no indication that the individual requirements are reduced over time. This may be a consequence of the most efficient companies (the so-called 'front') continuously implementing measures that increase their efficiency, thus widening the gap to the less efficient companies on an ongoing basis.

The current regulation adopts a number of prudence considerations when setting the individual requirements. These include that the individual requirement must constitute maximum 2 per cent of the revenue cap, that each company's best score from two different benchmarking methods is used and that the companies' age and each company's geographical distance between customers are taken into account. In addition, a thorough check is performed of whether each front company is representative as a benchmark for the rest of the sector.

Two groups of companies are excluded from the analysis of the recoupment of the efficiency potential in the water sector. *Firstly,* companies that charge less than 200,000 m³ water per

[51] Section 6(5) of the Danish Water Sector Act

year are excluded. The reason for this is that these companies are regulated solely based on a self-sustaining breakeven principle. The current revenue cap regulation therefore does not lay down any requirements for these companies. *Secondly,* consumer-owned companies that charge 200,000-800,000 m^3 water per year are excluded. The reason for this is that these companies may choose to be exempt from regulation from 2021. This concerns 86 per cent of the water companies (80 per cent of the revenue caps) in this size group. The waste water companies are all municipally owned.

The calculation of the recovery of the efficiency potential also takes into account that supplements to the companies' revenue caps are granted in the period 2020-2030. The current regulation also lays down efficiency requirements for the supplements. It is assumed that the average supplements follow the historical development. In the period 2011-2019, average annual supplements of DKK 44 million were granted to the water companies' revenue caps and DKK 69 million to the waste water companies' revenue caps.

3.2 Politically decided measures are expected to increase the recovery of the potential to some degree

Depending on the actual implementation, the politically decided changes to the regulation that are expected to enter into force in 2022 may potentially increase the recovery of the efficiency potential to some degree.[52]

1. **Introduction of individual requirements for small companies:** Companies that charge 200,000-800,000 m^3 water per year will be benchmarked from 2022. However, from 2020, small consumer-owned companies may choose to withdraw completely from economic regulation. It is therefore assumed that, in future, only benchmark-based individual efficiency requirements can be made for small municipally owned companies

2. **Introduction of flexible revenue caps:** The introduction of flexible revenue caps from 2022 means that, after each regulation period (i.e. every four years), the companies' revenue caps must be reduced to their average actual costs, but that the revenue caps may also be adjusted upwards based on a number of criteria. A final model for flexible revenue caps has not yet been established. However, it is expected that the flexible revenue caps will reduce the regulatory profit in the water sector.

3. **Introduction of rate of return caps and WACC in the regulation:** The introduction of rate of return caps may potentially increase the recovery of the efficiency potential, as this is expected to lead to a higher degree of loan financing among the companies. This means that, in the short term, the companies can reduce the current water rates, as they do not have to let their current consumers pay for future investments through equity capital provisions. The purpose of introducing rate of return caps and WACC (*Weighted Average Cost of Capital*) in the regulation is therefore to ensure a better distribution between loan financing and equity capital financing in the water sector. At the same time, however, the rate of return cap also increases the companies' ability to charge a higher price. Therefore, the measure must be seen and implemented in close connection with the introduction of flexible caps.

[52] Stemmeaftale om justeret økonomisk regulering af vandsektoren (2018) (Voting agreement on adjusted economic regulation of the water sector (2018)), https://www.kfst.dk/media/54111/justeret-oekonomisk-regulering-af-vandsektoren-22112018.pdf

3.3 Four recommendations for new measures that can contribute to realising the full potential

In addition to the measures that have already been adopted politically, there is scope for improving the regulation and realising a greater share of the estimated efficiency potential in the water sector – including parts of the potential that have not been included in the estimate. The assessment is that the recommendations can be implemented with full consideration for the green transition, high security of supply, high customer service and continued technology development.

1. **New and stronger incentives for consolidation.** The current regulation provides relatively weak incentives for consolidation – and some regulatory conditions may act as barriers. It is therefore recommended that previous analyses and recommendations should be reviewed and that a supplementary analysis should be made of further opportunities for and barriers to consolidation. It is also recommended that the municipalities be obliged to examine possible benefits and costs of consolidations of municipal water companies.

2. **A higher threshold for efficiency requirements.** The current benchmarking-based, individual efficiency requirements for the least efficient companies – and for companies with revenue caps that exceed their costs – must not exceed 2 per cent per year, even though low efficiency suggests that the requirement should be stricter. In 2019, 13 per cent of waste water companies had an efficiency that warranted a higher individual requirement than 2 per cent. The figure is 14 per cent in 2018 for water companies charging over 800,000m^3 water a year. This means that consumers who are supplied by these companies currently have excessive water bills, which will remain too high in the coming years as a result of efficiency requirements that are too low. It is therefore recommended to raise the threshold for the maximum annual individual efficiency requirement.

3. **Better opportunity to avoid cross-subsidisation and excessively high settlements.** Reduced transparency due to scattered regulatory competence and unclear rules entail a risk of cross-subsidisation and that settlements in large utility groups are not made at arm's length prices. Both elements may lead to, or possibly conceal, excessive costs for consumers. It is therefore recommended to gather the supervisory obligation in one single authority and to introduce clearer rules that give the supervisory authority sufficient opportunity to ensure compliance with the rules on behalf of the consumers. It should be ensured in this connection that the supervisory authority can obtain all necessary information about the water companies' transactions – both internally with other companies in a group and externally, including with owner municipalities.

4. **Efficiency in consumer-owned water utilities.** Today, water utilities that charge less than 200,000 m^3 water are not subject to economic regulation. From 2021, this also applies to consumer-owned water utilities that charge less than 800,000 m^3 water and choose to withdraw from the regulation. All these utilities are consumer-owned and can charge tariffs at the cost level they themselves assess as appropriate. The incentive for cost effectiveness may thus be low, as the consumers as owners may, in effect, have difficulty in ensuring efficient operations. A general efficiency requirement for these water utilities could be made in a simple way that is easy to administrate – for the benefit of the consumers and undertakings that are supplied by small, consumer-owned water utilities. A general efficiency requirement can only recover a minor share of the efficiency potential in these water utilities, but it could encourage consolidations and thus lower overall costs. There are currently just over 2,000 small water utilities in Denmark. It is recommended that an analysis be made of how a simple regulatory model can be designed and what a lower limit for this could be.