Annex III

Housing Committee 2009-10
B 38 Appendix 4
Public

ERHVERVS- OG BYGGESTYRELSEN

Report

Working group on mandatory individual use of water meters

September 2010

Working group on mandatory individual use of water meters

Contents:

1 Terms of reference, composition and work of the working group

In many multi-occupancy properties, such as condominiums and rental properties, there are no water meters for measuring cold and hot water in each apartment, but a joint payment for the property's total water consumption. Many elderly pensioners and single people complain that they pay for their neighbors' water consumption. At the same time, the use of meters can lead to water savings that benefit the environment.

However, for existing buildings, the costs of establishing individual metering can be high. This is because the installations are sometimes designed so that up to seven meters must be installed in each apartment in order to measure the total consumption, as the pipes run across apartment boundaries. In addition, the water pipes are often hidden, so individual water meters will necessitate renovations. It is therefore important to map the cost level for different building types and the savings potential, so that it is determined how any requirement for individual water metering can be set so that it is profitable for the individual consumer.

In November 2009, the Danish People's Party proposed a parliamentary resolution on the mandatory use of water meters for hot and cold water in all multi-occupancy properties, including commercial properties and rental properties (B38). In its report of 16 March 2010, a unanimous Housing Committee decided that a working group should examine a number of issues in connection with a possible requirement for mandatory individual use of water meters for hot and cold water in all multi-occupancy properties.

1.1 Tasks of the working group

The working group is tasked with:

- Investigate the technical possibilities for measuring water, including developments since the introduction in 1996 of a requirement that new buildings must be prepared for the installation of meters for the purpose of individual measurement of water consumption.

- Investigate the economic consequences of mandatory individual water metering. This applies to the economic consequences for tenants and owners in both public buildings and private rental properties.

- Investigate the need for a possible change in rental legislation and building legislation before a possible requirement for measuring hot and cold water can be introduced in existing buildings.

- Clarify the distributional effects for a number of different representative and typical family types, including singles, in private as well as public rental housing. The interaction with different forms of housing benefit and taxes related to water consumption must be included in this context.

- Establish possible solution models for introducing requirements for individual metering of hot and cold water in new and existing buildings

based on the analyses carried out. This includes solutions for

possible exceptions to the provisions if it turns out that installing individual water meters is not profitable for the individual citizen.

1.2 Composition of the working group and submission deadlines

Danish Enterprise and Construction Authority	Dorothy Nøhr Andersen, Office Manager (chairman) Owner Jerking, Civil Engineer Martin Rasmussen, Special Consultant Marie Kring, Clerk
Ministry of Economic Affairs and Business	Ulrik Hyrup Mogensen,
Executive Director Danish Safety Technology Authority	Paul
Claudi Johansen, Civil Engineer	
Ministry of Finance	Scrooge Søndergaard Hansen, Chief Consultant
Ministry of Social Affairs	Annette Klint Kofod, Office Manager
Pensions Agency	Sophie Mørch, Clerk
Urban and Landscape Authority	Catharina Carstensen, Secretary,
Housing Companies' Association	Bent Madsen, CEO, ABF Jan
Hansen, Director	
The Danish Real Estate Association	Torben Christensen,
CEO.Director Jyske Grundejere	Keld Frederiksen, Chairman
DANVA[1]	Karin Larsen, Function Manager
Copenhagen Energy	Charlotte Storm, Water Saving Advisor ISTA
Denmark A/S	[2] Preben Jensen, Key Account
Manager TEKNIQ	Søren Rise, Chief Consultant
Kamstrup A/S [2]	Peter Fischer Jensen, Product Consultant

Secretariat: Danish Enterprise and Construction Authority

The working group has held four meetings.

1 DANVA is the interest organization for everyone who works professionally with water and wastewater supply.

2 ISTA Danmark A/S, which provides installation and reading of consumption meters, is appointed by DI Byggematerialer. Kamstrup A/S, which is a meter manufacturer, is appointed by Veltek, a trade association for plumbing and electrical suppliers.

2 Summary

Based on a resolution proposal from the Danish People's Party (DF) on the mandatory use of water meters for hot and cold water in all multi-occupancy properties, including commercial properties and rental properties (B38), the Housing Committee unanimously decided in its report of March 16, 2010, to establish a working group.

The working group has held four meetings. The working group included representatives from relevant ministries, industry organizations, metering companies and housing organizations.

2.1 Working group conclusions

Technical options

The working group concludes that it will be technically easy to install meters in new buildings. Furthermore, it will be relatively easy to install meters in properties built after 1997, as since 1 February 1997 there has been a requirement that water installations must be prepared for the installation of meters. A survey has shown that cold water meters have already been installed in 92 percent of the properties surveyed built after 1997 and hot water meters in 87 percent of the properties.

In many properties from before 1997, it will be more complicated to install meters. In many cases, in properties from before 1997, up to 7 meters will have to be installed in a residential unit.

In many properties from before 1997 – and in some cases also in newer properties – there may also be inconvenience and costs for the residents because the installations are not accessible. Depending on the age of the buildings, it may be necessary to incur greater or lesser follow-up costs so that the meters can be installed, e.g. in the form of drilling holes in shaft walls, dismantling kitchen elements, dismantling and reinstalling tiles in bathrooms and kitchens, etc.

As far as meter technology is concerned, there is good experience with the reliability of cold water meters. On the other hand, there is currently no experience with the reliability of hot water meters. According to current legislation, both cold and hot water meters must be replaced or sampled every 6 years, and only type-approved meters may be used. From 2016, the requirements for the reliability of meters will be tightened as a result of an EU directive.

Distributional consequences of setting up meters

The working group has calculated the distributional consequences of installing meters, see table 1. The results are calculation examples and may vary in both directions as explained in the report. It should be noted that consequential costs are not included in the table.

Table 1. Water saving and redistribution effects of installing meters – hypothetical example in a special property* (excl. follow-up costs), DKK per apartment per year.

	Changed expense (negative number = saving)					
Family type	Redistribution	Water saving (20%)	Installation on and operation	Total	Fall in housing benefit	Total
An adult	-2.671	-544	1,431	-1,784	396	-1.388
A pensioner	-3.095	-459	1,431	-2.123	2,568	445
An adult, a small child	-1.727	-908	1,431	-1.204	1,992	788
One adult, two small children	-345	-1.272	1,431	-186	2,268	2,082
Two adults, no children	-1.268	-1.087	1,431	-924	0	-924
Two adults, two small children	688	-1.812	1,431	307	0	307
Two adults, two teenagers	3,865	-2.447	1,431	2,849	0	2,849
Average	0	-1.421	1,431	10	803	813

* It is assumed that the property consists of 9 apartments, one of each of the 7 family types in the table, but two of each of the two family types with two adults and two children. The original distribution of water costs is assumed to be area-dependent, and the assumed housing sizes are 70 m2 for single adults, 80 m2 for the single adult with 1 child, 85 m2 for the single adult with two children and the adult couple without children, and finally 104 m2 for the adult couple with children.

Note: It is assumed that the water meters are replaced every 6 years. The installation costs are calculated for the installation of 7 meters per housing unit. The average water consumption rate of the water supply companies has been used. As far as housing benefit is concerned, it is assumed that families with two adults do not receive housing benefit.

As can be seen from the first column, a requirement for individual metering can have major redistributive consequences. Consumers with low consumption gain from individual metering, while consumers with high consumption lose. In this context, it is important to note that the distribution of family types in many properties will be more similar than is apparent from Table 1. If the distribution of family types in the property is more similar, the redistributive effects will be smaller for most people and the savings for the individual family will consequently be smaller.

The second column shows the savings from introducing individual metering. There is relatively good evidence that financial incentives affect water consumption. Therefore, it is assumed that all families will achieve an average of 20 percent savings on water consumption from introducing individual metering.

The installation and operating costs in the third column cover the installation of meters, ongoing reading and maintenance. The costs here are calculated for 7 meters per apartment in an apartment built before 1997. If only two meters are to be installed in the apartment, the price will instead be DKK 451 (as mentioned, excluding incidental costs).

When receiving housing benefit, a requirement for individual measurement and settlement of water costs could have consequences for the amount of housing

benefit, cf. the last two columns in Table 1. In the examples shown, housing benefit decreases when water costs are separated from the rent. When water costs are separated from the rent, according to current regulations, a fixed rent supplement per square meter can instead be paid to cover the water cost. However, in these calculations, the fixed supplement does not fully compensate for the loss of housing benefit.

Those who already have meters and separate water billing will generally not experience any consequences from the introduction of individual water metering.

Overall, the example in the table shows that the homes, on average and before including housing benefit, neither gain nor lose when measured individually. The redistribution effects are considerable in the example shown. A pensioner who does not receive housing benefit may gain when measured individually, but if he receives housing benefit, the result may be the opposite.

As mentioned, the calculations in Table 1 are an imaginary example in a specific property. It is important to note that a number of factors can lead to different distribution effects:

- Installation and operating costs do not include any subsequent costs for dismantling kitchen cabinets, etc. Estimates from the Danish Real Estate Association indicate that these costs can amount to between DKK 3,000 and DKK 80,000.
- Since the majority of water companies' expenses are fixed costs, lower water consumption may result in water companies having to raise tariffs. The tariff increases will affect all water consumers, including, for example, households in detached houses. When tariff increases are taken into account, households will on average lose out on the introduction of individual water metering.
- The example is based on a property with many different family types. In practice, many properties will be more uniformly composed. For example, many senior citizens' homes will be completely identical and almost all will be occupied by one pensioner. Here, the redistribution effects between the housing units will be significantly more limited and based only on differences in the habits of the individual residents.

2.2 Solution models

The working group's report sets out four solution models for the possible introduction of requirements for individual metering of hot and cold water in new and existing buildings based on the analyses carried out.

A) **No changes**. This means that new residential units and commercial units in multi-occupancy properties are prepared for meters, but it is the owner who decides whether meters should be installed. In existing buildings, meters are not installed unless the owner decides to do so (however, in rental housing, it is not the owner, but the tenants, who can decide to install meters). When installing new water installations in multi-occupancy properties, the installations must be prepared for individual metering, regardless of the age of the property.

B) **New construction.**Residential units and commercial units in new multi-occupancy buildings must in future have their consumption of cold and hot water measured. The same applies to the establishment of new water installations in existing multi-occupancy buildings.

C) **New construction and existing construction built after 1997.**Residential units and commercial units in new and newer multi occupancy buildings built after 1997 must have measured the consumption of cold and hot water. The same applies for the establishment of new water installations in existing multi-user properties from before 1997.

D) **All construction.**Residential units and commercial units in all multi-occupancy properties must have their consumption of cold and hot water measured.

Proposals B, C, and D could be advantageously combined with rules for exceptions, as there will always be examples of buildings where a requirement is not economically or technically reasonable. Possible rules for exceptions could include the need for more than 3 or 4 meters per housing unit, or installation costs (including follow-up costs) of more than DKK 3,000, 5,000, or 10,000 per housing unit.

If solution B or C is chosen, the number of cases where a possible exemption is relevant will probably be limited. If model D is chosen, many exceptions will be needed if users are not to be imposed large costs.

The exemption solution could either be a task for the municipalities, which are the building authorities, or a scheme where criteria are set for exemption from measurement, so that the owner can assess for himself whether a building can be exempted from measurement.

2.3 Societal consequences of individual meters

An actual socio-economic assessment of individual measurement has not been carried out in this report, but would have to compare the societal resource consumption for installation, operation and the residents' consequential costs with the societal resource savings.

In socio-economic calculations, the water savings will have to be valued corresponding to the variable costs of conveying and diverting water, rather than the current cubic meter rate, i.e. at around 12 DKK/m3 rather than 47 DKK/m3 as assumed in Table 1. The savings to society will therefore be significantly less than shown in Table 1.

However, the report and table 1 do not assess the environmental and resource benefits of reduced water consumption as a result of mandatory individual water metering. Implementation of the proposal will reduce water consumption throughout the country, while there is a large difference in the need for water savings from region to region. The proposal will reduce energy consumption for heating hot water and thus contribute to lower CO2 emissions.

2.4 Legislative consequences

A possible requirement for mandatory water measurement can be implemented by amending the Danish Business Authority's Executive Order No. 891 of 9 October 1996, and thus does not require an amendment to the Building Act.

If a general requirement for payment for water according to distribution meters is introduced in existing properties, it will, on the other hand, require a change in the Tenancy Act, as there is currently no legal basis for distribution meters to be installed without the residents' consent.

The proposal has no consequences for the Public Tenancy Act, the Commercial Tenancy Act, the Owner-Owned Apartment Act or the Cooperative Housing Act.

It should also be considered whether water meters should in future be subject to the requirement for mandatory VA approval if water meters become mandatory in multi-use properties.

3 Technical options

3.1 Metering options

The section deals with the technical possibilities of water meters. The current regulations on the installation of water meters and the Danish Safety Technology Authority's regulations on type approvals and inspection of water meters are described. Experience with the reliability of water meters, including the durability of the meters and the need for maintenance, is then described.

3.1.1 Current regulations on water meters

The applicable rules on the use of water meters are found in the Ministry of the Environment's executive order on payment for water according to measured consumption, etc. at property level, with subsequent amendments, and the Danish Enterprise and Construction Authority's executive order on individual metering of electricity, gas, water and heat, with subsequent amendments.

For meters installed in connection with the regulations in the Ministry of the Environment or the Danish Enterprise and Construction Authority's executive order, the Danish Safety Technology Authority's regulations on type approval, initial verification, conformity assessment, CE marking and ongoing monitoring apply.

Danish Environmental Protection Agency Executive Order No. 525 of 14 June 1996 on payment for water according to metered consumption at property level, with subsequent amendments

The executive order lays down the detailed rules on payment for metered consumption of cold water at property level. According to this executive order, since 1 January 1999, meters have had to be installed at property level on all properties connected to public water supplies, cf. section 3(3) of the Water Supply Act. The executive order does not concern a possible distribution of the water bill between residential units and commercial units in the individual property. The rules therefore do not concern the tasks specified in the terms of reference.

Danish Business and Construction Authority Executive Order No. 891 of 9 October 1996 on individual metering of electricity, gas, water and heat, as amended.

Pursuant to Section 4 A of the Building Act, the Executive Order sets out the requirements for the installation of individual meters. The Executive Order refers to Executive Order No. 525 of
June 14, 1996 on payment of water according to metered consumption at property level.

According to sections 6 and 7 of Executive Order No. 891 of 9 October 1996, as amended, water installations in individual residential or commercial units have since Preparations for the installation of meters for measuring the consumption of cold water were to be made on 1 February 1997 and preparations for the installation of meters for measuring the consumption of hot water were to be made on 16 July 1997. Likewise, in existing buildings, when new water installations are installed in buildings, preparations must be made for the installation of meters for measuring the consumption of cold and hot water in the individual residential unit or

commercial unit.

If meters are installed to measure cold and hot water, they must comply with the Danish Safety Technology Authority's regulations on water meters, according to sections 6 and 7 of Executive Order No. 891 of 9 October.

3.1.2 The Danish Safety Technology Authority's regulations on water meters

The Danish Safety Technology Authority's regulations for water meters can be found in the following executive orders:

Executive Order No. 436 of 16 May 2006 on the entry into force of the EC Directive on Measuring Instruments (MID) and on the designation of notified bodies
and
Executive Order No. 1034 of 17 October 2006 on metrological control of meters used for measuring the consumption of hot and cold water

In these two executive orders, the Danish Safety Technology Authority lays down rules regarding meters, including the rules regarding type approvals, where they may be used, and when they must be replaced.

In general, these two orders implement EU regulations on cold and hot water meters used in households, commercial environments and light industry. Therefore, no other technical rules on cold and hot water meters can be laid down, as this would constitute a technical barrier to trade.

Type approvals and checks of meters in use
Based on the two executive orders, type-approved meters must be used where there is a requirement to measure hot or cold water. Furthermore, rules are laid down for how meters in use must be checked.

The basis for type approvals of water meters is changed by the EC Directive on Measuring Instruments (MID Directive) and Executive Order No. 436 of 16 May 2006, however with a transitional period until 2016. Meters with valid type approvals do not have to be type approved according to the new rules before 2016. Meters that are type approved after 2006 must be approved according to the provisions of the MID Directive.

The technical difference between the requirements for water meters in the MID Directive and the older EU Directives is primarily that the older EU Directives do not cover electronic meters. In addition, the MID Directive imposes increased requirements on the insensitivity of the meters to the design of the installation in which the meter is placed, so that pipe bends may not be placed immediately before or after the meter if this affects the measurement result in the form of so-called flow disturbances.

Flow disturbances can cause the meters used today to not measure correctly, but to either measure too much or too little. This may therefore mean that with the new type approval a straight piece of pipe must be established on each side of the water meter, so that a longer inlet length can prevent flow disturbances. It is not clear how long this straight piece of pipe should be, as it largely depends on the quality of the meter. It may be possible to use a more expensive/better meter alone in places where it is not possible to establish a straight piece of pipe before and after the meter.

The design of the installation with flow disturbances is thus part of the basis for type approval of meters according to the MID directive. The type approval must protect

against incorrect measurements and indicate how the individual meter must be installed to ensure correct measurement.

According to the MID Directive, type approval will be indicated by the CE marking and a supplementary metrological marking. These are affixed by the manufacturer.

The rules for how meters in use must be checked stipulate that the owners of the meters (the water utility / hot water supplier3) must either replace their meters every 6 years or carry out statistical checks to see whether the meters continue to measure correctly. The check measurements must start no later than the 6th year of use, but the service life can be extended as long as the meters measure correctly.

If the proposal for mandatory individual metering of cold and/or hot water is introduced by an amendment to the Executive Order on Individual Metering of Electricity, Gas, Water and Heat, these meters will be covered by Executive Order 1034 without the need for amendment. As described, the new type approval rules, based on the MID Directive and Executive Order 1034, will finally come into force in 2016. This will mean that all meters must be CE marked, and that straight pipe sections must therefore be established before and after the meter, or that more expensive/better meters must be used.

The metering companies in the working group have stated that none of the small vane meters frequently used today are type approved according to the MID directive. There is therefore no concrete knowledge yet as to whether these meters can still be used or whether there will be a need for other meter types. However, the metering companies estimate that any additional costs will not exceed DKK 0-100 per meter in 2016.

3.1.3 Experience with reliability of water meters

As described above in section 2.1.2, owners of meters in use must either replace their meters every 6 years or carry out statistical checks to see whether the meters continue to measure correctly. If the meters are to be used in future to determine how much the individual will pay in water bills, it is, however, very important to assess the experience of whether the meters also measure correctly during the 6-year period.

Reliability of cold water meters

There is a lot of experience with cold water metering, as it was already required in 1996 that water utilities should carry out random checks or replace their own meters. In 1996, the deadline for this random check or replacement was 8 years. This proved to be too long a period, which is why it was reduced to 6 years in a subsequent review in 2007. The Danish Safety Technology Authority does not yet have sufficient experience to be able to decide whether 6 years is sufficient or whether replacement should possibly take place at a shorter time interval.

Reliability of hot water meters

There is no similar Danish experience with measuring hot water, as it is only in multi-tenant buildings that it may be relevant to measure the consumption of hot water. This is because the heating of hot water most often takes place centrally in

3 Hot water suppliers can be housing associations, condominium associations and other building owners. In addition to actual water works, water utilities

also depend on the design of the water installations, including housing associations, condominium associations and other building owners.

multi-occupancy buildings. There are only a few buildings with production of hot water in the individual residential unit in multi-occupancy buildings.

The Danish Safety Technology Authority has been in contact with all the laboratories accredited for the inspection of water meters. However, none of these have experience with the inspection of hot water meters. On this basis, the Danish Safety Technology Authority cannot comment on whether hot water meters are reliable for 6 years, so for the time being the directive's requirement for replacement or random inspection every 6 years must therefore be applied.

The hardness of the water affects how long meters show correct readings.
The chemical composition of the water and the content of minerals etc. varies greatly from water well to water well and from waterworks to waterworks. Water hardness is measured in °dH and varies from 5 – 30 °dH. The hardness of the water can affect how long a water meter shows the correct reading. It is therefore likely that there may be significant differences in how long a water meter shows the correct reading depending on differences in the composition of the water and thus differences from region to region.

The Danish Safety Technology Authority has carried out a small survey based on random checks of ordinary vane meters for measuring cold water. The survey is based on a division of the country into 9 parts based on postal codes. The survey shows a difference, as 32-33 percent of the meters checked in North Jutland and on Funen did not meet the requirements after the first inspection period, which at the time of the survey was 8 years. In West Zealand, Lolland, Falster and Møn, only 14 percent of the meters did not meet the requirements after the first period. On average, 3/4 of the meters passed the first inspection period, while less than ¼ passed the second inspection period.

Table 2. Geographical differences in the reliability of cold water meters after 8 and 16 years old.

Postal codes	Passed the first test Percentage	Passed at 2nd check Percentage
0000 - 2999	-	-
3000 - 3999	77	22
4000 - 4999	86	13
5000 - 5999	67	16
6000 - 6999	81	6
7000 - 7999	83	16
8000 - 8999	83	33
9000 - 9999	68	27

Source: Danish Safety Technology Authority

Investigation of flow disturbances
In June 2010, Flowcenter Denmark (FORCE Technology and the Danish Technological Institute) began an analysis of the importance of installation conditions for whether the meters show the correct reading. They state that there is an example of a property having its meters replaced, after which the measured consumption increased by 40 percent. However, it turned out that the new meters

were installed with a short inlet section, which caused major flow disturbances. When the new meters were installed with a long inlet section, the measured consumption fell to the previous level.

The study is conducted with five different meter makes/principles, and two commonly used meter sizes are examined.

The first results from the laboratory tests are expected in the fall of 2010. The project will be completed in mid-2011.

3.2 Technical possibility for setting up meters

The options for installing meters depend on the design, condition and location of the water installations in the individual building and the metrological requirements for the meters. The technical options for installing water meters in different building types are reviewed below.

3.2.1 Cold water installation

New buildings

Installation of cold water meters in connection with new construction can be carried out without technical complications. The individual residential and commercial units will normally be supplied with water at a point from which it is distributed to the unit's taps, mixers and cisterns. This means that the consumption of cold water can be measured with meters as the only additional cost.

Existing buildings constructed after February 1, 1997

As mentioned, for buildings that have received a building permit after 1 February 1997, there is a requirement that the water installation must be prepared for the installation of meters for measuring the consumption of cold water.4

The guidance attached to the requirement states how this preparation can be done so that the installation simply involves inserting the meters. Installation of meters should therefore be possible without technical problems.

Since 1997, 5,065 apartment buildings with 67,127 residential units have been built. In addition, there are 38,130 terraced houses. However, for new terraced houses, they generally have their own heating supply with district heating or their own gas boiler and their own water connection. They therefore already have metering of water consumption and energy consumption.

There has been uncertainty about the preparation that, according to Executive Order No. 891 of 9 October 1996, has to be made in new buildings, also in practice implies that meters can be easily established without significant costs. Therefore, the Danish Business and Construction Authority has had a small study of this carried out in connection with the work of the working group. The study is based on an extract from the BBR of the properties built after 1997. The study includes apartment buildings and terraced houses, a total of 93 properties.

The study showed that 92 per cent of the properties surveyed are already equipped with meters to measure the cold water in the individual residential or commercial unit. 3 per cent are prepared for the installation of meters and the remaining 5 per cent are not prepared for this. The 5 per cent that are not prepared for water meters thus do not meet the requirements of Executive Order 891 of 9 October 1996. See also Appendix 2.

4 See Danish Business and Construction Authority Executive Order No. 891 of 9 October 1996.

The study also assessed whether it is possible to install a straight pipe section before and after the meter of 250 mm, if the MID directive's requirements for the reliability of meters in the finished installation make this necessary. Only in 12 per cent of the properties are the individual meters installed according to this principle. However, conversion can be done as pure plumbing work in 97 per cent of the cases studied, which is why installation of meters will continue to be relatively easy.

In this connection, it should be emphasized that it is far from certain that the MID directive will require the installation of a 250 mm straight pipe section on each side of the meters. Often, it may be a shorter pipe section, or the problem can be solved by choosing a different meter type.

In only 3 percent of the properties did the study show that there is a need to demolish fixtures, shaft walls, and the like to gain access or the necessary space to place the meters.

High inbuildings

In 1992, the Minister of Housing established the "metering committee", which in 1995 submitted its report 1286. This report assumes that there have been no significant changes to the existing buildings since 1995. Many apartments have been modernised since 1995 and have in this connection received new kitchens and bathrooms, but in the vast majority of cases, experience has shown that the existing pipework has been retained. In many cases, however, it can be expected that in connection with the establishment of new kitchens and bathrooms, access to pipework where any meters are to be installed has been blocked. This can therefore be expected to entail costs for demolition and re-establishment.

The water installations in the older buildings are described in more detail in the Meter Committee's report (Appendix 5). The information below is taken from the report from 1995.

The housing census as of January 1, 1993 shows that there are 938,709 apartment buildings.

For apartment buildings built after 1960 (approximately 325,000 homes in 1993), the installations are often located in shafts. Some of these shafts are only equipped with a small inspection hatch, which cannot be used for the installation of meters. Here it is necessary to make holes in the shaft wall, which can be made of masonry or lightweight concrete. Many shafts are also so small that the placement of meters is not possible.

For properties built before 1960 (approximately 615,000 homes in 1993), installations were often supplied from risers across apartment boundaries. Here, metering at each tap point, i.e. at each tap and cistern, is the only option.

Based on telephone interviews, the metering committee estimated that, as a general rule, there was no individual metering of cold and hot water consumption in apartment buildings.

Therefore, the Metering Committee's report in 1995 concluded that the predominant option for installing meters in existing properties is meters on

the individual tap point (tap, shower or cistern). The measurement of cold water consumption can thus be done with 1-4 meters per housing unit depending on the existing installations. The costs of installing meters will depend on whether the water installation is accessible or whether the pipes are hidden.

3.2.2 Domestic hot water installations

New buildings

Hot water installations are equipped with circulation to ensure that the individual The user has hot water available without the entire pipe system having to be emptied of cold water first5. Individual metering of hot water consumption means that metering must take place after the circulation connection. This can be easily established in new buildings, where each home or business unit is typically supplied with hot water at one point, after which the water is distributed with separate pipes to the individual taps and mixers. This allows the consumption of hot water to be measured with a meter.

Existing buildings constructed after July 16, 1997

In existing buildings that have received a building permit after 16 July 1997, the Danish Business and Construction Authority's executive order requires that the water installation must be prepared for measuring hot water. The associated guidance explains how this can generally be done with a meter for the hot water per residential unit or commercial unit.

Since 1997, 5,065 apartment buildings with 67,127 residential units have been built. In addition, there are 38,130 terraced houses. However, for new terraced houses, they generally have their own heating supply with district heating or their own gas boiler and their own water connection. They therefore have metering of water consumption and energy consumption.

There has been uncertainty about the preparation that, according to Executive Order No. 891 of 9 October 1996, has to be made in new buildings, also in practice implies that meters can be easily installed without significant costs in these buildings. Therefore, the Danish Business and Construction Authority has had a small study of this carried out in connection with the work of the working group. The study is based on an extract from the Danish Building and Construction Register of properties built after 1997. The study includes apartment buildings and terraced houses, a total of 93 properties.

The study showed that 57 per cent of the properties surveyed are already equipped with meters to measure the hot water in the individual residential or commercial unit. 30 per cent of the buildings surveyed have their own hot water production in the individual residential and commercial unit. This is because the BBR extract and thus the study also includes newer terraced houses. Here, the total water consumption for each terraced house is measured with a cold water meter. 13 per cent are not prepared for the installation of meters. The 13 per cent that are not prepared for water meters do not meet the requirements of Executive Order 891 of 9 October 1996. See also Appendix 2.

5 Building Regulations, Executive Order No. 1353 of 17 December 2008 on the publication of Building Regulations 2008 (BR08), Chapter 8.4.2.2, Subsection 2

The study also assessed whether it is possible to install a straight pipe section before and after the meter of 250 mm, if the MID directive's requirements for the reliability of meters in the finished installation make this necessary. Only in 14 per cent of the properties are the individual meters installed according to this principle. However, conversion can be done as pure plumbing work in 97 per cent of the cases studied, which is why installation of meters will continue to be relatively easy.

In only 3 percent of the properties did the study show that there is a need to demolish fixtures, shaft walls, and the like to gain access or the necessary space to place the meters.

Older buildings
As in the section on cold water, this is based on Appendix 5 of the Meter Committee's report from 1995. Similarly, as in the section on cold water, it is expected that many apartments have been modernized, but that this has not had any impact on the original piping. In most cases, kitchens and bathrooms have subsequently been installed. This means that the piping will today be hidden in many places. This may result in additional costs in connection with the installation and establishment of water meters.

Based on telephone interviews, the Metering Committee assessed in 1995 that, as a general rule, there is no individual metering of hot water consumption in apartment buildings.

Here, the hot water installations in buildings from before 1960 are typically carried out according to the same principle as the cold water installations with risers to the bathroom and kitchen. In buildings after 1960, there are typically one or two shafts per housing unit from which the hot water installations are led.

Therefore, the Metering Committee concluded in 1995 that the predominant option for establishing metering was water meters at the individual tap point. However, metering can be carried out with a meter in properties where the residential unit or commercial unit is supplied from one shaft. Metering of hot water consumption can thus be done with three, two or one meter. The costs of installing meters will depend on whether the water installation is accessible or whether the pipes are hidden.

3.2.3 Corrosion of water meters in new pipe systems

Corrosion is the unintentional breakdown of metals under the influence of water and oxygen. The composition of certain materials in water installations can lead to problems with corrosion. According to SBi instruction 227 “Corrosion in plumbing installations”, in recent years there has been a sharp increase in the number of damages to brass valves and unions on water meters, which have corroded after a short number of years in areas with hard water with high conductivity.

Corrosion can be prevented relatively easily by taking into account the composition of materials in water installations and their chemical properties.

When installing water meters, care must therefore be taken to ensure that the newly installed meters do not contribute to increased corrosion in the water installation.

It must be ensured that the water meter does not corrode due to the pipe materials of the water installation.

If requirements are set for mandatory individual use of water meters in multi-tenant properties, efforts must also be made to provide information about this.

3.2.4 Exemption from VA approval

A VA approval is a Danish approval scheme for products in contact with drinking water, which is intended to ensure that the health requirements for the quality of Danish drinking water are met, e.g. the limit value for lead, cf. the Ministry of the Environment's Executive Order No. 1449 of 11 December 2007 on water quality and supervision of water supply systems (the Drinking Water Executive Order). The Danish Urban and Landscape Authority is the Danish authority for drinking water. Thus, a construction product must have a VA approval if it is part of or connected to a water installation6. The VA approval is issued by the Danish Business Authority at ETA-Danmark A/S. A VA approval is valid for three years, after which it must be renewed. In particular, water meters are exempt from VA approval.

The Danish Urban and Landscape Authority and the Danish Enterprise and Construction Authority have not so far required that water meters in a building should be VA-approved. This is because the content of, for example, plastic softeners in a water meter has been minimal in relation to the amount of substances harmful to health that it can contaminate with drinking water. It has therefore been assessed that the health requirements for the quality of drinking water would be complied with. In addition, none of the other European countries require that water meters must be approved. It is therefore currently voluntary for a manufacturer to have water meters VA-approved. According to ETA Denmark, a number of companies currently use voluntary VA-approval of their water meters.

If it is decided that water meters should be mandatory in multi-occupancy buildings, it will mean that there will be a larger market for different types of water meters in Denmark than is the case today. This means that some of these types of water meters may contain several substances that mean that the health requirements for the quality of Danish drinking water are not met.

Against this background, it should be considered whether water meters should in future be subject to a requirement for mandatory VA approval if water meters become mandatory in multi-occupancy properties. Any requirement for VA approval of water meters should apply regardless of the building type.

6 BR08, chapter 8.4.1, paragraph 6

4 Economic consequences

The section describes the financial consequences for residents of establishing individual metering of cold and hot water. The installation and operating costs are compared through a number of calculation examples with the redistribution of the water bill in a property and the expected water savings. Factors that cannot be easily measured are also discussed. The regulatory basis for the distribution of water costs is initially described.

4.1 Rules for the distribution of expenses in different types of housing

The applicable rules for the distribution of costs for water consumption and the installation and operation of meters in different types of housing are found in the Tenancy Act, the General Tenancy Act, the Commercial Tenancy Act, the Cooperative Housing Act and the Ownership of Apartments Act.

Ministry of the Interior and Social Affairs Executive Order No. 989 of 7 October 2009 of the Rent Act

If it is the landlord who supplies water to the home according to the agreement, that is, it is not the tenant who has a direct contractual relationship with the water utility, the main rule today is that the tenant pays for water in addition to the rent.

If a property is transferred to pay for water according to consumption meters, it follows from section 46 j, subsection 3 of the Tenancy Act that the costs for this are considered an improvement that can be included in the rent as an improvement increase.

In properties covered by the Housing Regulation Act's rules on cost-based rent, the water tax is included in the budget rent and is distributed together with the other costs according to the relative value of the apartments.

In properties that are not covered by the Housing Regulation Act's rules on cost-based rent, the water charge is included in the rent in accordance with sections 50-52 of the Rent Act. The cost is distributed in proportion to the applicable rent. As a rule, only an increase in the rate and not an increase in consumption can lead to a rent increase, but case law is not clear.

Chapter VII B of the Tenancy Act lays down detailed rules on tenants' payment for water according to distribution meters. The rules are based on the fact that payment for water can only be collected outside the rent if water meters have been installed. These rules thus constitute the exception to the above-mentioned main rule.

If water meters are installed and the tenant's payment for consumption is collected outside the rent, this must be done via a water account, cf. the rules in Chapter VII B of the Tenancy Act. These rules correspond to those that apply to collecting payment for heating.

The water accounting rules were introduced in 1994 with the aim of allowing water to be billed according to distribution meters. The rules were introduced as part of the implementation of the Metering Committee's (1993-1995) recommendations.

Ministry of the Interior and Social Affairs Executive Order No. 1204 of 10 December 2009 of the Act on the Rental of Public Housing.
The rules on payment for water in public housing are in principle similar to those that apply to private rental housing. The water charge is included in the rent, cf. the balanced rent principle, and the rent is distributed according to the relative value of the apartments.

Chapter 10 of the Public Tenancy Act contains rules on collecting payment for water according to distribution meters, corresponding to the rules in the Tenancy Act on this matter.

If a public housing development switches to paying for water according to consumption meters, the costs for this are considered an improvement, cf. Section 54(5) of the Public Housing Act, i.e. they can be included in the rent.

Ministry of Economic Affairs and Business Act No. 934 of 20 December 1999 on the rental of commercial premises, etc. (the Commercial Lease Act).

According to Section 47(2) of the Commercial Lease Act, the landlord may demand that the previous distribution of water and heating costs be changed so that the distribution in future must be based on distribution meters.

Expenses resulting from a changed distribution of water and heating expenses are considered an improvement. The landlord may demand that the rent be increased by an amount corresponding to the increase in the use value of the leased property, cf. Commercial Lease Act section 31, subsection 1, cf. section 47, subsection 3.

Finally, it follows from Section 47(4) of the Commercial Leases Act that upon transition to settlement for water according to distribution meters, the rent must be reduced by an amount corresponding to the part of the water cost that has previously been included in the rent.

The landlord is thus entitled to pass on the costs of introducing individual distribution meters to the tenants, unless the above provisions have been waived by agreement.

Ministry of Economic Affairs and Business Act No. 960 of 19 September 2006 on the Act on Cooperative Housing Associations and Other Housing Communities (Cooperative Housing Act).

The Cooperative Housing Act does not address the distribution of water costs between the members of the cooperative housing association.

If there are no individual water meters in the individual cooperative homes, the cooperative housing association's articles of association will normally state how water costs are to be distributed between the cooperative housing association's members.

The Danish Business and Construction Authority has drawn up standard statutes

for cooperative housing associations. The standard statutes do not address who should bear the costs of installing individual distribution meters.

If the cooperative housing association's articles of association do not relate to expenses of the above-mentioned nature, it will be up to the cooperative housing association's general meeting to decide how the expenses for installing distribution meters are to be financed.

Ministry of Economic Affairs and Business Act No. 53 of 30 January 2006 on the Act on Owner-Owned Apartments (the Owner-Owned Apartments Act).

The Condominium Act does not contain provisions on the distribution of expenses associated with water supply between the members of the condominium association.

If the individual apartments in an owners' association do not have individual water meters, the owners' association's bylaws typically state how water costs are to be distributed among the owners' association members.

The Danish Business and Construction Authority has prepared standard statutes for homeowners' associations that apply when an homeowners' association has not adopted other statutes. The standard statutes do not address who should bear the costs of installing individual distribution meters.

If the owners' association's articles of association do not relate to the distribution of expenses of the above-mentioned nature, it will be up to the owners' association's general meeting to decide how the expenses for setting up distribution meters are to be financed.

4.2 Costs of installing and operating individual water meters

There are both installation and operating costs when establishing individual meters, and the costs depend on both the property and the meter types. In this section, a total annual cost per home is calculated by adding interest and deductions for installation costs to the annual operating costs. This cost can subsequently be compared with expected annual savings.

The installation costs depend on the design of the apartments and in particular on how many meters need to be installed in each apartment. The reading costs are almost the same from apartment to apartment, as it does not require significantly more time to read, for example, four than two meters, once access to an apartment is gained.

The installation costs are underestimated for two reasons. First, the "follow-up costs" and the inconvenience that residents have because they have to make room for the craftsmen are not included, cf. the box below. Second, the data are from homes that have voluntarily installed meters, and other homes where it is particularly costly to install meters are therefore probably underrepresented.

Unmeasured consequential costs for meter installation

There are quite good estimates of the costs of materials and plumbing work for meter installation when the apartments are furnished so that the work only consists of plumbing work. In many cases, however, the installations are not so accessible. For apartment buildings built after 1960, the installations are often located in shafts. Some of these shafts are only equipped with a small inspection hatch, which cannot be used for the installation of meters. Here it is necessary to make holes in the shaft wall, which can be made of masonry or lightweight concrete. Many shafts are also so small that the placement of meters is not possible.

In addition to the actual structural changes, in many cases other costs also arise, for example in the form of dismantling kitchen elements, dismantling and reinstalling tiles in bathrooms and kitchens.

No actual study of such conditions has been carried out, but realistic, imagined examples in apartments with large consequential costs and resident inconveniences may be

- *Pipes in the bathroom are located behind a wall that needs to be torn down or in which large holes need to be cut.*
- *Pipes are placed out of reach in the shaft.*
- *Pipes are located behind old kitchen cabinets from, for example, the 1920s, which cannot be put back up after being dismantled. Dismantling a cabinet will therefore mean that the entire kitchen equipment must be replaced if the equipment is to look uniform.*

It may only be in a few cases that the consequential costs will be severe, but an unconditional requirement for meters will certainly lead to great costs and inconvenience in some properties. As mentioned, there are no actual statistical or systematic calculations of these consequential costs, but one estimate of the consequential costs is between 3,000 and 80,000 DKK per apartment.

Table 3a-d shows estimates of the annual costs of installing and operating meters under different assumptions. In each table, the costs are shown for different building types, with the main difference being the number of meters required to be installed in each apartment.

If meters of the type common on the current market are to be replaced every 6 years, the annual costs are between DKK 1,431 and DKK 451 per apartment, cf. Table 3a.

Meters with better durability and remote reading capability are expected to become common in the market. The immediate material costs will be

higher, but the total costs are estimated to be at the same level as for conventional meters, cf. table 3b.

In some apartments it will be more expensive than average to install meters. The annual costs of a 50 percent higher installation cost are shown in Table 3c. Costs for reading etc. are assumed to be unchanged.

The common meters on the market can probably last for 12 years in many cases, but if they are to last that long, a sample is required after every 6 years. The annual costs will be reduced as a result, see table 3d.

Table 3a.Costs for installation and operation of water meters – replacement every 6 years

Building type	Installation costs	Installation costs	Administration,reading and accounting	Total
	DKK/apartment 1	DKK/apartment/ year2	DKK/apartment/year 3	DKK/apartment/ year
Built before 1997 4 cold water and 3 hot water meters	6,563	1,231	199	1,431
Built before 1997, assembly construction with shafts 2+2 meters	3,750	704	168	871
Construction from 1997 or later 1+1 meter	1,625	305	146	451

Source: Information from ISTA7, own calculations.
1. It is assumed that the costs for meters, other materials and plumbing work are DKK 750 per installed meter, but DKK 650 per meter in new construction, excluding VAT. The costs apply to a property with 75 apartments.
2. Calculated over 6 years and assuming a return of 5 percent.
3. The costs are DKK 100 per year per apartment and DKK 8.5 per meter per year, excluding VAT.

Table 3b.Costs for installation and operation of water meters – remote meter reading

Building type	Installation costs	Installation costs	Administration,reading and accounting	Total
	DKK/apartment	DKK/apartment/year	DKK/apartment/year	DKK/apartment/year
Built before 1997 4+3 meters	11,813	1,269	100	1,369
Built before 1997, assembly construction with shafts 2+2 meters	6,750	725	84	809
Construction from 1997 or later 1+1 meter	3,125	336	73	409

Source and note: See table 3a. However, information from Kamstrup8 is included, installation costs are assumed to be DKK 600 higher per meter (excl. VAT), operating costs are assumed to be half as high as in table 3a, and it is assumed that the meters last for 12 years.

7 ISTA is a company within the installation and reading of consumption meters, as well as the distribution of costs for water and heating consumption.

8 Kamstrup A/S is a company within the field of manufacturers of system solutions for energy measurement.

Table 3c.Costs for the installation and operation of water meters – 50 percent higher installation prices

Building type	Installation costs	Installation costs	Administration,reading and accounting	Total
	DKK/apartment	DKK/apartment/year	DKK/apartment/year	DKK/apartment/year
Built before 1997 4+3 meters	9,844	1,847	199	2,046
Built before 1997, assembly construction with shafts 2+2 meters	5,625	1,055	168	1,223
Construction from 1997 or later 1+1 meter	2,438	457	146	604

Source and note: See table 3a, however installation prices are assumed to be 50 percent higher.

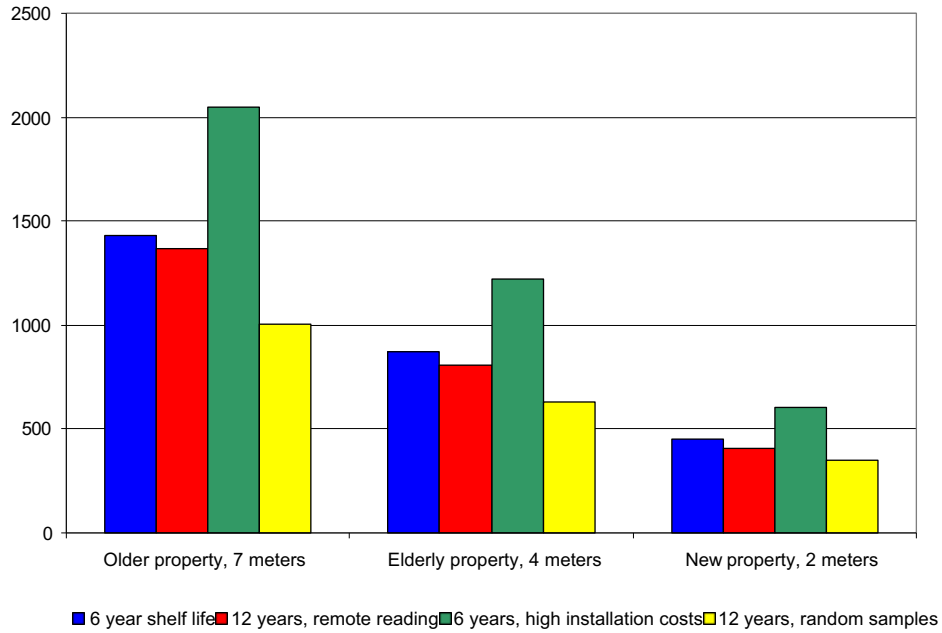
Table 3d.Costs for installation and operation of water meters – replacement every 12 years and spot checks

Building type	Installation costs	Cost-for random samples	Installationand sampling costs	Administrationon, reading and accounting	Total
	DKK/apartment	DKK/apartment	DKK/apartment/year	DKK/apartment/year	DKK/apartment/year
Built before 1997 4+3 meters	6,563	963	809	199	1,008
Built before 1997, assembly construction with shafts 2+2 meters	3,750	550	462	168	630
Construction from 1997 or later 1+1 meter	1,625	275	204	146	350

Source and note: See table 3a, however it is assumed that the meters can typically last for 12 years, but random checks are required after 6 years. Approximately 15 percent of the meters are tested, and the cost of each test is DKK 750 excluding VAT.

The results for building types and meter alternatives are summarized in Figure 1.

Figure 1. Annual costs for installation and operation of meters, DKK per apartment

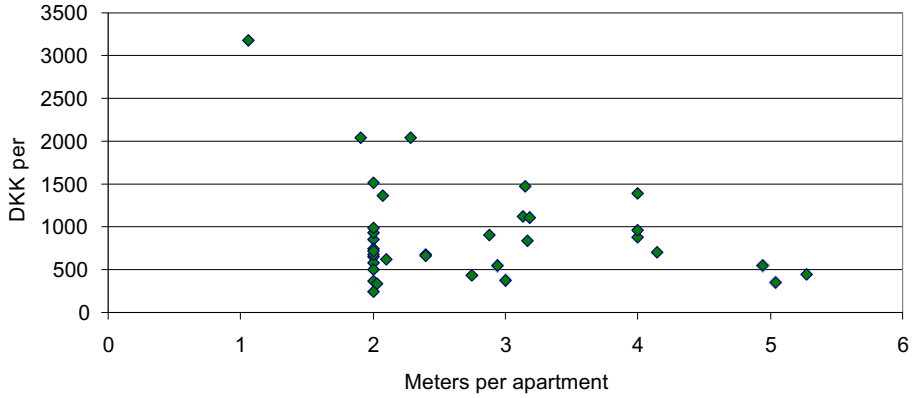


Source: Table3a-d.

Table 3a-d concerns small meters that are currently on the market or are expected to be on the market. It is unknown whether these meters will meet the future requirements for CE marking or the MID directive. When assessing the impact of any increases in the meter price, it should be noted that the cost of the meter in Table 3a only constitutes a small part of the total costs including installation (approximately DKK 100 out of the DKK 750).

The tables assume that the purchase and installation of a meter costs DKK 750 (DKK 938 incl. VAT). Based on information from Copenhagen Energy, an average cost of DKK 755 (incl. VAT) can be calculated based on the setup of a good 6,000 meters in 35 properties. The cost per meter decreases the more apartments there are in the property, and (especially) the number of meters per apartment. However, there is a significant variation in the cost, even when this relationship is taken into account. Figure 2 shows how the costs depend on the meters installed per apartment. The figure also shows significant variation in costs, even when the same number of meters per apartment is installed.

Figure 2. Costs for installing meters and number of meters installed per apartment



Source: Copenhagen Energy, correspondence, own calculations.
Note: Each dot shows a property.

4.3 Water companies' tariff policy and cost structure

The water companies' costs consist of large, fixed, consumption-independent costs and smaller variable, consumption-dependent costs. Thus, the water companies' costs fall relatively little when water consumption is reduced.

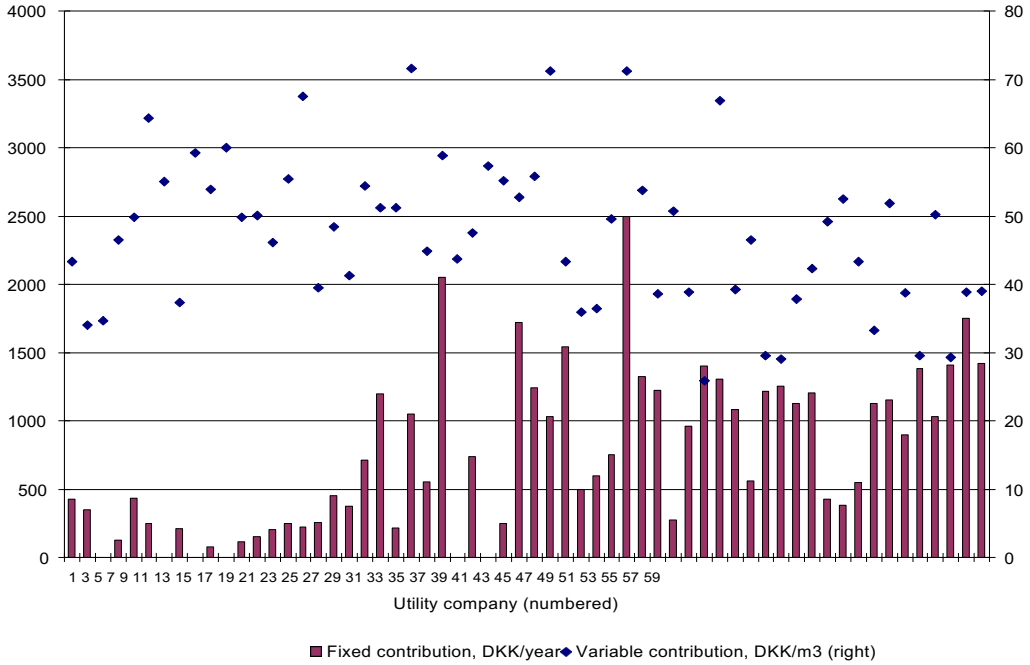
Similarly, the companies have two tariffs, namely a fixed element that each household pays per year and a variable element per cubic meter of water consumed.

However, the consumption-dependent, variable tariff is typically significantly higher than the variable costs – the tariffs are not "cost-oriented". This means that when water consumption is reduced, the water companies' revenues will fall more than the costs, and the water companies will eventually have to increase the tariffs. The tariff policy and cost structure are explained below, and then it is explained how this tariff policy and cost structure have been taken into account in the following calculations.

DANVA9 has calculated the fixed and variable tariffs from the water supply companies. As a simple average across water supply companies, the fixed contributions can be calculated at DKK 750 (per home per year) and the variable price at DKK 47 per cubic meter of (cold) water. The water utilities' total income from fixed contributions is estimated to only constitute 10-20 percent of their total income. The tariff policies and cost ratios of the supply companies are different, and the tariffs vary. The fixed contribution fluctuates from DKK 0 to DKK 2,497 per year and the variable from DKK 26 to DKK 72 per cubic meter of cold water. Figure 3 shows the variation in the tariffs.

9 DANVA is the interest organization for everyone who works professionally with water and wastewater supply. The association is an independent non-profit association, financed by its members and through revenue-based activities.

Figure 3.Fixed and variable contribution for water supply companies for water supply and drainage, DKK per year and DKK per m3



Source and note: Information from DANVA. Contributions include VAT.

The fixed costs in water supply are mainly the costs of maintaining plants and supply and drainage pipes, while the variable costs consist of energy consumption for transporting water, as well as taxes. In some water supply areas – such as Copenhagen – there is more than one waterworks, and a permanent reduction in water demand could lead to the closure of one or more waterworks. This option does not exist in water supply areas with a single waterworks.

Table 4 attempts to classify the elements of the water price according to whether the underlying costs are variable (dependent on the consumption of water) or fixed. The table is based on information from Copenhagen Energy. The average price of DKK 46 per m3 is slightly lower than the national average based on DANVA's information.

Table 4. Classification of price elements

Element	DKK per m3	*Of which*	
		Fixed costs	Variable costs
Water	14.22	14.22 minus variable part4	DKK for energy1, plus up to the remaining part if waterworks can closed.
Groundwater protection	0.50		0.50
Water tax	5.00		5.00
Water drainage contribution, transport	12.66	12.66	
Water drainage contribution,	4.27	4.27	
purificationWastewater tax to the state	0.30		0.30
VAT	9.24	25 % of the above	25 % of the above
Total	46.19	33.94	12.25 possibly more

Source: Copenhagen Energy, ww.ke.dk, own estimates.

1 Energy consumption typically amounts to just under 2 kWh of electricity per m3 of water (DANVA 2009 "Water in Figures" p. 30) or just under DKK 4 per m3 at typical consumer prices for electricity.

The fixed costs may thus constitute up to 73 percent of the total costs, i.e. far more than the fixed rate, which, as mentioned, covers perhaps 10-20 percent of the total revenues for the water supply companies.

The calculations in the following sections are initially based on the water utilities' current tariff policy, i.e. that the variable costs are DKK 47 per cubic meter. Every time a cubic meter of water is saved, the water utilities' budget will therefore deteriorate by approximately DKK 47-12=35, and the water companies must therefore increase the tariffs. The effect of this is illustrated by calculating how large a tariff increase is necessary, cf. the last part of section 4.4.2. An alternative method is to calculate the effect of individual metering as if the water utilities' tariff policy were cost-effective, i.e. as if the variable tariff were DKK 12 per cubic meter. Such calculations are also relevant if the socio-economic (and not just the private economic) consequences of individual metering were to be evaluated.

The calculations below also assume that the property's practice for distributing the total water bill to the apartments follows the waterworks' rates – i.e. that the property's charge also consists of a fixed and a variable element, where the cubic meter rate corresponds to the waterworks' cubic meter rate (47 DKK/m3).10

Water heating costs

The above only concerns costs for cold water, but it is proposed that the apartments' consumption of hot water is also metered, so that the energy costs for heating domestic water can be paid individually.

10 Alternatively, the water bill for entire properties could be distributed according to water consumption, i.e. also the water company's fixed rate.

The energy consumption for domestic water consists partly of the consumption-dependent, utilized energy contained in the hot water coming out of the taps, and partly of a consumption-independent energy loss during the circulation of hot water.11

In the following calculations, it is assumed that the apartments' consumption-independent payment for heating water corresponds to the energy used. The tariff for heating one cubic meter of water is set at 50 DKK.12 13

4.4 Distributional impacts and savings opportunities

4.4.1 Experiences with water savings

Information on savings resulting from the installation of water meters is available from Copenhagen Energy. The consumption of (cold) water is calculated at property level before and after the installation of individual meters, and the change in consumption can be compared with the average water consumption, which is around 120 litres of water per person per day. For properties where consumption is significantly below average, increases in water consumption are typically experienced after the installation of water meters, for properties with consumption slightly below average, water consumption is approximately constant, and for properties with consumption above average, consumption drops drastically, see table 5.

Presumably, some meters are installed in connection with other work. This may be the reason for the increase in consumption for properties with low consumption in the initial situation – the meters may be installed when bathrooms are extended, etc. Perhaps the very large decreases in consumption for properties with high consumption in the initial situation are an expression of something similar, namely that the property's water system is renovated because the residents believe that water consumption is too high, and meters are installed in connection with renovations. As was the case for the information on installation costs, it should be remembered that the table includes properties that have voluntarily installed meters, and that the calculation may therefore systematically overestimate savings to some extent.

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11 The circulation ensures that the apartments receive hot water a few seconds after the hot water tap is opened. In many properties, the circulation loss is at least as great as the energy used.

12 The need for (utilized) energy to heat water to 50 degrees is 58.3 kWh/m3 and the cost of this is DKK 49.6 at a typical (for district heating) energy price of 85 øre per kWh. It is calculated as follows:

Utilized energy for heating: $4200 \frac{kJ}{C^0 m^3} \cdot 50\ Co \cdot 2.778 \cdot 10^{-4} \frac{kWh}{kJ} \cdot 58.3 \frac{kWh}{m^3}$.

Cost of heating 1 m3 of water: $58.3\ kWh \cdot 0.85 \frac{kr}{kWh} = 49.6 \frac{kr.}{m^3}$

13 If, alternatively, all costs for heating water – i.e. also the costs for circulation losses – are to be distributed according to the apartments' consumption of hot water, a meter must be installed in the heating basement that measures the property's total energy consumption for hot water. In this

connection, it can be stated that, according to initiative 7 in the government's "Strategy for reducing energy consumption in buildings" (April 2009), requirements will be introduced for measuring separate energy consumption for hot water in new residential and commercial properties and public buildings. The same requirements will be introduced in connection with significant conversions and renovations.

Table 5. Change in water consumption depending on consumption before installation of meters

Liters per person before installation of meters	Percentage change in consumption after three to six years
<100	15
100-120	-2
121-140	-21
141-160	-34
161-180	-23
>200	-40

Source: Copenhagen Energy.

Individual water metering is not only being considered in Denmark. Studies of the effect of metering have been conducted in several other countries.

Worthington and Hoffman conclude14 that the price of water has an effect on consumption, and the introduction of individual water metering alone can have a saving effect on water consumption among consumers with high water consumption.

In the London area, consideration has also been given to the introduction of individual water metering, and a report15 summarises four interesting American studies. In three of the four studies, a reduction of 7-30 percent in water consumption is achieved by introducing individual metering. This is also supported by Koplow and Lownie16. Their study examines various properties in the USA and the effect on their water consumption before and after the installation of individual water meters and payment. The study shows that the installation of meters results in a reduction in water consumption of 18-39 percent.

The studies are of varying quality and described with varying degrees of thoroughness. Overall, however, the study attempts to isolate the effect on water consumption from water prices or individual metering from other factors, such as campaigns to save water.

There are limited Danish studies of individual water measurements. However, a study has been conducted on Danish consumers' preferences for water consumption by Lars Gårn Hansen17. Hansen estimates that a price increase of 10 percent leads to a reduction in water consumption of 1 percent, i.e. a "price elasticity" of 10 percent or -0.1. Hansen's estimate of the price elasticity is relatively low compared to foreign studies, cf. Worthington and Hoffman, who summarize several international studies and find price elasticities to be in the range -0.75 to -0.25. If this applies to Danish consumers, a 10 percent increase in the water price will lead to a reduction in water consumption of 7.5 to 2.5 percent.

14 "A state of the art review of residential water demand modelling", AC Worthington and M. Hoffman.

15 “International experience on submetering”, Gareth Walker.

16 “Submetering, RUBS and water conservation”, Doug Koplow and Alexi Lownie.

17 "Water and Energy price impacts of residential water demand in Copenhagen", Lars Gårn Hansen.

The overall conclusion from this is that there is good evidence that the financial incentive affects water consumption, and that it is generally quite reasonable to assume that consumption will decrease by 20 percent when meters are installed, as the experience from Copenhagen Energy indicates.

4.4.2 Savings for different family types

Installing meters has both a savings effect and a redistribution effect, and it is easiest to illustrate the two effects simultaneously.

In table 6a, the starting point is a property with an average consumption of 117 liters per person per day or 42.7 m3 per year. The table is an example, and the calculation can be varied in several dimensions, which is done in the following tables 6b-6f. As a starting point, it is assumed that water consumption falls by 20 percent, and that the individual homes' payment per cubic meter reflects the water supply companies' tariffs and the additional energy costs of using hot water. It is also assumed that consumption in the apartments only depends on the family type and not on variations within each family type. In other words, water consumption is assumed to be the same for all families with, for example, two adults and two teenage children. This is completely unrealistic18, and the calculation therefore only shows the distribution effects from family type to family type.

Column a shows the calculated annual consumption for different family types in cubic meters. Columns b and c show the consumption measured in kroner before and after the transition to individual metering.

Before the reduction in water consumption is included, the average cost per apartment is DKK 7,855 per year. The "redistribution effect" is calculated as the difference between the water cost before and after the transition to individual metering, but before the water saving effect is included, cf. column d. Apartments with low water consumption gain from the redistribution, while apartments with high consumption lose. A 20 percent reduction in water costs corresponds to DKK 1,421 per apartment per year on average. The savings are naturally greatest in apartments with high water consumption, cf. column e. The sum of the redistribution and saving effects is shown in the last column. The redistribution effects are so large that apartments with high consumption lose from individual metering despite the reduction in water consumption.

18 Kirsten Gram Hansen (in "Household energy and water consumption" SBi (2005)) has examined water consumption as a function of a wide range of socio-economic factors (but not the water price). Such a statistical model can explain 31 percent of the variation in water consumption in apartment buildings, 45 percent in terraced houses and 40 percent in detached houses. More than half of the variation in water consumption cannot be explained by reference to, for example, family types alone. The redistribution effect therefore has one more dimension than is shown in Table 6a-6f, namely the redistribution that will occur between families with high and low consumption within each family type. The fact that water consumption is not solely determined by family type is also in good agreement with the fact that there is a certain saving effect by installing water meters or raising water prices – if water consumption were almost fixed for a certain family type, one would not think that economic incentives would have much significance.

Table 6a. Water saving and redistribution effects of installing meters – hypothetical example in a special property ***, DKK per apartment per year.**

	Before installing the meter, clay		After installation tion	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption1	Expenses when distributed by residence league area	Expenses when distributed according to consumption, before savings2	Redistribution	Water saving3 (20%)	Total
	a	b	c	d=cb	e	f=d+e
1 adult	42.7 m3	6,140	3,469	-2.671	-544	-3.215
1 pensioner	36.0 m3	6,140	3,045	-3.095	-459	-3.554
1 adult, 1 small child	71.3 m3	7,017	5,289	-1.727	-908	-2.635
1 adult, two small children	99.9 m3	7,455	7,110	-345	-1.272	-1.617
Two adults, no children	85.4 m3	7,455	6,187	-1.268	-1.087	-2.356
Two adults, two small children	142.3 m3	9,122	9,810	688	-1.812	-1.124
Two adults, two teenagers	192.2 m3	9,122	12,987	3,865	-2.447	1,418
Average	111.6 m3	7,855	7,855	0	-1.421	-1.421

Source: Copenhagen Energy, "Household energy and water consumption" SBi (2005), own calculations.

* It is assumed that the property consists of 9 apartments, one of each of the 7 family types in the table, but two of each of the two family types with two adults and two children. The original distribution of water costs is assumed to be area-dependent, and the assumed housing sizes are 70 m2 for single adults, 80 m2 for the single adult with 1 child, 85 m2 for the single adult with two children and the adult couple without children, and finally 104 m2 for the adult couple with children.

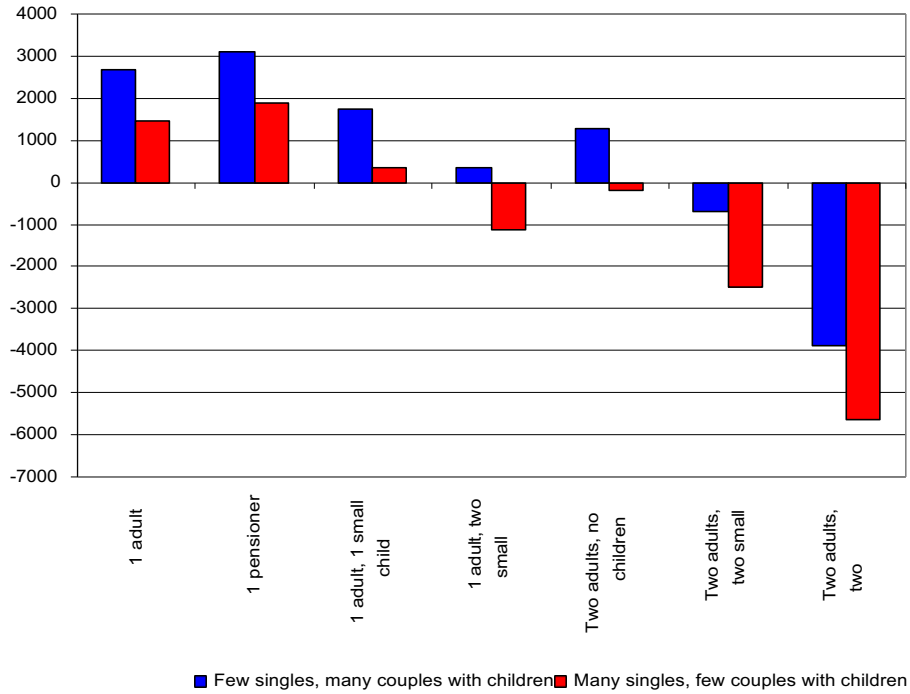
1 The starting point is that an adult has a consumption corresponding to the average, i.e. 42.7 m3. The variation over age and family type is estimated based on SBi's report. The consumption is measured in cubic meters of water per apartment per year.

2 The assumed rates are DKK 750 as a fixed rate per year for the installation of cold water, DKK 47 per m3 of cold water and DKK 50 for heating one cubic meter of water. Each time a cubic meter of cold water is used, one third is heated. The cost of energy for heating is therefore one third of DKK 50 each time a cubic meter of cold water is used.

3 The savings are calculated as 20 percent of the physical savings in column a, valued at DKK 47 per m3 of cold water plus ⅓*DKK 50 per m3 for heating water.

The distribution of family types in the calculation in Table 6a (two apartments with two adults and children, one apartment with each of the other family types) may not be typical for apartment buildings. If the distribution in the property is shifted towards relatively more single families, the redistribution effect becomes less advantageous for singles and even more disadvantageous for families with many members, because fewer large families each lose a larger amount to more singles, cf. Figure 4. Table 6b shows the calculation for such a property type.

Figure 4. Redistribution effect of individual water metering for different family type composition in the property



Source: Tables 6a and 6b.

Table 6b. Savings- and redistribution effects when installing meters, DKK per apartment per year – property with many single people and few couples with children.

	Before installing the meters		After installation-on	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption	Expenses when distributed by residence league area	Expenses when distributed according to consumption, before saving	Redistribution	Water saving (20%)	Total
	a	b	c	d=cb	e	f=d+e
1 adult	42.7 m3	4,934	3,469	-1.466	-544	-2.009
1 pensioner	36.0 m3	4,934	3,045	-1,890	-459	-2.348
1 adult, 1 small child	71.3 m3	5,639	5,289	-350	-908	-1.257
1 adult, two small children	99.9 m3	5,991	7,110	1,119	-1.272	-153
Two adults, no children	85.4 m3	5,991	6,187	196	-1.087	-892
Two adults, two small children	142.3 m3	7,331	9,810	2,479	-1.812	667
Two adults, two teenagers	192.2 m3	7,331	12,987	5,656	-2.447	3,209
Average	111.6 m3	5,679	5,679	0	-986	-986

Source and note; As in table 6a, however, 3 apartments with single adults, 2 apartments with one adult with children and two adults without children, and 1 apartment with two adults with children are assumed, the property thus consists of 14 apartments.

Tables 6c-6e show supplementary calculations.

If the water consumption is initially 90 percent of the average consumption, and the savings are only 10 percent, the savings will be only DKK 639 per year per apartment in total.

average (instead of DKK 1,421), cf. table 6c. If only 5 percent is saved, this corresponds to DKK 320 per apartment (not shown).

Table 6c. Savings and redistribution effects of installing meters, DKK per apartment per year – low initial consumption and small savings

	Before installing the meters		After installation	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption	Expenditureby distribution according to living space	Expenses when distributed according to consumption, before saving	Redistribution	Water saving (10%)	Total
	a	b	c	d=cb	e	f=d+e
1 adult	38.4 m3	5,584	3,197	-2.388	-245	-2.632
1 pensioner	32.4 m3	5,584	2,815	-2,769	-207	-2.976
1 adult, 1 small child	64.2 m3	6,382	4,835	-1.547	-409	-1.955
1 adult, two small children	89.9 m3	6,781	6,474	-307	-572	-879
Two adults, no children	76.9 m3	6,781	5,643	-1.137	-489	-1.627
Two adults, two small children	128.1 m3	8,297	8,904	607	-815	-208
Two adults, two teenagers	173.0 m3	8,297	11,763	3,466	-1.101	2,365
Average	100.4 m3	7,144	7,144	0	-639	-639

Source and note: As table 6a, however, the starting point is a consumption of 90 percent of the consumption in table 5 and a saving of 10 percent.

Conversely, if the water consumption is initially 120 percent of the average consumption, and the savings are 25 percent, the savings will be DKK 2,131 per year per apartment on average, cf. table 6d.

Table 6d. Savings and redistribution effects of installing meters, DKK per apartment per year – high initial consumption and large savings

	Before installing the meters		After installation	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption	Expenditureby distribution according to living space	Expenses when distributed according to consumption, before	Redistribution	Water saving(25%)	Total

			saving			
	a	B	c	d=cb	e	f=d+e
1 adult	51.2 m3	7,250	4,012	-3.238	-816	-4.054
1 pensioner	43.2 m3	7,250	3,503	-3.747	-688	-4.435
1 adult, 1 small child	85.6 m3	8,286	6,197	-2,089	-1.362	-3.451
1 adult, two small children	119.9 m3	8,804	8,382	-422	-1.908	-2,330
Two adults, no children	102.5 m3	8,804	7,275	-1.529	-1.631	-3,160
Two adults, two small children	170.8 m3	10,772	11,622	850	-2.718	-1.868
Two adults, two teenagers	230.6 m3	10,772	15,434	4,662	-3.671	991
Average	133.9 m3	9,276	9,276	0	-2.131	-2.131

Source and note: As table 6a, however, the starting point is a consumption of 120 percent of the consumption in table 6a and a saving of 25 percent.

In a water district where the variable tariff is among the lowest, the water savings will be an average of DKK 1,112, cf. table 6e.

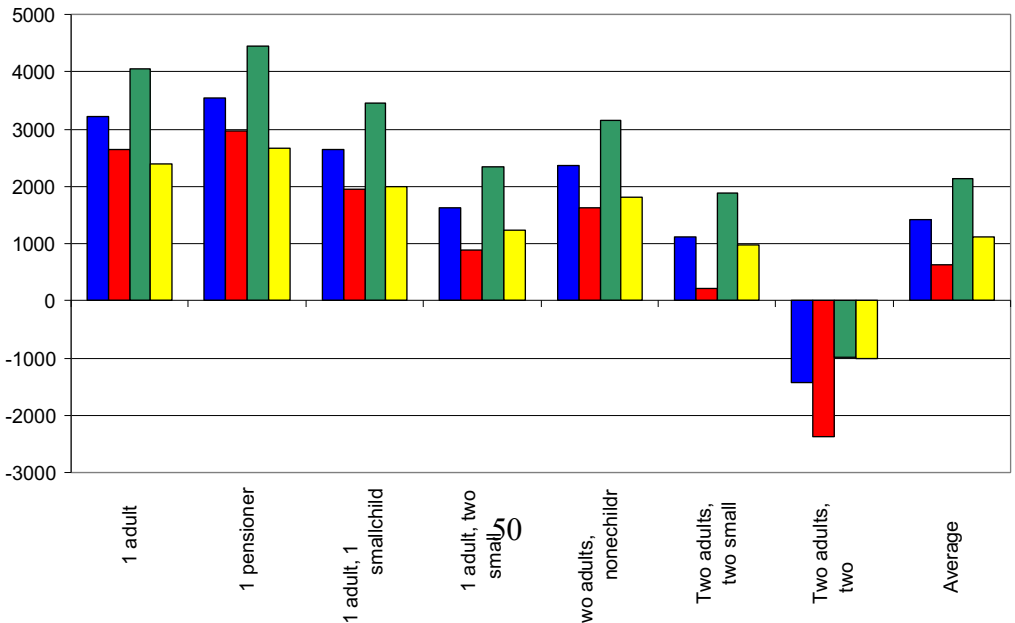
Table 6e. Savings- and redistribution effects when installing meters, DKK per apartment per year – for municipalities with low variable rates

	Before installing meters		After installation	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption1	Expenditureby distribution according to living space	Expenses when distributed according to consumption, before savings see2	Redistribution	Water saving3 (20%)	Total
	a	b	c	d=cb	e	f=d+e
1 adult	42.7 m3	5,226	3,253	-1.973	-426	-2.398
1 pensioner	36.0 m3	5,226	2,921	-2.305	-359	-2.664
1 adult, 1 small child	71.3 m3	5,972	4,678	-1.294	-711	-2.005
1 adult, two small children	99.9 m3	6,345	6,103	-243	-996	-1.238
Two adults, no children	85.4 m3	6,345	5,380	-965	-851	-1.816
Two adults, two small children	142.3 m3	7,764	8,215	452	-1.418	-966
Two adults, two teenagers	192.2 m3	7,764	10,702	2,938	-1.915	1,023
Average	111.6 m3	6,685	6,685	0	-1.112	-1.112

Source and note; As in table 6a, however note 1:
1 DKK 1,125 as a fixed rate per year for the installation of cold water, DKK 33 per m3 of cold water. These rates are for the water supply company with the sixth lowest variable rate according to DANVA,

The results of these alternative calculations are summarized in Figure 5.

Figure 5. Total savings from individual water metering under different assumptions, DKK per year per household



Source: Table 6a-6e.

Finally, the redistribution becomes greater if the original expense is distributed in equal shares to each apartment instead of distribution by living area (not shown).

Effect if water rates increase as a result of water savings

If the introduction of water meters leads to water savings, the water supply companies' income and costs will fall. Income will fall far more than costs because, as mentioned, the companies' consumption-dependent tariff is on average DKK 47 per cubic metre of cold water, while the variable costs for conveying and diverting water are DKK 12 per cubic metre, cf. section 4.3. In order to avoid deficits, the water supply companies must therefore increase their tariffs in the event of a reduction in water demand. The following calculation therefore calculates the effect of individual water metering if changed tariffs are taken into account.

For every cubic meter of water consumption reduced, the water supply company's budget is worsened by 47-12=35 DKK. On average (see table 6a), each apartment is assumed to consume 111 cubic meters of water before the installation of meters and to reduce this by 20 percent, i.e. 22 cubic meters. For each apartment building, the water supply company's income is therefore reduced by 35 DKK/m3 times 22 m3, i.e. 770 DKK.

The water supply company must recover this loss by increasing the tariff. For the sake of the example, it is assumed below that it is the fixed annual tariff per household that is increased. If all of the water supply company's customers are multi-family properties, the fixed tariff will have to increase by DKK 770, but if, for example, only half of the households are located in multi-family properties, the fixed tariff will only have to increase by half of DKK 770, i.e. DKK 385. Both households in multi-family properties and in single-family houses are affected by this tariff increase.

In table 6a it was calculated that an average apartment in a multi-family building reduced the cost by DKK 1,421 per year. If the effect of increasing fixed rates is included, the savings will be on average DKK 1,421-770=651 per apartment, although part of the rate increase of DKK 770 as mentioned is imposed on households in single-family houses.

Another way to arrive at approximately the same result (approx. DKK 651) is to imagine that the utility companies' tariffs are "cost-sensitive", i.e. that the variable tariff is DKK 12 per cubic meter instead of DKK 47. The result is shown in Table 6f. The redistribution and water saving effects are significantly smaller than with current tariffs (cf. Table 6a). If the tariffs were cost-sensitive, single-family homes would not be affected by the savings in lower water consumption in apartment buildings.

Table 6f. Savings- and redistribution effects when setting up meters, DKK per apartment per year – cost-effective tariffs

	Before installing the meters		After installation	Changed expense after installation of meters (negative number = saving)		
Family type	Physical consumption1	Expenses when distributed by residence league area	Expenses when distributed according to consumption, before savings2	Redistribution	Water saving3 (20%)	Total
	a	b	c	d=cb	e	f=d+e
1 adult	42.7 m3	6,140	5,880	-260	-245	-505
1 pensioner	36.0 m3	6,140	5,689	-451	-207	-657
1 adult, 1 small child	71.3 m3	7,017	6,700	-317	-409	-726
1 adult, two small children	99.9 m3	7,455	7,520	64	-573	-508
Two adults, no children	85.4 m3	7,455	7,104	-351	-490	-841
Two adults, two small children	142.3 m3	9,122	8,735	-387	-816	-1.202
Two adults, two teenagers	192.2 m3	9,122	10,166	1,044	-1.102	-58
Average	111.6 m3	7,855	7,855	0	-640	-640

Source and note; As in table 6a, however note 1:
1 DKK 4,656 as a fixed rate per year for the installation of cold water, DKK 12 per m3 of cold water. The variable rate of DKK 12 is estimated based on statistics on actual rates, cf. Table 5. The fixed rate is calculated so that the water supply company does not incur a deficit as a result of individual metering.

Consequence for family types when housing benefit is included

Housing benefit is provided to pay rent for tenants and as a loan to cover housing costs for certain owners and cooperative members. The housing benefit is generally 75 or 60 percent of the rent, with income adjustment according to detailed rules that are not explained here.

When the water cost is included in the rent, housing benefit is provided for a portion of the water cost. This means that changes in the water cost are offset by the change in housing benefit, which can be 75 percent of the water cost.

When the water cost is separated from the housing cost, a calculation-technical addition to the housing cost of DKK 28.25 or DKK 30.00 per square meter of eligible housing area can be made according to current rules. In many properties, the water cost is currently paid in addition to the housing cost.

A home where the water cost is currently included in the rent, and which is also expected to achieve a gain through individual metering, will experience a change in net rent. On the one hand, housing benefit falls by – as a rule – 75 percent of the water consumption, because this is deducted from the rent, but conversely, the decrease in housing benefit is reduced due to the rent supplement of DKK 28.25 (housing insurance) or DKK 30.00/m2 (housing benefit).

The subsidy rules may mean that the housing subsidy is reduced by more than the

gain from realistic water savings. The decisive factor is how much water consumption is in relation to the mentioned square meter surcharge of DKK 28.25 or DKK 30, respectively, and how much water savings are.

Table 7 shows, for selected family types, how changed housing benefit can be expected to influence the effect of individual payment for water. The calculations are made under the assumption that the water cost is charged on top of the rent before the transition to individual payment, and that it is then paid alongside the rent. The table shows that for a single pensioner and for single adults with children, housing benefit falls so much that the immediate gain from individual payment is exceeded by the falling benefit, so that these households actually lose out on the transition to individual metering.

Table 7. Effects of installing meters when housing benefit is included, DKK per apartment per year.

Family type	Changed expense (negative number = saving)		
	Redistribution, water saving (20%) and installation costs, excluding changed housing benefit	Decrease in housing benefit*	Total
An adult	-1,784	396	-1.388
A pensioner	-2.123	2,568	445
An adult, a small child	-1.204	1,992	788
One adult, two small children	-186	2,268	2,082
Two adults, no children	-924	0	-924
Two adults, two small children	307	0	307
Two adults, two teenagers	2,849	0	2,849
Average	10	803	813

Source and notes: The first column is copied from column f in table 6a, but with installation costs of DKK 1,431 deducted, cf. table 3a.

* The housing benefit calculation is in collaboration with the Danish Pensions Agency. Water costs can be charged through the rent or separately. The calculated change in housing benefit applies to those beneficiaries who pay water through the rent. For the other beneficiaries, individual metering will not have an effect on the benefit.

4.4.3 Societal consequences of individual meters

So far, the private economic consequences of individual metering have been described. A traditional socio-economic assessment of individual metering has not been carried out in this report, but would have to compare the societal resource consumption for installation, operation and the residents' own costs against the societal resource savings.

The societal resource consumption will (with some modifications) correspond to the costs as described above (Table 3a-d and consequential costs).

On the other hand, resource savings must be measured by the water companies' real, variable costs of producing and transporting water to consumers and the costs of diverting the water away again. This in itself will mean that water prices approximately corresponding to the above-mentioned cost-effective prices must be used, and the savings will therefore be relatively small, as shown in Table 6f.

Furthermore, a socio-economic assessment should also include water resources and environmental conditions. The water supply companies' costs for water production and transport do not include a price for the water itself, as groundwater itself does not have a market price. Excessive water consumption can also harm the environment, as the water level in lakes and streams can decrease. However, water resources and environmental conditions vary greatly from region to region. In Jutland, there are generally abundant water resources, while the groundwater level has fallen significantly in North Zealand. Consideration of water shortages should therefore ideally be determined by regional conditions.

Among other things, consideration for the climate can justify saving on energy consumption for heating hot water.

Resource and environmental conditions can be promoted through individual metering, although a general requirement does not take into account the significant regional differences in water resources. Similarly, resource and environmental conditions are promoted by water supply companies' cubic meter prices being higher than variable costs.

4.5 Overall assessment of economic consequences

Table 8 summarizes the key examples from Tables 3a, 6a and 7. As explained above, the economic consequences vary somewhat depending on the conditions of the property, and the table is therefore only valid as a guide. On average, the savings per year correspond approximately to the annual costs of installing meters and operating before taking into account housing subsidies, cf. column d. The redistribution effects are significant and may for some apartments exceed the water saving effects despite the fact that a decrease in water consumption is estimated at 20 percent. The decrease in housing subsidies is so large for many apartments that the gain from individual metering is changed into a loss.

Table 8. Consequences of individual water metering, DKK per apartment per year.

	Changed expense (negative number = saving)					
	Redistribution	Water saving(20%)	Install-tion and opera tion	Total, excluding housing benefit	Fall in housing support	Total
	a	b	c	d=a+b+c	e	f=d+e
An adult	-2.671	-544	1,431	-1,784	396	-1.388
A pensioner	-3.095	-459	1,431	-2.123	2,568	445
An adult, a small child	-1.727	-908	1,431	-1.204	1,992	788
One adult, two small children	-345	-1.272	1,431	-186	2,268	2,082
Two adults, no children	-1.268	-1.087	1,431	-924	0	-924
Two adults, two small children	688	-1.812	1,431	307	0	307
Two adults, two teenagers	3,865	-2.447	1,431	2,849	0	2,849
Average	0	-1.421	1,431	10	803	813

Source and notes: See tables 3a, 4, 6a and 7. The amended housing benefit applies to beneficiaries where the water cost is included in the rent.

As discussed above, the calculations in the table are only calculation examples that should be taken with a number of caveats, e.g.:

- Installation and operating costs do not include any subsequent costs for dismantling kitchen cabinets, etc. Estimates from the Danish Real Estate Association indicate that these costs can amount to between DKK 3,000 and DKK 80,000.
- As a result of the water companies' tariff policy, the reduction in water consumption could lead to budget cuts for the companies, and they must therefore raise tariffs. This tariff increase could amount to approximately DKK 770 per apartment with an installed meter, and the amount must be collected through tariff increases. The tariff increases will affect all water consumers, including, for example, households in detached houses. When tariff increases are taken into account, homes will on average lose out on the introduction of individual water metering.
- The example is based on a property with many different family types. In practice, many properties will be more uniformly composed. For example, many senior citizens' homes will be completely identical and almost all occupied by one pensioner. Here, the redistribution effects between the housing units will be significantly more limited and based only on differences in the habits of the individual residents.

5 Legal basis for making claims

The following examines whether the current regulatory framework provides the authority to establish a possible requirement for individual water metering.

5.1 Building Act

Section 4 A of the Building Act authorizes the Minister of Urban Affairs and Housing (now the Minister of Economic Affairs and Business) to lay down detailed rules that meters for individual measurement of consumption items, including water, must be installed in new buildings and existing buildings, and that the necessary technical installations be carried out in connection therewith. The Minister of Economic Affairs and Business may, among other things, lay down rules that individual meters must be used as the basis for measuring consumption, and in which cases an exception may be made from the requirement for individual measurement.

The authority in Section 4 A of the Building Act is applied by Executive Order No. 891 of 9 October 1996 on individual metering of electricity, gas, water and heat, as amended by Executive Order No. 565 of 1 July 1997. The Executive Order sets out the requirements for the installation of individual meters. The authority in Section 4 A of the Building Act was introduced in 1995 on the basis of a bill submitted as a follow-up to Report No. 1286 on individual metering of consumption items, which was submitted in February 1995 by the Committee on Mandatory Individual Metering of Consumption Items. The comments on the bill, as well as the Housing Committee's report on the bill, state that the consumption items must be metered for the individual household, which must only pay for its own consumption, which the household is thus able to regulate itself.

The Building Act thus contains the necessary authority to introduce requirements for individual metering of hot and cold water in multi-occupancy properties and to lay down any further rules on exemptions therefrom.

5.2 The Tenancy Act

If a general requirement for payment for water according to distribution meters is introduced, it will require that the landlord has the necessary authority to comply with such a public law requirement and unilaterally implement a change to the previous distribution.

According to section 46 j of the Tenancy Act, the resident representatives or a majority of the tenants may decide that the future distribution of water costs shall be based on distribution meters. Accordingly, under the current rules, the landlord does not have the necessary authority to unilaterally change the previous distribution method and will therefore not be able to meet a requirement in this regard. It will therefore be necessary to introduce the necessary authority by means of a legislative amendment.

5.3 Cooperative Housing Act

The Cooperative Housing Act is a framework law that only relates to specific issues such as calculating the cooperative value.

The Act is supplemented by the cooperative housing association's articles of association, which regulate the relationship between the cooperative housing association's members, including any distribution of benefits.

utility costs if there are no individual water meters in the housing cooperative.

The Cooperative Housing Act therefore does not contain provisions on the distribution of costs associated with water metering. A requirement for individual water metering would not necessitate an amendment to the Cooperative Housing Act.

5.4 Public Tenancy Act

According to section 54(2) of the General Tenancy Act, the landlord has the authority to change the distribution. This means that the department can decide to change the basis for distribution. The department thus has the necessary authority to meet a requirement for a transition to distribution of water costs by meter.

5.5 Commercial Lease Act

The Commercial Lease Act applies to the rental and sublease of premises that are exclusively rented out for purposes other than residential purposes.

Chapter 9 of the Commercial Leases Act deals with the distribution of expenses related to water and heating, etc.

According to section 47(1) of the Act, the distribution of water and heating costs between tenants can be done according to usual calculation rules, according to suitable heat distribution meters, according to gross floor area, according to the number and type of hot water taps or the number of rooms.

However, the landlord may stipulate that the costs for water and heating are changed so that in future the distribution is based on distribution meters, cf. section 47(2).

The above provisions may be waived by agreement between the landlord and tenant. However, the parties are obliged to comply with any legal requirement for individual water metering.

A possible requirement for individual water metering therefore does not require a change to the Commercial Leases Act.

5.6 Condominium Act

The Act on Owner-Owned Apartments regulates the conditions under which owner-owned apartments can be divided.

If the individual condominiums in an owners' association do not have individual water meters, it is stated in section 6(1) of the Danish Condominium Act that all common expenses must be distributed according to the registered distribution figures. If there is no registered distribution figure, the expenses must be distributed equally between the condominium owners, cf. section 2(1) of the Danish Condominium Act.

However, the statutes may stipulate that certain costs are distributed in a manner other than according to distribution figures, in particular so that greater consideration is given to the individual's consumption, including, for example, water

and heating.

The Danish Condominium Act does not contain provisions on the distribution of costs associated with water metering. A requirement for individual water metering would not necessitate an amendment to the Condominium Act.

6 Establishment of solution models

Below are solution models for the possible introduction of requirements for individual metering of hot and cold water in new and existing buildings based on the analyses carried out. Below are solutions for possible exceptions to the provisions.

Four solution models are described below.

A) **No changes**. This means that new residential units and commercial units in multi-occupancy properties are prepared for meters, but it is the owner who decides whether meters should be installed in the new building. Meters are not installed in existing buildings unless the owner decides to do so (however, in rental housing it is not the owner but the tenant who can decide to install meters). When installing new water installations in multi-occupancy properties, the installations must be prepared for individual metering.
B) **New construction.**Residential units and commercial units in new multi-occupancy buildings must in future have their consumption of cold and hot water measured. The same applies to the establishment of new water installations in existing multi-occupancy buildings.
C) **New construction and existing construction built after 1997.**Residential units and commercial units in new and newer multi-occupancy buildings built after 1997 must have their consumption of cold and hot water measured. The same applies when establishing new water installations in existing multi-occupancy buildings from before 1997.
D) **All construction.**Residential units and commercial units in all multi-occupancy properties must have their consumption of cold and hot water measured.

Re A) No changes
Developments in the metering area are currently very rapid, so that informative meters available on the market are expected to become significantly cheaper in the near future. These are meters that can be read remotely, provide the consumer with information about consumption and register errors in the form of leaks or poorly functioning installations such as running cisterns or taps.

The transition period for type-approved meters under the MID directive expires in 2016. It is expected that measurement based on the type approval will be more accurate because the installation method is included in the testing of these meters.

A suggestion could therefore be to wait for developments before introducing requirements for mandatory water metering, because the meters that can be installed in 5 years will be much better.

The proposal has no legislative consequences.

Ad B. New construction.
Technically, it is uncomplicated to establish measurement of cold and hot water in

the individual new home or commercial unit at the time of construction or in connection with replacing the building's water installation.

The proposal can be implemented by amending the Danish Enterprise and Construction Authority's Executive Order No. 891 of 9 October 1996.

The proposal will mean that residents in brand new buildings will have to pay for consumption in future. If there are residents in these buildings who receive housing benefit, this could mean that they will receive less housing benefit than otherwise. It can therefore be assumed that this will mean that residents who are dependent on housing benefit will not move in.

The proposal has no consequences for the Public Tenancy Act, the Commercial Tenancy Act, the Ownership of Apartments Act, the Cooperative Housing Act and the Tenancy Act.

Ad C. New construction and existing construction constructed after 1997
Existing buildings built after 1997 must, according to Executive Order No. 891 of 9 October 1996, be prepared for individual metering of cold and hot water. It is therefore technically uncomplicated and economically affordable to install meters in these buildings. In connection with the working group's report, the Danish Enterprise and Construction Authority conducted a study to determine whether the Executive Order in practice means that meters can be easily installed without significant costs in these buildings. The survey has shown that 92 per cent of the properties examined built after 1997 have cold water meters installed. Only 5 per cent of the properties are not prepared for the installation of cold water meters. For hot water, 13 per cent of the properties are not prepared for individual metering, despite the fact that they should be prepared according to Executive Order No. 891 of 9 October 1996.

The proposal can be implemented by amending the Danish Business Authority's Executive Order on individual metering of electricity, gas, water and heat No. 891 of 9 October 1996, with subsequent amendments.

Implementation of the proposal also requires an amendment to the Tenancy Act. If owners of buildings are to be required to install meters, a legislative amendment will be necessary - in buildings covered by the provisions of the Tenancy Act - if the form of settlement is to be changed to be based on meters.

The proposal has no consequences for the Public Tenancy Act, the Commercial Tenancy Act, the Ownership of Apartments Act and the Cooperative Housing Act.

For residents of buildings built after 1997, a requirement for individual water metering will have redistributive consequences.

The requirement for individual metering may have consequences for housing benefit, as the separation of the water bill means that the rent falls and thus also the housing benefit.

Ad D. All construction
Existing buildings built before 1997 are characterised by the fact that the supply of

cold and hot water to the individual installations, taps, showers and toilets, often runs across apartment boundaries. This means that many meters may be necessary to measure the total consumption of hot and cold water in the individual home or business unit. Installation of meters in the existing building

The installation of meters from before 1997 can therefore involve the installation of many meters and, in a number of cases, necessitate changes to installations and minor structural interventions.

Provisions on the measurement of cold and hot water in all residential and commercial units in multi-occupancy properties can be implemented by amending the Danish Business Authority's executive order.

Implementation of the proposal requires, as C), an amendment to the Tenancy Act.

The proposal has no consequences for the Public Tenancy Act, the Commercial Tenancy Act, the Ownership of Apartments Act and the Cooperative Housing Act.

There will be significant redistribution effects from requiring individual water metering in all buildings. For single people, the redistribution effect can make it very advantageous to settle according to metered consumption. However, a reduction in housing benefit may mean that there is no advantage to metering for, for example, a single pensioner.

However, the tables in section 4 also show that the costs of installation, the savings opportunities and the actual consumption have a significant influence on whether it is advantageous for the property as a whole, for the single person and for the pensioner to have meters installed. In addition, in many cases there will be large follow-up costs associated with a requirement for individual metering, as older buildings are not prepared for meters, like buildings built after 1997. Therefore, for example, kitchen elements and tiles in bathrooms and kitchens will have to be removed and reassembled.

Models for exemption from a possible measurement requirement
Proposals B, C and D require rules for exceptions, as there will always be examples of buildings where a requirement is not economically or technically reasonable. The following describes a number of examples of exceptions and criteria for the exceptions. There are basically two models for exceptions:

1) Exemption
2) Exemption due to owner's assessment

Re 1) Exemption
The current exemptions regarding electricity and heating in the Danish Business and Construction Authority's Executive Order No. 891 of 9 October 1996 are based on the municipalities, for a fee, deciding on a possible exemption from the provisions for those buildings that meet the criteria for exemption. The exemption solution is applicable if there are only a few cases where an exemption is relevant.

If solution B or C is chosen, the number of cases where a possible exemption is relevant will probably be limited.

Re 2) Exemption based on the owner's assessment
If model D is chosen, many exceptions will be needed if users are not to be imposed

large costs. It is therefore obvious to set sharp

criteria for exemption from measurement, so that the owner can assess for himself whether a building can be exempted from measurement.

Depending on the form of ownership, the "owner" of the property may have different incentives to have meters installed. In private rental properties, meters are considered an improvement. Installing meters thus does not entail costs for the owner. In owner-occupied housing associations, cooperative housing associations, and public housing departments, however, the economic consequences will affect the decision-makers.

Possible criteria for exemption from measurement

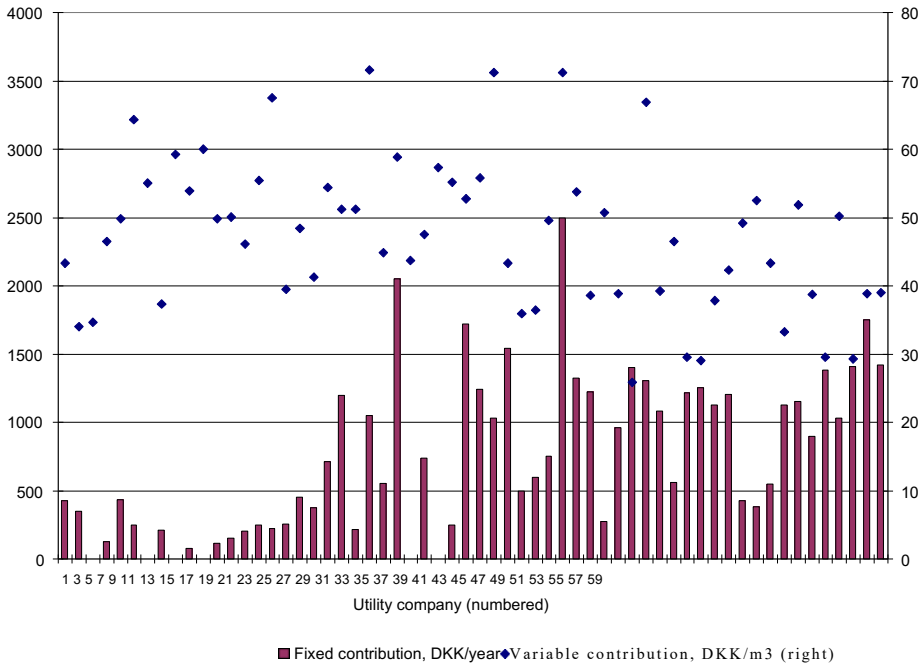
Some possible suggestions for general exceptions could be:

1. Low consumption per resident/user in the property (less than 80, 100, 120 or 140 liters per person per day (LPD)).
2. Need for more than 2, more than 3 meters, more than 4 meters per unit to measure consumption.
3. A low consumption per resident/user in the property (less than X LPD) + need for more than Y meters per unit to measure consumption. That is, a combination of 1 and 2.
4. Installation costs of more than DKK 3,000, 5,000, 8,000 or 10,000 per residential or commercial unit.
5. Installations that are more than 30, 40 or 50 years old and are expected to be renovated soon.
6. Homes/institutions where owners and users do not have the opportunity to significantly influence consumption (e.g. senior housing intended for the mentally disabled or demented).
7. Other solutions, e.g. office or commercial properties, where flexible leases make individual metering impossible.
8. Calculation of profitability based on average savings of 10, 15 or 20 percent on the water bill.
9. Commercial properties with minimal consumption per commercial unit (water consumption less than 0.5, l.0 or 1.5 l per m^2 per day).
10. Water supply areas with abundant water.

7 Appendix

Appendix 1. Variation in water supply company tariffs

FigureA.Fast and variable contribution for water supply companies for water supply and drainage, DKK per year and DKK per m3



Source and note: Information from DANVA. Contributions include VAT.

Appendix 2. Investigation into whether newer buildings are prepared for individual metering of cold and hot water

Rambøll has conducted a random survey for the Danish Enterprise and Construction Authority to determine whether multi-occupancy properties built after 1977 are prepared for individual metering of cold and hot water.

93 properties were selected based on an extract from the BBR register. The study aims to be nationwide, but due to the short time for implementation, it does not contain data from South Jutland, Funen and Lolland Falster.

92 percent of the properties surveyed have individual cold water meters. 3 percent of the remaining properties are prepared for meters, 5 percent are not.

57 percent of the properties have individual meters for measuring hot water. In addition, 30 percent have their own production of hot water. The remaining 13 percent are not prepared for measuring the hot water.

When 30 percent of the properties surveyed have hot water production in the individual housing unit, it is because the survey also includes terraced houses. The units in question then have a cold water meter that measures the total consumption of cold and hot water in the individual housing unit.

Table A. Preparation in percentage based on 93 selected properties built after 1997.

	Has meter	Prepared for measurement	Not prepared	Not applicable 19
Cold water	92	3	5	
Hot water	57	0	13	30

Installation conditions

For 67 properties, an assessment has been made of the cost of a requirement for meters that require a straight pipe section of 250 mm on each side of the meter to comply with the MID directive from 2016. It is currently uncertain whether there will be a need for a straight pipe section of this length before and after the meter or whether the requirements for reliable measurement results can be achieved without such pipe sections by choosing a better meter type.

The study shows that meters are immediately installed at no cost in 12 percent of cases. In 45 percent of cases, changing water installations will cost less than DKK 3,000. 40 percent of cases will cost DKK 3-5,000 and 3 percent will cost more than 5,000 kr.

19 The property has hot water production in the individual residential or commercial unit. These are typically terraced houses where the total water consumption in the individual home is measured with a water meter on the cold water.

There are only 3 percent of cases where, in addition to changes to the water installation, there is a need to demolish shaft walls, fixtures and the like to make room for straight pipe sections and meters.

Table B. Costs of changes resulting from straight pipe sections before and after the meter to ensure reliable measurement based on registration in 67 properties built after 1997.

Property	No	0 -3,000 kr.	3 – 5000 kr.	More than 5,000 kr.
	12	45	40	3