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DANISH ENVIRONMENTAL PROTECTION AGENCY
CEWP PI LOT 5

GETTING INVESTMENT PLANNING IN WATER SUPPLY AND SANITATION (WSS) RIGHT

FINAL

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Colophon

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SUMMARY

How to make sure you get value for money when investing in new pipes, pumps and filters in the water sector? How to choose between different options when it comes to, for instance, an enlargement of the network? How to get long-term economic and environmental perspectives into decision-making? How to secure stable and reliable financing? How to avoid the prevailing paradoxes in the water sector, such as substantial water losses in areas characterized by water scarcity? These are the key questions that this report addresses.

It does so in four chapters, excluding the introduction. Throughout the text several country specific cases are presented. Most of these stems from China, but there are also cases from, among others, South Africa, Spain and Ukraine. Furthermore, Danish experience is highlighted in an annex. The cases are aimed at making the report concrete, detailed and user-friendly.

The importance of making the investment planning right is emphasized. It is emphasized that water is not a free good, that capital investments in water supply and sanitation, foremost in wastewater treatment, are capital intensive, and that the infrastructure inevitably deteriorates if investment planning is not right. Subsequently, it is highlighted that framework conditions matter since they provide incentives to Water Service Providers and their consumers, whether good or bad, and that they are plenty. Many of the paradoxes that we face – for instance, huge water leakages in areas with water scarcity – may, in fact, be explained by framework conditions providing anything but good incentives.

A major precondition for prober investment planning is that the Water Service Provider may manage and operate its utility and, hence, has an incentive to operate with a long-term economic and environmental perspective. Among others, it shall know its revenue stream many years ahead. The framework conditions shall ensure this.

There are three possible revenue sources. These are Tariffs (levied on consumers), Taxes (levied on wage earners, companies and others) and Transfers (provided by donors in terms of development aid). Only, Tariffs may provide a stable and reliable revenue stream for the Water Service Providers. The reason being that Taxes and Transfers, if the country is eligible for Transfers at all, may easily change substantially from year to year. Hence, Tariffs should ideally cover both capital expenditure and operating expenses.

Certainly, this may imply that Tariffs become unaffordable for certain segments of population. If so, specially designed direct household assistance programs should be provided to households whose tariffs exceed a certain threshold (e.g. 4% of household income). It may be done in terms of a subsidy or a block tariff system (implying that tariffs vary according to consumption levels or ranges).

When the Water Service Provider itself conducts investment planning it is key that two requirements are met. These are:

- The Total Cost of Ownership Approach should be applied. That is, investment decisions are based on financial calculations of investment projects (NPV and IRR calculations) – and, most important, all costs are accounted for, not only "the top of the iceberg". Maintenance, decommissioning, rehabilitation, training…, all these costs are accounted for, not only acquisition costs. It may very well turn out that the investment with the lowest capital expenditure turn out to be the most expensive if operating expenses are properly accounted for. In other words, it may be expensive buying cheap.

- An Asset Management System should be in place. That is, all water assets are registered based on the year of establishment, risks are attached to the status of the assets based on regular inspection, and metering equipment is properly installed and used as part of digitalization.

In conclusion, the report provides a proposal for actions towards proper investment planning. Some of these are more relevant for some countries and some Water Service Providers than for others. Hopefully, they, as the report, may serve as a valuable source of inspiration for decision makers and practitioners eager to improve the cost-effectiveness of the delivery of some of the most basic services to humans, safe drinking water and sanitation.

LIST OF ABBREVIATIONS

BAT	Best Available Technology
BREF	BAT reference documents
CAPEX	Capital expenditure
CEWP	China Europe Water Platform
DEA	Data Envelopment Analysis
EEA	European Environmental Agency
EECCA	Eastern Europe, Caucasus and Central Asia
EPC	Engineering Procurement Construction
ESG	Environmental, social and governance
EU	European Union
FPTWU	Financial Planning Tool for Water Utilities
FYP	Five-Year Plan
FYROM	Former Yugoslav Republic of Macedonia
GHG	Greenhouse gas
ICWE	International Conference on Water and the Environment
IEA	International Energy Agency
IFI	International financial institution
KfW	Kreditanstalt für Wiederafbau
MEE	Ministry of Ecology and Environment
MoF	Ministry of Finance
MOHURD	Ministry of Housing and Urban-Rural Development
MWR	Ministry of Water Resources
NDRC	National Development and Reform Commission
NGO	Non-governmental organization
NWSC	National Water and Sewerage Cooperation
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OPEX	Operating expenses
PI	Partnership Instrument
PPP	Public Private Partnership
SDG	Sustainable Development Goal
SFA	Stochastic Frontier Analysis
TOTEX	Total Expenditure
WB	World Bank
WSS	Water supply and sanitation
WTA	Water Technology Advisory
WTTP	Wastewater Treatment Plant

FOREWORD

In recent years, the challenges facing the water sector throughout the world have become even more and bigger than anticipated just a decade ago.

Definitely, there is a wealth of strong developments. Water supply and sanitation has been extended to cover millions more people around the globe, and in many ways the progress regarding SDG 6 seems to be on a good track.

But, at the same time, the carbon footprint of the water sector remains to be addressed, water leakage rates are immense in a huge number of places, even places severely affected by water scarcity, and the uptake of the potentials of digitalization as a leaver to improve efficiency of the water sector is, at best, very unevenly distributed. The demand-supply gap seems to be widening, rather than being closed. In quite a number of cases, observations indicate that an important root cause of matters is the inefficient tender procedures, leading to "buy cheap" being promoted at the expense of "buy clever".

During 2018-2022, the China Europe Water Platform Business Program has in a series of 25 events and webinars, showcasing more than 150 presentations, mainly technology cases presented by companies, addressed the availability of state-of-the-art technologies and the degree to which, in principle, all water sector challenges could be addressed, and which barriers that exist to this.

Several observations, confirmed by a questionnaire among the participants, point to the lack of adequate framework conditions for the Water Service Providers, causing lack of incentives for these to operate and invest within a long-term economic and environmental perspective.

Important to notice, as also illustrated in this report, this situation seems to exist both in China and Europe, and even beyond in several other places.

This report takes the discussion of the China Europe Water Platform further and elaborates on the importance of stable and reliable financing and investment planning, as well as the framework conditions required to promote this. The ambition of this report is to provide insight and inspiration to ensure long-term value creation in the water supply and sanitation sector and to ensure maximum benefit of the substantial investments made to secure water for all.

Copenhagen, 7 September 2022

Henrik Dissing
CEWP Business Program Manager

CONTENTS

1 Introduction

How to make sure you get value for money when investing in new pipes, pumps and filters in the water sector? How to avoid inefficient use of money? How to choose between different options when it comes to an enlargement of the network? How to secure stable and reliable financing? How to get long-term economic and environmental perspectives into decision-making? These are the key questions we address in this report.

The report provides insight into investment planning within the water supply and sanitation (WSS) sector, and how this constitutes a prerequisite for sustainable water management.

Getting investment planning right is fundamental for the water sector to increase water use efficiency, to bring water losses to a minimum, to develop a carbon neutral water sector, to improve asset management and to retain water services at a socially acceptable price level, while at the same time increasing the water supply and water quality service levels.

Hopefully, the report may contribute to an improvement of investment planning and its framework conditions, to a strengthening of the enabling environment for investments, facilitating a higher degree of financial realism into the operation and management of water utilities in China and Europe thereby ensuring water security in a long-term perspective.

If the framework conditions are not properly in place, incentives for the Water Service Providers (or water utilities) will not lead to sustainability in the sector. Investment decisions and operational priorities will be flawed, and accordingly procurement, as well as use and asset management of equipment, will not be optimal. This will come with excessive economic costs to the society. An

example: If the key performance indicator for a Water Service Providers is volume of water sold, water use efficiency and long-term sustainable may be neglected, even in case the area in question suffers from water scarcity.

The target group of the report consists of Chinese and European authorities at all levels (national, regional, and municipal) as well as Chinese and European water utilities. Key Chinese institutions are Ministry of Water Resources (MWR), Ministry of Housing and Urban-Rural Development (MOHURD) and Ministry of Ecology and Environment (MEE) – as well as National Development and Reform Commission (NDRC) and Ministry of Land Resources. Key European institutions are ministries and other entities responsible for water management.

Box 1-1 Questions for reflections

The following questions are meant as possible questions for reflections, while reading the report. They are in no way exhaustive.

Authorities

- Which improvements in prevailing legal and regulatory framework regarding investment planning may be made in the short and mid-term?
- How to support and monitor Water Service Providers in operations and management, while at the same time keeping an arm's length approach
- Where do we see huge gaps between dominating technologies in a certain market and Best Available Technologies as formulated, for instance, by the EU – and how may changes in the legal and regulatory framework address these gaps?

Water Service Providers

- Could we improve the methodologies and tools we apply in investment planning and asset management?
- How to ensure ongoing skills upgrading of staff?
- How may we benefit from increased digitalization?

Producers of equipment

- Are there particular issues to be aware of when penetrating a new market or region (in China or any other country)?
- How and when reaching out to local governments and Water Service Providers?
- Which performance indicators to highlight when preparing sales materials?

The report consists of five chapters, including the current:

- Chapter 2 sets the scene, highlighting why proper investment planning is that important to authorities, Water Service Providers and consumers – and, hence, society as a whole

- Chapter 3 briefly addresses financing – both sources of financing and major observation points in connection with financing decisions

- Chapter 4 deals with investment planning and accompanying asset management
- Chapter 5 puts forward a number of actions to be taken to introduce proper investment planning in a country, where it is not yet in place.

Three annexes are attached to the report – one on references, another on concepts used and yet another on Danish experience with investment planning.

Throughout the report the reader will find boxes addressing a certain issue. This has been done to make the report readable, user-friendly and concrete. Many of the boxes concern China. The country specific boxes are highlighted by a flag.

The report has been prepared by COWI A/S within the framework of the CEWP PI project, funded by the EU Partnership Instrument. The Danish Environmental Protection Agency, leader of the CEWP PI Lot 5 Business Program, is the Client.

A number of experts, in addition to the main contributors mentioned in the colophon, have provided useful input to the team preparing the report – in terms of meetings, both online and offline, and mails. These are:

- Thor Danielsen, Sector Expert WTA EU
- Benny Nielsen, Head of Department, Herning Water
- Søren Larsen, Asset Manager, Aarhus Vand
- Xavier Leflaive, Principal Administrator, OECD
- Juan Vera Sarría, Senior Advisor, Royal Danish Embassy in Spain.

However, final responsibility of the report, including possible errors, rests with COWI A/S.

2 Setting the scene

If investment planning is not right, inefficient use of money combined with a decrease in service levels is unavoidable. However, getting it right, is not just a walk in the park. All countries have experienced this, including China and countries in Europe.

2.1 Why it's important making investment planning right

Investment planning in the WSS sector is about planning one or more actions aimed at improving and/or extending the WSS system in a given area, thereby increasing service levels to the benefit of population, industries and others. The sequence of actions (e.g. acquisition of pumps, pipes and meters and their installation) is of importance in this regard. So is the lifetime of the assets, capital expenditure (CAPEX) and operating expenses (OPEX).

The ultimate goal of investment planning is to make the best use of available assets and financing resources, and harness new sources of finance, if and when required. If that goal is achieved, investment planning is right. Water losses decrease, energy efficiency increase, and service levels improve; this in the most cost-effective way, thereby providing value for money to the society.

In this context it's important keeping in mind that investments in water supply and sanitation are capital intensive and long-lived with sunk costs. That is, initial investments are high-cost investments with long pay-back periods (20-30 years). This is, especially, true regarding investments in wastewater treatment. Hence, it should not take anybody by surprise that CAPEX in the WSS sector according to the OECD amounts to roughly 50% of the total costs (OECD, 2022a). It underpins why it's so important getting investment planning right so as to make the best use of capital available, keeping in mind that investment planning is not only about CAPEX but also about the resulting OPEX.

If investment planning is not right the infrastructure deteriorates. The reason being that appropriate CAPEX and OPEX are not provided. Impacts are many. Irregular services due to breakdowns, leakages, and possible contamination of drinking water pipes, and, hence, difficulties in reaching the SDG 6 on clean water and sanitation. In countries, where the current infrastructure dates back many years the impacts of a further deteriorating infrastructure may be disastrous. It is the case in many EECCA countries. In Armenia, for instance, 60% of water supply networks and sewage collectors were built more than 35 years ago, and the infrastructure deteriorates alarmingly these years.

Box 2-1 Weaknesses, Chernivtsi Water Utility, Ukraine

Chernivtsi is a city in the Western part of Ukraine with a little less than 300.000 inhabitants (before 24 February 2022). In 2020, COWI was entrusted a KfW contract aimed at improving the water supply and discharge infrastructure in the city in line with EU requirements; the infrastructure dates back to the Soviet era, to the 1970's and 1980's. The project is still ongoing; it is expected it will be extended by, at least, two years.

As part of the project the weaknesses of Chernivtsi Water Utility were identified and thoroughly discussed so as to find out how to mitigate the weaknesses by, among others, improving existing legal and regulatory framework at various levels and adjusting prevailing management practices.

Among the weaknesses identified are the following:

- Infrastructure is deteriorated, energy efficiency of existing equipment is low and non-revenue water constitutes a big problem (due to leakages);
- Laws, regulations and other by-laws are not aligned (even ownership rights of land may be unclear);
- Existing standards and norms do not comply with best available technology reference documents (e.g. BAT notes or BREFs) issued by the EU; in some cases, they are more strict, in others, less;
- Tariff setting depends on political decisions, foremost by the Chernivtsi City Council; little trust in the National Energy and Utilities Regulatory Commission, which lays down methodology for tariff setting (due disputes about its mandate, influence of politicians on its activities, questionable appoints of senior staff, etc.);
- Insufficient investments in new infrastructure and rehabilitation (CAPEX);
- Existing tariffs cover only part of OPEX and not investment and depreciation costs at all; hence, the Water Service Provider is permanently in need of government subsidies (from municipal budget);
- Metering coverage is low; they are virtually absent at household level;
- Organizational structure of Water Service Provider is complicated and suffers from unclear division of powers and responsibilities (also vis-à-vis the municipal government); its revenues are not ring-fenced;
- Lack of inhouse staff for strategy planning, lack of young staff – and lack of clear and transparent skills upgrading programme;
- Relatively, low salary levels;
- High dependency on external financing from IFIs (some would say "too high").

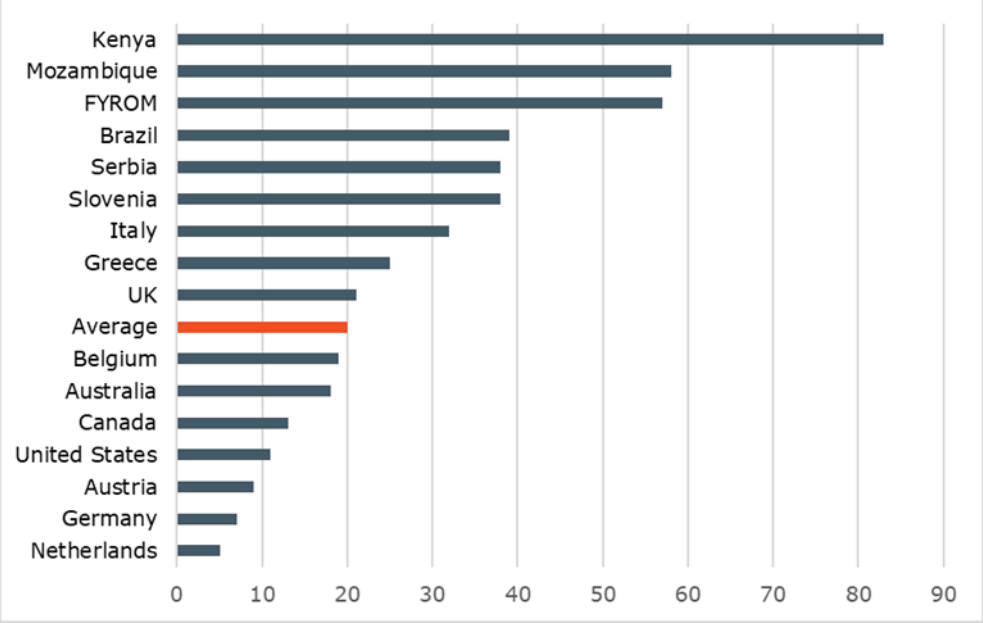
2.2 Framework conditions matter…

How investment planning is made, whether it is right or not, depends on the framework conditions. These matter a lot, to put it mildly.

If framework conditions are not in place – if they do not enable solid investment planning – one will find many apparent paradoxes that all arise from adverse incentives. Examples hereof can be found all over the world. They include situations, where:

- Water losses are huge at the same time as water scarcity is profound. The EEA reports water leakages of more than 25% of the total water supply in many eastern and southern European countries. Also in China, leakage rates are often in two-digit numbers. Worldwide, leakage rates in water distribution networks amount to about 20% in average, cf. Figure 2-1. Often, there is a strong resemblance between countries with huge leakage rates and countries, where tariffs only cover only a portion of the financing source – and also between countries with huge leakage rates and countries suffering from water scarcity. It indicates a strong correlation and inadequate framework conditions for the Water Service Providers to embark on long-term value creation.

Figure 2-1 Water losses vary a lot – and they are huge in some countries[1]



Note: 1) Leakage rates in water distribution networks world-wide. Data from Global Water Intelligence, 2008.
Source: Laspidou, C.S., 2014.

- It is cheaper to a Water Service Provider to extract more water than to reduce water losses. In the absence of appropriate framework conditions, it may happen that it does not pay off for the Water Service Provider to invest in lowering leakage rates and, hence, also lowering non-revenue water. This

is the case if it is cheaper to a Water Service Provider to extract more water than to reduce water losses. In some countries (e.g. in Africa), the pressure of the system is kept at a low level so as to reduce water leakages since financing to improve the system is not available; the consequence is that the water pressure is so low that upper floors of an apartment block receive no water, maybe except for odd hours, say nights during weekends.

- Water Service Providers do not invest in technologies capable of reducing energy consumption due to heavily subsidized energy prices. Overall, the IEA estimates that the water sector's share of global electricity consumption amounts to 4% and remains at this level by 2040. There are, however, regional differences. In Europe and United States, it's share is about 3% and remains at this level by 2040; in the Middle East, it is about 9% and may increase drastically in the period up to 2040 due to a rise in desalination capacity, up to 16%. If the electricity is produced by fossil fuel sources, this implies a significant contribution to GHG emissions, on top of which comes the GHG emission contributions from CO_2, N_2O and methane from the wastewater treatment processes. Technologies exists to convert wastewater treatment facilities into net energy producing and climate neutral plants, but without appropriate framework conditions, including energy prices being without subsidies, the Water Service Providers will not invest in state-of-the-art technologies allowing for strongly improved asset management and long-term value economic and environmental value creation.

In this context it is worth reminding that water comes with a price, one way or the other. Water is not a free good as highlighted in Box 2-2 below.

Box 2-2 Water is not a free good

From time to time, one may meet people, be it decision makers, representatives of NGOs or others, who advocate that water is and should be considered a free good.

From an economic point of view this is totally wrong.

The reason is twofold:

- Water is a finite and vulnerable resource

  Since 1992, when the so-called Dublin Principles for managing freshwater resources were established and approved at the International Conference on Water and the Environment (ICWE) in Dublin, this has been widely recognized throughout the world. Although water is a renewable source, it is a finite and vulnerable resource. The supply decreases if the groundwater is extracted in excessive quantities in a relatively short time, as is the case in, for instance, northeastern China, where the groundwater level falls every year.

- There are costs as well as benefits linked with the provision of clean drinking water and sanitation to all (SDG 6)

  On the cost side, we have construction, extraction, pumping, transmission, distribution, treatment, staff, energy, IT and many other cost items. On the benefit side, we have public health, good wine, tourism, biodiversity and others.

Hence, water comes with a price. The price shall reflect the scarcity and nudge the water users to water savings, while at the same time covering the costs linked with the provision of clean drinking water and sanitation. To what extent the price shall reflect scarcity – and to what extent it shall take into account the many benefits putting a price tag on these – is a point of discussion. As a rule, the focus is on the costs when establishing the price.

Framework conditions shall ensure that Water Service Providers are legal entities operating as companies. If the framework conditions provide the right incentives, the companies are indirectly forced to do what prevailing legislation and the Regulator (or another administrative body) wants them to do. If, for instance, an efficiency improvement target is imposed by the Regulator, the companies will try to comply with the improvement target, either through savings on the operations or through investments reducing operating costs. In this way the framework conditions separate functions and powers of policy from operations; the Water Service Providers may make their own decisions, including investment decisions, as long as they comply with prevailing legislation and public management decisions. This implies that the municipal owner –

Box 2-3 Struggling with water losses, Poland

In Poland, water scarcity is becoming more and more apparent. Poland ranks as the fourth lowest country in the EU in terms of freshwater per capita, below countries like Spain and Italy. This means that water loss can pose a real issue, not just in accounting terms for the Water Service Providers, but also for the security of water supply in the future. A recent report by the National Auditing Board of Poland found serious issues with water loss in the audited Water Service Providers; water loss levels up to 60% were found. This calls for a proper regulation and target setting of the level of water loss, as well as an auditing system to enforce the regulation.

Currently, Poland is aiming to future proof their regulation to lower water loss and optimize the efficiency of utilities through implementation of the water framework directive and through its own measures. The Polish authorities revised its regulation of the water sector with the Water Act, which has been in effect since 2018. The act aimed to centralize the economic regulation of the Polish utilities and ensure the efficient use of revenues for water services.

The act ensured that the state regulator Wody Polskie (Polish Waters), under the Ministry of Infrastructure, was given the full regulatory responsibility of the water sector and the task to review and approve tariff increase approvals put forward by the utilities. The regulator ensures that no dividends are paid to the municipality, which is usually the owner. Dividends are not explicitly prohibited, which weakens the goal of achieving ring-fenced budgets of utilities. The Polish economic regulation means that depreciation of assets is included in the tariffs, which allows for the utility to fund CAPEX investments partly based on their own revenues. This means that CAPEX investments in Poland are approximately 60% financed by the revenues of utilities, while 20% comes from national funds, and the rest is from EU funds and loans.

It is well acknowledged in Poland that a well-designed and transparent benchmarking, auditing and reporting system is very much in need to promote water use efficiency. The system is under development.

assuming the local government, as is usually the case, ultimately owns the Water Service Provider – are not able to interfere in the operations of the Water Service Provider, and that all revenues from selling water services should remain within the Water Service Provider (i.e. revenues are ring-fenced). The municipal owner shall only be able to influence the development of the Water Service Provider through its representation in the Board of Directors of the Water Service Provider. Decisions should solely be made by the management of the Water Service Provider without any interference from the owner. However, some investment decisions must be approved by the Board of Directors if the investments are above a certain threshold.

Furthermore, it is crucial, as repeatedly mentioned by international organizations such as the Global Water Partnership, OECD and World Bank, for the Water Service Providers to have autonomy, including decision-making power for pricing, developing corporate policies for financial dispositions, prioritization of asset management, and investment decisions which are crucial for the Water Service Providers to think in long-term objectives and comply with the regulations of the sector. However, prices cannot be set higher than the regulatory set revenue cap; see below. This is the most optimal way to secure that the Water Service Provider can achieve the service targets set by the authorities regarding water quality, service quality, etc. Independent economic regulation can support the transition towards sustainable financing strategies.

Box 2-4 Local government is in the drivers' seat, China

In China, investments in WSS are decided upon by local governments (at municipal or district levels). The reason being that the provision of safe drinking water and sanitation for all is considered the responsibility of the local governments. The local government's FYP address the WSS sector and lists investment projects to be carried out in the next five-year period.

An example: The 14th FYP for Guangzhou, approved by the Guangzhou Municipality on 30 March 2022, includes a water sector development plan[1]. It reflects FYP's at higher levels. It lists specific investment projects highlighting title and completion date.

Note: 1) http://www.gz.gov.cn/zt/post_8162661.html.

Box 2-5 Complexity is a key word, China

Even though local government is in the drivers' seat regarding investment decisions in WSS, complexity is a key word when describing and analysing the WSS sector in China.

Many features contribute to this, including:

- 34 provincial level administrative divisions – with differences between cities in terms of exact role of local government, capabilities of local stakeholders, including research and design institutes, and investment models applied when implementing investment projects (EPC, PP or another model);
- Many stakeholders – with different mandates, different agendas (or policy goals) and changing agendas over time;
- Varying climate conditions – with differences from North to South and Est to West.

Hence, the analyst or supplier who wants understanding the exact investment planning process in a certain Chinese city has to obtain information and data from this particular city.

Box 2-6 Non-revenue water, China

Still, non-revenue water is a major challenge within water supply in China.

The reason hereof is multifaceted. Lack of sustainable financing of the water supply system hampers prober maintenance and upgrade of the water supply system (because tariffs are too low), the water utilities pay little attention to non-revenue water (maybe because they experience a soft budget constraint in terms of subsidies) and essential equipment and software for solid non-revenue water management is not in place throughout the country (could be that water meters in water supply stations and residential buildings are not installed).

It is noteworthy that the last-mentioned reason prevents the implementation of a fully-fledged, digitalized asset management system in many Chinese municipalities. The water groups do have data bases of existing assets (by age, state, etc.), but equipment and software to easily monitor changes in the state of the assets are still lacking.

2.3 … and they are plenty

Framework conditions matter. It follows from the section above. Moreover, framework conditions are plenty. They comprise many instruments. Hence, establishing a framework that enable solid investment planning is a challenge.

When describing and analyzing the framework a distinction may be made between the legal framework and the regulatory framework. The legal framework concerns the preparation and approval of legislative acts and orders, whereas the regulatory framework concerns the institutional set-up, public management and implementation of legislative acts and orders.

Table 2-1 provides an overview of selected topics addressed by the legal framework and regulatory framework, respectively. It does not provide a comprehensive picture of the many topics that are addressed.

Table 2-1 Framework conditions, Selected topics[1]

	Topics	Examples
Legal framework	Ownership	› Clear legal status of Water Service Providers › Clarity about ownership of land and assets › Clear division of powers and responsibilities of utilities vis-à-vis municipalities (owners)
	Ring-fenced	› Revenues of Water Service Providers cannot be used for other purposes than water services
	Tariffs	› Tariffs paid by the consumers to Water Service Providers are well established and monitored
	Subsidies	› Targeted subsidies to address household affordability constraints in accessing WSS services
	Procurement rules	› Clear procurement rules › Frequent update of standards, norms, etc. referred to in procurement › Methodology (e.g. unit cost methodology) to fight corruption
Regulatory framework	Governments (at all levels)	› Intra- and inter-governmental water policy co-ordination mechanisms › Policy goals regarding service levels (e.g. SDG 6)
	Regulator	› Independent central Regulator overseeing and supporting Water Service Providers taking into consideration policy goals of the governments (e.g. in tariff setting) › Promoting benchmarking within the sector › Facilitating the further digitalization in the operations and management of Water Service Providers
	Water Service Providers	› Information systems (e.g. data collection, monitoring, and early warning systems on water quality) › Inventory providing overview of assets available and accompanying asset management › Ongoing, formalized skills upgrading of staff

Note: 1) When developing this table, the authors have drawn valuable inspiration from the OECD (2022a).

Box 2-7 Framework conditions suffer from lack of independent Regulator

There is a huge financing gap in the WSS sector in Spain. This is the biggest problem. According to some recent studies, investments in urban areas are 70% less than required if only the existing infrastructure is to be properly maintained and replaced. The solution is under discussion. Some advocates for increased involvement of private investors to obtain additional financing, others state there is no way out but to increase tariffs (emphasizing that by the end of the day consumers will have to pay, one way or the other, independent of whether private investors are involved or not).

Half of the population is served by private or public-private water utilities that operate under concession contracts with the municipalities (providing services to the consumers in a certain area). However, the municipalities are the majority owners of the water infrastructure, such as purification plants, distribution and sewage networks and wastewater treatment plants.

Consequently, the central, regional and local administrations are after all in charge of managing water in Spain. Their roles differ:

- The central government is responsible for transposing EU Directives into national laws. It has the responsibility of controlling and monitoring water management in accordance with European regulations (for example, with discharge limit values among other parameters). However, the lack of a single and independent Regulator at central level responsible for this makes it almost impossible to conduct comprehensive, systematic and forward-looking water management in Spain and provide solutions to the many problems faced by the sector.
- At the regional level, each autonomous community (executing body at the regional level in Spain) acts in accordance with national laws, but it may, within the framework of these, develop and implement regulations on its own for the control of water management on its territory, especially in relation to wastewater treatment.
- The municipalities carry out the provision of final services to the users, such as the supply of drinking water, sewage and wastewater.

The autonomous communities and municipalities are in charge of tariff setting subject to national laws. There is not an independent Regulator at central level, who may intervene in tariff setting. Moreover, there is no cap for tariffs. Only it is well acknowledged that the mayor who introduces a substantial increase in tariffs may not be re-elected. So, whenever the tariffs are low and do not secure stable and reliable financing allowing the Water Service Provider to cover CAPEX and OPEX through tariffs, it is for political reasons.

It should be noted that Spain has some of the lowest urban water supply tariffs in Europe. It is almost 50% below the EU average.

Box 2-8 Conglomeration may increase efficiency, Uganda

Uganda National Water and Sewerage Cooperation (NWSC) is the major Water Service Provider in Ukraine responsible for water supply and sanitation in more than 250 towns and urban centres. It was created in 2013 by a Government decision as a conglomeration of 27 towns and urban centres.

The NWSC has been responsible for all stages in the project cycle regarding new investments, in addition to operations and management of its infrastructure and many customers (today, it serves more than 650,000 connections). It is widely respected for being a well-managed company.

There is little doubt that the conglomeration increased the efficiency of NWSC substantially – and that this increase in efficiency has provided some shield from political influence.

2.4 Key messages in a nutshell

Key messages in this chapter are:

- Investment planning - in the WSS sector, as well as in other sectors - shall ensure the best use of available assets and financing resources, and harness new sources of finance;
- If this is not the case, the infrastructure deteriorates;
- Framework conditions are crucial for the possibility of conducting solid investment planning;
- The framework shall, among others, ensure that the arm's length approach apply in the relationship between a municipality and the municipally owned Water Service Provider;
- Framework conditions are plenty, and it is a challenge establishing a framework that enable solid investment planning.

3 Securing stable and reliable financing

Stable, multi-year financing is crucial. If it is not in place, an investment will inevitably turn into the liquidation of assets due to the lack of funds and, hence, proper maintenance of the infrastructure. Basically, the three T's (Tariffs, Taxes and Transfers), in one or the other combination, provides the financing.

3.1 Three T's

Stable, multi-year financing in water supply and sanitation implies that sufficient financing is provided in the mid to long term. Sufficient financing is financing capable of covering costs, both CAPEX and OPEX, linked with the maintenance and enlargement of the infrastructure to the benefit of households, industries and others in the service area in question. Services should be reliable, and service levels in line with promises made. Water Service Providers should be able to do financial planning for several years ahead (e.g., at least, 10 years).

When doing financial planning and, hence, establishing future revenue streams, the Water Service Providers have, when all comes to an end, only three sources. This holds true independent of whether the Water Service Provider is municipal owned or not, whether it is ring-fenced (or fenced-off) from the other activities of its owner, or whether loans, bonds and equity are obtained one way or the other. The three sources are frequently referred to as the three T's from the capital letters of the three options, namely Tariffs, Taxes and Transfers.

Features of the three T's are:

- *Tariffs*

  These are, as a rule, collected by the Water Service Providers and provides a regular revenue stream. They constitute the foundation of future revenue streams. Tariff setting may be regulated by a Regulator, an independent central agency. Independent of the existence of a Regulator, tariff setting is closely linked with questions about affordability and political acceptability. It is important that tariffs are affordable to all segments of population and also that there is a high degree of willingness to pay among consumers. Usually, one finds that willingness to pay for water supply and sanitation services is high in both rural and urban areas.

  To what extent tariffs cover CAPEX and OPEX vary a lot across countries. In many countries, tariffs do not cover CAPEX at all and only part of OPEX.

- *Taxes*

  Taxes is, in fact, synonymous with government budget (usually, municipal budget). That is, the municipality may use the taxes it receives, as well as funds received from the national government or an intergovernmental organization (could stem from Chinas 14th Five Year Plan or from EU funding), to provide financial support to the Water Service Provider – typically, in terms of a subsidy negotiated annually in connection with the preparation of the annual budget of the municipality and also of the Water Service Provider. This source does not provide a regular revenue stream, even though it may not change that much from year to year.

- *Transfers*

  In this context transfers refer to international grants or Official Development Assistance (ODA). This is mainly done through bilateral aid programs provided by IFIs and bilateral donors. Such transfers may finance part of CAPEX but cannot be used to finance OPEX.

  ODA eligible countries consist of all low-income countries and some middle-income countries below a certain threshold based on gross national income per capita. A country experiencing increasing prosperity may become non-eligible for ODA. This has, for instance, been the case with China.

  It should be noted that loans only relocate cash payments in time. Eventually loans have to be repaid from taxes or tariffs. Loans do not constitute an ultimate source of finance but are rather a bridging arrangement to postpone payments from taxes or tariffs.

Please note, that a PPP model, no matter which, does not imply that new sources are introduced – by the end of the day, consumers or taxpayers have to pay through the three T's. PPP models are widely used in the WSS sector in many countries throughout the world, including China.

Box 3-1 Tariffs account for less in the new EU countries than in the old

According to calculations made by the OECD on the sources of finance for water supply and sanitation services in the EU, tariffs accounted for 69% in all EU Member States in 2011-2015 (average), whereas taxes accounted for 31% (OECD, 2022a). The shares were a little different for the old EU countries (EU-15-countries, including United Kingdom) and the new EU countries (EU-13 countries, i.e. Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovak Republic and Slovenia). For EU-15 tariffs accounted for 71%, for EU-13 they accounted for only 57%.

Historically, tariffs have accounted for a less share in the EU-15 countries.

Box 3-2 Various business models, China

Investment projects are implemented in different ways, depending on the business model applied. In China, two business models are frequently used:

- EPC

  This model entails that the project owner (typically, the water group) identifies a main contractor who is entrusted the investment project, from design and procurement over construction to commissioning of the engineering construction project in accordance with the contract concluded. The project owner may include clauses and provisions in the contract with regard to technical standards, equipment and/or use of sub-contractors. The project owner supervises the contractor, but has limited influence on the project implementation.

- PPP

  This model entails that a consortium is established, usually upon the initiative of the local government or project owner. The consortium will consist of different partners (local government, water group, design institute, private developer, construction company, supplier, etc.). As a rule, these are Chinese. However, there are examples of consortia in the WSS sector with participation of international partners (e.g. the Chongqing Sino French Water[1], which is a Sino foreign cooperative enterprise jointly invested and established by Chongqing Water Group Co., Ltd. and Chongqing Sino French Investment Co., Ltd., mainly engaged in the production and sales of drinking water in the franchise area, the construction, operation and management of

relevant water plants and supporting facilities and water supply related businesses). If, the consortium is not led by the local government, it will be registered as a project company according to the partners' (or shareholders') agreement. The PPP itself may take many forms varying in the extent of involvement of and risk taken by the non-government parties: Build-Transfer (BT), Build-Operate-Transfer (BOT), Design-Build-Operate (DBO), Build-Own-Operate-Transfer (BOOT), Renovate-Operate-Transfer (ROT) and JV. That is, the PPP arrangements in China within the WSS sector are not narrowly connected with BT or BOT models as is the case in many countries throughout the world. Many models are applied. They all encompass long-term alliances between local governments and private partners aimed at sharing associated risks of an investment project, whether big or small.

Note: 1) Chongqing Sino French Water website: http://www.cqsf.com.cn/.

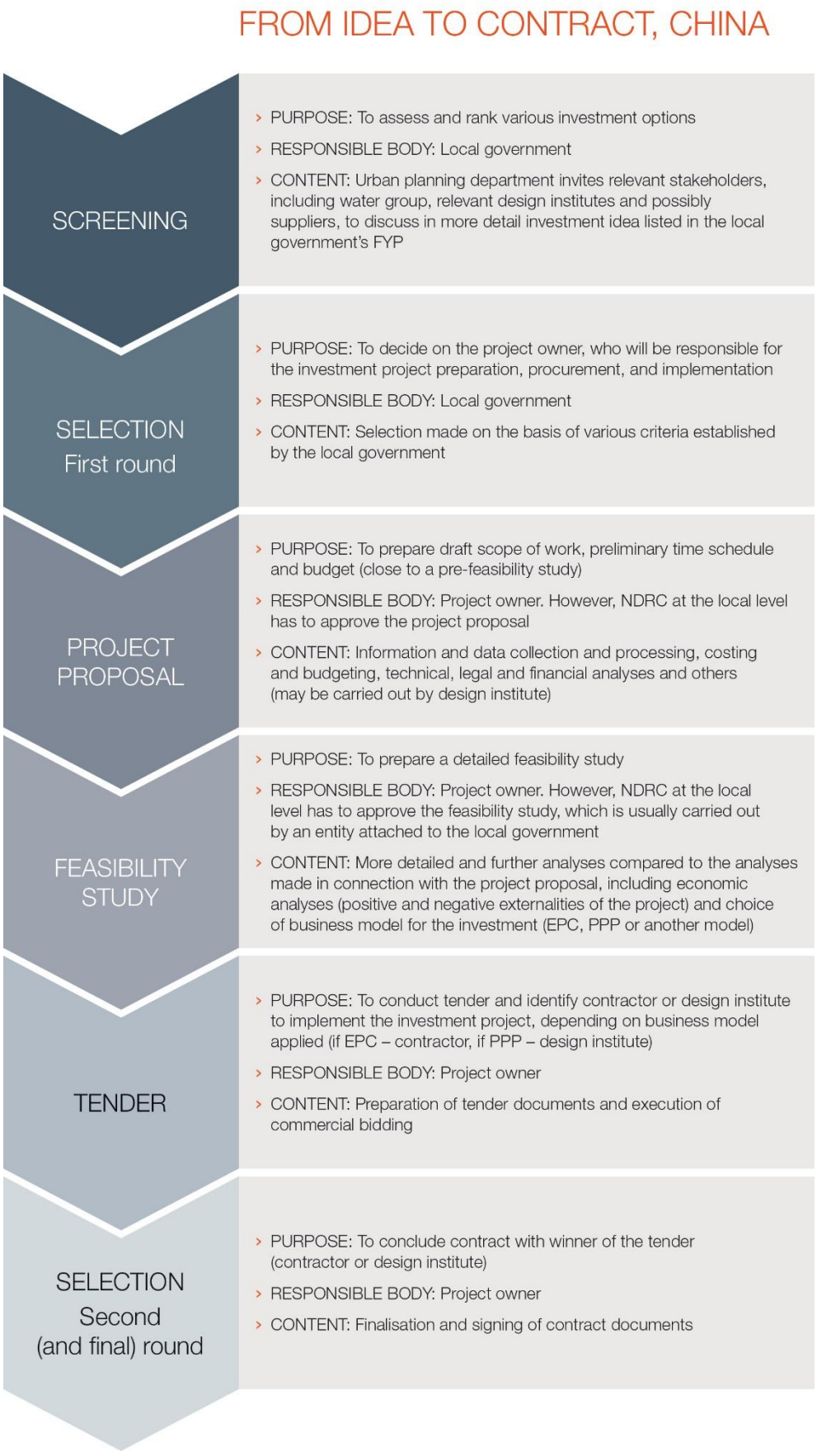
3.2 Financing strategies

Policy goals, plans and projects, including investments, shall be accompanied with robust and realistic financing strategies. Such strategies are often lacking.

They should be applied throughout the initial stages of the project cycle – not least, when conduction strategic planning and screening various investment options – and they should clearly set priorities and drive investment decisions. They should include provisions for investments in new infrastructure to increase service levels, maintenance of existing infrastructure and accounting for the backlog of under-investment in maintenance in the past. Strategies should also include targeted social measures to address affordability constraints.

In particular, the financing strategies shall ensure that serious funding gaps do not arise, that Water Service Providers are creditworthy making it easier to attract finance, and that financial realism prevails in decision making.

Chart 3-1 From idea to contract, China



Box 3-3 Serious funding gap, South Africa

The water supply and sanitation sector in South Africa suffers, as in many other countries around the world, from a serious funding gap. When preparing the National Water and Sanitation Master Plan in 2018, the Water & Sanitation Department assessed the magnitude of this financing gap over the next 10 years (Water & Sanitation Department, 2018). Assuming no changes in service levels, tariffs or subsidies to the sector calculations revealed a funding gap of 33% of funding requirement. Funding requirement was estimated at 899 billion Rand, funding available at 566 billion Rand – and funding gap at 333 billion Rand.

A gap of this magnitude inevitably lead to further service interruptions, increase in water losses and widespread consumer dissatisfaction.

Various tools to prepare financing strategies in the WSS sector. One of these is FEASIBLE, which was developed more than 20 years ago.

Box 3-4 Financing strategies, FEASIBLE

FEASIBLE is a software tool developed to support the preparation of environmental financing strategies for water, wastewater, and municipal solid waste services. The name FEASIBLE stands for: Financing for Environmental, Affordable and Strategic Investments that Bring on Large-scale Expenditure. The first version of FEASIBLE, a spreadsheet-based version for water and wastewater, was released in 2001. FEASIBLE Version 2 is a stand-alone application based on a database. The FEASIBLE model is freeware and can be obtained through the web pages of the OECD, DEPA/DANCEE and COWI. FEASIBLE can be used to facilitate the iterative process of balancing the required finance with the available finance. It provides a systematic, consistent, and quantitative framework for analysing feasibility of financing environmental targets. Being a computerised model, FEASIBLE may be used to analyse "what if" a certain policy is changed and to document its financial impacts in a systematic and transparent manner.

If you want to know more, please visit:
www.oecd.org/env/outreach/methodologyandfeasiblecomputermodel.htm.

3.3 Subsidies, Watch out

Subsidies stem from the public budget (i.e. from taxes). They refer to payments to Water Service Providers or to vulnerable groups who may find it difficult to pay the water bill due to affordability constraints. It is key, no matter whether

the subsidy goes to a Water Service Provider or a household, that the subsidy is predictable, transparent and, not least, carefully targeted and maybe even time bound. Very often this is not the case. In the words of the OECD (2022a): "Subsidies often fail to meet these criteria (predictable, transparent and carefully targeted, *authors*), instead distorting prices or creating perverse incentives that negatively affect water availability, quality or demand".

One should be careful in introducing subsidies from municipal budget to the utility – in terms of, for instance, direct disbursements of funds.

Subsidizing a Water Service Provider from the municipal budget is, in fact, an outdated form of providing financial support to the WSS sector in addition to the revenue stream from the tariffs. In recent two-three decades, it has largely been replaced by direct household assistance programs in virtually all countries in the world. The main reason for this development is that a public subsidy to a municipal enterprise is politically driven, not stable, and varies in size from time to time. When deciding on such subsidies the municipal administration rely on information regarding upcoming financial conditions of the enterprise. First, such information is usually forecasted and unreliable, Second, it is interfering with commercial decision-making of the enterprise. In contrast, direct household assistance programs do not impact on the revenues of the Water Service Provider.

Certainly, social protection measures may be very much in need. Typically, in cases when financially well-founded tariff increases imply tariffs above the affordability threshold for low-income households for WSS services (this threshold amounts to 3-5% of an average household income according to donors and IFIs). Two overall options exist. One is a direct household subsidy, not affecting the tariff levels. Another is to make tariffs affordable to low-income households – through volumetric tariff systems, where tariffs increase with volume consumed, cross-subsidies, where rich people pay more than poor people, or introduction of different tariffs for different types of consumers (e.g. residential, commercial and industrial).

From an economic point of view the preferred option is the direct household subsidy. It is fair, transparent, and allows the Water Service Provider not to engage in social affairs, but to operate on a commercial basis – and it ensures that all consumers, also the poor consumers, pay for water, no matter how much they use, and hence have an incentive to save water. A direct household subsidy basically allows the enterprise to treat all households equally. However, a block tariff system as it exists in many African countries, cf.

Box 3-5 may be recommended, as well – not least, because it may be more socially and politically acceptable among poor segments of population.

Box 3-5 Subsidizing the poor, African experience

Most African countries, if not all, have a block tariff system (or volumetric tariff system) regarding water supply to households. The policy goal is twofold: First, it shall encourage water savings. Second, it shall subsidize the poor. The last-mentioned goal is by far the most important.

In Johannesburg, South Africa, the block tariff system regarding water supply to metered residential consumers consists of eight blocks (latest block tariffs became effective on 1 July 2022). Each block is defined by a level of water consumption (0-6 m^3/month, 6-10 m^3/month, etc.; the last block is above 50 m^3/month) and a price per m^3 (this price increase from block to block). Water consumption within the first block is free of charge. That is, the household that consumes up to 6 m^3 per month will not pay for the water.

Also in South Africa, only in rural areas, the Department of Water and Sanitation has set the minimum quantity of safe water at 25 litres per person per day (about 750 litres per month or 0.75 m^3). It is for drinking, personal hygiene and food preparation. No tariff is levied on this amount. UN has assessed minimum quantity of safe water at 20-40 litres per person per day.

Please note that the prevailing funding gap in South Africa, cf. Box 3-3, indicates that the block tariff system all in all generate too few revenues.

In Kenya, there is a block tariff system, very similar to the one in Johannesburg. In its tariff regulations the Water Services Regulatory Board states: "The Regulatory Board strongly encourages (water utilities) to propose a rising block tariff for metered residential consumers, where higher tariffs apply for consumers that consume beyond a threshold volume for each month (for example 6 m^3/month)."

Please note that a block tariff system requires metering – at household level or, at least, building block level.

Box 3-6 Many stakeholders, China

Even though investments in WSS are decided upon by local governments, many stakeholders are involved. That is, when it comes to investment planning in the WSS sector local governments must involve, one way or the other, various stakeholders at the local level many of which are subordinated government bodies at national or provincial levels.

Guangzhou, a city with a little less than 20 million inhabitants, may serve as an example. Here, the local government must involve, among others, the following government bodies:

- Provincial government (Guangdong Province Government) and, especially, the 11 district governments in the city (e.g. Zengcheng District Government)[1]. They provide input related to demographic development and urban planning.
- Water Resources Authority, which is subordinated the Ministry of Water Resources[2]. It is overall responsible for ensuring the rational development and utilization of water resources in the city. It formulates water development plans, organizes the preparation of water affairs plans, such as the city's comprehensive water resources plan, and conducts comprehensive planning of important river and lake basins. Focus is on water supply for different uses, including quality of water supplied.
- Housing and Urban-Rural Development Bureau, which is subordinated MoHURD[3]. It is in charge of operational and technical work related to urban drainage and sewage treatment management, drainage monitoring management, construction, operation and maintenance management of drainage facilities and urban drainage and waterlogging prevention. Focus is on wastewater treatment plants and network of drainage pipelines. Please note that pipeline maintenance, both water supply pipelines and drainage pipelines, is the responsibility of the City Management Bureau within the local government.
- Municipal Planning and Natural Resources Bureau, which is subordinated the State Council of the People's Republic of China[4]. It is tasked with management of land use and involved in site selections. It is responsible for the unified right confirmation and registration of natural resources and the rational development and utilization of these.
- Ecology and Environment Bureau, which is subordinated the Ministry of Ecology and Environment[5]. It is responsible for water quality. Hence, it is tasked with, among others, drinking water source protection, treated wastewater discharge, as well as supervision and management of pollution prevention plans.
- Local branch of the National Development and Reform Commission[6]. It formulates the economic and social development strategies, as well as medium and long-term plans and annual plans, at various levels. It is responsible for the proper coordination of economic, social and spatial planning.
- Ministry of Finance[7]. It is overall responsible for the allocation of funds for public investments. It contributes to the formulation of infrastructure investment policies, foremost at national level, and develops and maintains infrastructure financial management systems to be applied throughout China.

Notes: 1) Cf. http://www.gz.gov.cn/). 2) Cf. http://swj.gz.gov.cn/, http://swj.gz.gov.cn/mssw/zdjs/index.html and http://www.mwr.gov.cn/. 3) Cf. gz.gov.cn. 4) http://ghzyj.gz.gov.cn/. 5) Cf. http://sthjj.gz.gov.cn/ and https://www.mee.gov.cn/. 6) https://www.ndrc.gov.cn. 7) Cf. http://www.mof.gov.cn/.

Box 3-7 Towards state-owned enterprises, China

Water groups comprising water utilities (in charge of water supply), wastewater treatment plants and/or network of pipes are publicly owned. As a rule, they are owned by the municipal governments (or district governments in case of small facilities or big cities). In many years, virtually all water groups had the status as agencies within the local government. Today, the water groups are transferred into state-owned enterprises. In some provinces and cities this reform process has been almost completed, in others it has not yet started. The reform process began in 1993 (e.g. Beijing had its drainage utility reformed in 1993[1]).

A major concern has been whether the state-owned enterprises would be able to reach financial balance with minimum governmental subsidy. The state holds more than 50% of the stocks; could be much more (usually, 100%). However, much decision-making rests with the enterprise, not the owner (or owners). In this connection it is worth mentioning that an enterprise could be owned by governments at different levels. Some state-owned enterprises are owned by the central government, some by a provincial government and some by municipal governments. Water groups are, as a rule, owned by local governments.

Notes: 1) Cf. Beijing Drainage Group website (history of the group): http://www.bdc.cn/.

Box 3-8 Major challenge in procurement, China

Procurement in the WSS sector is carried out by the project owner subject to several documents which are updated on a regular basis. The most important of these are:

- "Provisions on the scope of infrastructure and utility projects that must be tendered", NDRC regulation No 843, 2018[1];
- "National regulation on bidding and tender procedure", NDRC regulation No 41, 2019[2];
- "Further implementing the provisions on engineering projects subject to bidding and the provisions on the scope of infrastructure and public utility projects subject to bidding", NDRC regulation No 770, 2020[3].

Based on these instructions, each province, city or district will draft specific instructions. For instance, the Housing and Urban-Rural Development Bureau in Jinan issued the document "Detailed rules for the administration of bidding and bid evaluation of housing construction and municipal infrastructure projects in Jinan" in 2020 (it is valid until 15 July 2023)[4].

There are national standards for water supply quality and wastewater discharge, as well as technical guidelines (to define best practice). These must be complied with at provincial, municipal and district levels. However, they may be further developed and detailed at lower levels (e.g. they may be stricter than at the national level). The standards and guidelines are developed by national institutes and updated on a regular basis.

A major challenge in procurement is ensuring that best practices are properly defined and laid down in standards and guidelines so as to ensure that investments are forward-looking.

Notes: 1) NDRC regulation [2018] No. 843: http://www.gov.cn/zhengce/zhengceku/2018-12/31/content_5433928.htm ; Full version of rule, refer to http://www.gov.cn/zhengce/zhengceku/2018-12/31/5433928/files/5c654f6cd3aa4ff7a8125fc394ca6946.pdf; 2) NDRC regulation [2019] No. 41, http://www.gov.cn/zhengce/content/2019-05/29/content_5395735.htm; 3) NDRC regulation [2020] No. 770 http://www.gov.cn/zhengce/zhengceku/2020-11/03/content_5556882.htm; 4) Rules "济南市房屋建筑和市政基础设施工程施工招标评标管理细则" https://www.sohu.com/a/410018493_120616149?_trans_=000014_bdss_dkqgadr.

Box 3-9 Some water groups operate nation-wide, China

Some of the water groups are doing business nation-wide, or even world-wide. For example, the Beijing Water Authority and Three Gorges Corporation. The Beijing Water Authority is a state-owned enterprise (Beijing City Government holds 100% of the stocks); it operates water utilities all over the world, not only in Beijing. Three Gorges Corporation, which is owned by the national government, operates water utilities along Yangtze River Basin.

3.4 Key messages in a nutshell

Key messages in this chapter are:

- The Water Service Provider shall know the financing available, its revenue stream, many years ahead;
- Policy goals, plans and projects, including investments, shall be accompanied with robust and realistic financing strategies;
- Subsidies from the public budget to a Water Service Provider should be avoided;
- Subsidies to poor segments of population shall be provided in terms of direct household subsidies or a block-tariff system.

4 Planning of investment costs

The so-called total cost of ownership approach is key in proper investment planning. The technique behind these is well-developed in many countries. Danish experience in this respect may be useful to engineers and planners throughout the world in the WSS sector.

4.1 Total cost of ownership approach

The total cost of ownership approach broadens the investment perspective from focusing solely on the acquisition costs of a water asset to include expected lifespan operating and maintenance costs, thereby taking a holistic view as a starting point. It thus includes both the costs of the initial investment, or the acquisition cost itself, and the current operational and rehabilitation costs throughout the period of use of the water asset. That is, the total cost of an investment is the sum of the acquisition cost and the net operating and rehabilitation costs for the entire period of use of the asset.

The assessment of the total costs is made by the calculation of all relevant and significant costs related to the investment during the entire period of use. The method is relevant to use when assessing the costs for both acquisition and the subsequent use (the use of net present values is dealt with below).

The total cost of ownership approach provides a tool to make an investment decision that gives value for money. It will often be possible to save money by applying the total cost of ownership approach and exploring various alternatives.

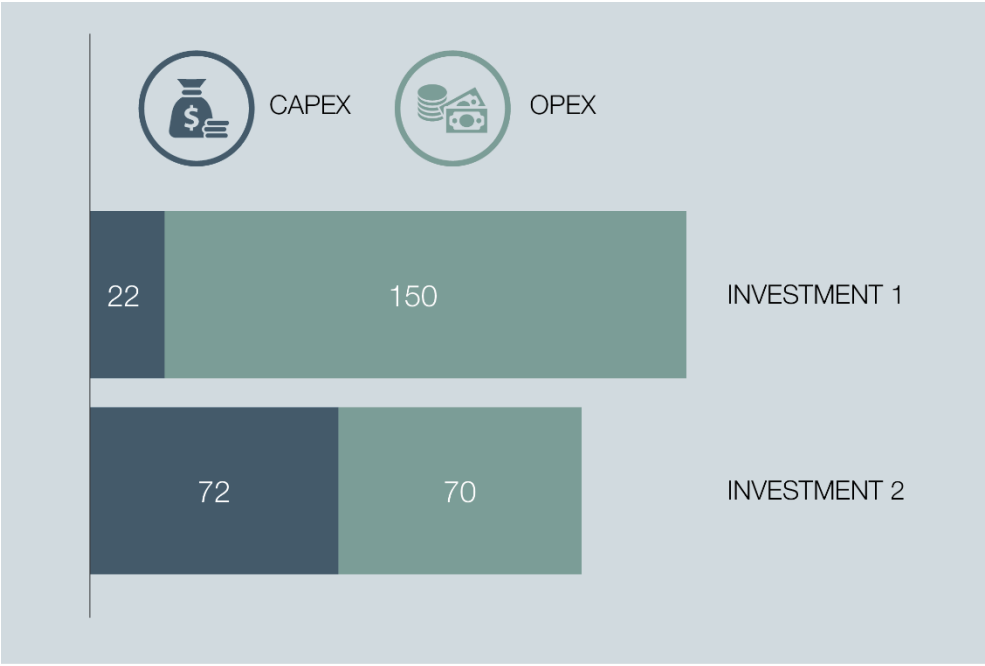
4.1.1 Purpose of total cost of ownership

The purpose of using the total cost of ownerships is to give a Water Service Provider an overview of an investment's total costs over the entire period of use. If a Water Service Provider are considering one or more alternative investments, it is important to keep in mind that it is not always the investment with the lowest acquisition cost that has the lowest total cost over the entire period of use. This is because some investments are cheap to acquire, but can be relatively more expensive to operate, as illustrated in Figure 4-1.

Figure 4-1 shows two different, fictive investment cases. Investment 1 has a low acquisition cost (22 MEUR) but high operating expenses (150 MEUR), all in net present values. The total cost appears from the total pillar for each investment project; that is, it appears from the capital expenditure (the dark blue part) and the operating expenses (the light green part). Investment 2 is significantly more expensive to acquire but has low operating expenses. Overall, Investment 2 has a 17 percent lower total cost than Investment 1. The question is which of the two investments is best to implement if applying the total cost of ownership approach? The answer is Investment 2, as the total costs are the lowest overall.

Important to notice is that total cost of ownership (often referred to as Total Expenditure (TOTEX) comprising both CAPEX and OPEX) rarely occurs in annual budgets or can be shown in a positive manner in annual accounts. Accordingly, decisions focusing on TOTEX must have a "corporate politics" character.

Figure 4-1 Illustration of the principle of total cost of ownership, MEUR[1]



Note: 1) All expenditures in net present values.

Box 4-1 Focus on CAPEX when selecting investment projects, China

As part of the feasibility study various investment options are analyzed to qualify the selection of the preferred option. Various selection criteria are applied. Focus is on CAPEX.

The feasibility study is usually done by an entity attached to the local government, one way or the other (e.g. the local Environmental Science Academy under local Ecology and Environment Bureau, which is subordinated the Ministry of Ecology and Environment). The selection criteria will include the quality of inflow water and outflow water, water quantity, size of service population, budget, etc. However, when the quality and quantity criteria are met, the option with the lowest CAPEX will be prioritized. Options involving higher quality will not be assessed. Most important is that OPEX is not being taken into due account. The reason being that in principle the CAPEX is to be covered through a combination of tariffs and taxes (i.e. subsidies), whereas OPEX is to be covered through tariffs only. So, the local government (or the project owner appointed by the local government) has an incentive to choose the investment option entailing the lowest CAPEX since it will reduce need for subsidies.

This focus on CAPEX when selecting investment projects may imply that an option which is cheap in the short term but expensive in the mid to long run.

Box 4-2 Tariffs differ across the country and are tiered, China

The 14th Five-Year Plan (2021-2025) pays much attention to water tariff setting. It highlights the need to establish a sound legal and regulatory framework for this.

Water tariffs are established at local level, often by the local branch of the National Development and Reform Commission. No separate independent regulator exists.

A methodology for tariff setting in the WSS sector exists. It is developed and approved at the national level. The most recent methodology was published in 2021 by the MoHURD and NDRC; it is titled "Urban Water Tariff Management Regulation"[1]. The methodology concerns both water supply and wastewater. With regard to water supply, the exact tariff for a certain consumer depends on the type of user (e.g. residential or non-residential) and amount of water consumed. Below are two examples regarding water tariffs in Beijing[2].

Table A Residential tiered water tariffs, Beijing Water Authority, 2022

Tier	Yearly accumulated water consumption per household (tons)	Water price (Yuan/ton)	Water resources fee (Yuan/ton)	Wastewater treatment fee (Yuan/ton)	Total water tariff (Yuan/ton)
I	0-180	2.07	1.57	1.36	5
II	181-260	4.07			7
III	261 and above	6.07			9

Table B Non-residential water tariffs, Beijing Water Authority, 2022

End-user Type	Water price (Yuan/ton)	Water resources Fee (Yuan/ton)	Wastewater treatment fee (Yuan/ton)	Total tariff (Yuan/ton)
General sectors[1]	4.2	2.3	3	9.5
Special sectors[2]	4	153	3	160

Note: 1) General sectors comprise all non-residential commercial and industrial water users. 2) Special sectors are those sectors that provide water as their final goods or part of these (e.g. purified water manufacturer, car washing stations, bath centre and golf courses).

As can be seen the water price is tiered regarding residential users. The more you consume, the more you pay. This is true throughout China. Apparently, it works (i.e. it promotes water savings). Water savings among other users are promoted through specially designed policies and programs, such as tax abatement for recycling and reusing water in industries.

In principle, the water tariffs should cover costs linked with services provided by water groups, both CAPEX and OPEX. However, two aspects of tariff setting in practice imply that this principle can only be adhered to with difficulty: First, the local government may prefer to deviate from a full cost principle when stabilizing the tariffs to gain support from the population (and cover the potential gap through a subsidy; consequences hereof are typically less obvious to the population). Second, the water tariffs

are often established so that they cover OPEX fully and CAPEX partly (in this case the gap will, once again, be covered by a subsidy provided by the local government to the water group in question).

Last, but not least it is worth highlighting that the water tariffs vary from city to city depending, among others, on water resources availability and level of economic and social development. An example: In Shanghai, which is rich in water resources, the water price of residential tiered water tariff varies from 1.92 to 4.3 Yuan/ton, and the wastewater treatment fee is 1.7 yuan/ton[3]. In Taiyuan, the capital city of the Shanxi Province, which suffers from shortage of water resources, the water price of residential tiered water tariff varies from 2.3 to 6.9 yuan/ton, whereas the wastewater treatment fee is 0.5 yuan/ton[4]. The reason why the wastewater treatment fee is lower in Taiyuan is that local average income is lower, land price and construction costs are lower, and it complies with national wastewater discharge standards, whereas Beijing has standards that are more stringent than the national ones.

Notes: 1) Cf. https://www.ndrc.gov.cn. 2) Beijing water pricing documents: http://swj.beijing.gov.cn/bmxx/sjxx/202002/t20200227_1670129.html .3) Cf. Shanghai water tariff document: https://fgw.sh.gov.cn/fgw_jggl/20211101/733d4cc217c243ea87cb416f3236d2da.html. 4) Taiyuan water tariff document: http://fgw.taiyuan.gov.cn/doc/2018/07/12/592356.shtml.

Box 4-3 Tariffs and fees are too low, China

Water tariffs and wastewater treatment fees are, as a rule, too low in all the provinces. The incomes they generate do not enable water groups to cover CAPEX and OPEX. When setting tariffs and fees the focus is on CAPEX, whereas OPEX is not taken into full account. The financing gap is closed through subsidies from the municipal or provincial government.

Impacts hereof are:

- Relations, formal and informal relations, with the municipal or provincial government becomes an important element of the business strategy of the water utilities.
- Infrastructure deteriorates to the extent that proper operations and maintenance of the system suffer from lack of funding and/or uncertainty about future funding. These years, the average age of pipes, water supply pipes and drainage pipes, is increasing. This in turn creates a series of problems, including increase in water losses and, most alarming, inflow of groundwater into the drainage system.

The MoHURD and NDRC are aware of the above and are taking actions to address the issue of unsustainable financing of the WSS sector.

4.1.2 Advantages of total cost of ownership

The acquisition cost often constitutes only a limited part of the total costs, and it may therefore be particularly relevant to look at the total costs when the OPEX makes up a large proportion of the total costs.

In addition, the use of total cost of ownership approach can be useful in the following situations:

- In a specific business case where the Water Service Provider shall assess costs, benefits, and risks in connection with a new investment, which will affect the Water Service Provider's finances in the future for a long period, as well as long-term water, environment, and climate impact profile. For example, when investing in sewer pipes, which has an economic life between 75 and 100 years.

- In the assessment of different business models, maintenance options or solutions. For example, whether to invest in digitalization, or in TV surveillance or guard system at pumping stations.

- In the assessment of different wastewater treatment plant options and subsequently choose the technology which are the cheapest seen over the entire period of use of the treatment plant.

- When the Water Service Provider want to understand all the relevant costs in the investment period of use. That is, how much do the current operating expenses of a capital investment mean for the Water Service Provider?

- When the Water Service Provider assess which provider offers the best and cheapest solution. For example, is it better to carry out and "operate" a water treatment plant, or is it worth outsourcing all or part of the task to an external supplier?

- When the Water Service Provider wants to assess the difference between procuring a costlier solution with long-term resilience (e.g. to increasing energy prices) versus a solution with low procurement costs, but not being resilient to future energy costs increases, future environmental regulatory steps, digitalization, removal of subsidies and others, most likely implying increases in operating and maintenance costs.

- In situations where the Water Service Provider shall keep actual expenses and income up against the budget, including an ongoing assessment of how good the Water Service Provider are at staying on budget and thus ensuring that the budget is not exceeded. It is in this context important that the total cost is used. The Water Service Provider can also use this approach in connection with the evaluation of external suppliers and what they have budgeted for in their offers.

- And finally in the assessment of whether it is best to make a new investment or continue the operation of an existing fixed asset. This means

a situation where the current operating, maintenance and repair costs must be kept up against the total cost of a new investment.

4.2 Technique behind total cost of ownerships

When calculating the total costs, it is generally relevant to include all the cost items associated with the investment. Whether the expenses are internal (e.g. the Water Service Provider's own time consumption in connection with the acquisition) or external (expenses for external suppliers). In this section, a closer look at different types of costs is taken as well as which costs are relevant to include in the calculation of the total costs.

In addition, examples are provided on how the Water Service Provider practically calculate the present value of future payments when the Water Service Provider need to calculate the total costs of an investment.

Box 4-4 Case, Financial planning at utility level, FPTWU

The Financial Planning Tool for Water Utilities (FPTWU) has been created by OECD to assist water utilities and the municipalities in which they are located improving their financial status through the introduction of medium-term planning, investment making process and operational performance.

With the help of the tool the Water Service Provider may:

- Rationalise the way their capital expenditure programme is established
- Determine the conditions for the balancing of their sources and uses of funds
- Improve the monitoring of the overall performance by analysing performance indicators output by the tool.

The tool is available on the OECD website. It consists of a manual and Excel file, which may be downloaded free of charge.

If you want to know more, please visit:
www.oecd.org/env/outreach/financialplanningtoolforwaterutilitiesfptwu.htm.

4.2.1 Costs to be included in total cost of ownerships

The preparatory work in connection with the calculation of the total costs lies in determining the future costs. The costs can be calculated both as the actual future costs or as an estimate if the exact costs are not known.

As a starting point, it can be a good idea to include all costs to create an overview of the various investment opportunities that the Water Service Provider face. When the Water Service Provider shall make the final calculation, however, it is only necessary to look at the cost items that may vary between the solutions - and not those that are the same.

When the Water Service Provider do not include cost items that are the same, the final calculation becomes simpler. If the Water Service Provider make a comparison of the costs of a current asset with a new investment, however, it is important that all costs are included.

There are often many different types of costs associated with an investment. The acquisition cost is typically just the tip of the iceberg when it comes to the total about costs associated with the decision to invest. To identify all relevant costs and income during the period of use of the investment, it is important not only to look at the acquisition cost, as there are costs below the surface that are important to include in the overall total cost of ownership assessment. Figure 4-2 below illustrates the different cost items involved in an investment decision.

Figure 4-2 Example of an investment's total cost during the period of use

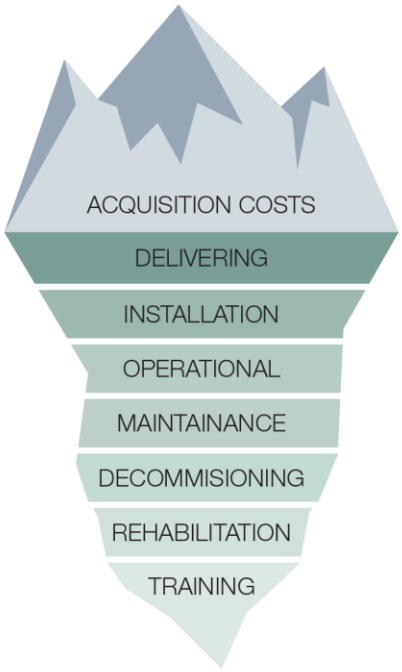


Figure 4-2 shows that the acquisition costs is usually just the tip of the iceberg. To be able to assess all relevant cost items in connection with an investment project, it is important to examine the costs which are hidden below the surface (i.e., in the future). In general, the cost of an investment can be divided into two different types, and they can relate to everything from an entire factory unit to a single product unit:

- *Direct / obvious costs* are the type of costs that are directly linked to the product. In addition to the acquisition cost itself, the direct costs can, for example, include material consumption and labour in the manufacture or installation of a specific product, including tender writing.

- *Indirect / less obvious costs* are costs that are not directly related to the product. These are, for example, costs related to taxes and fees, administration, electricity etc.

Table 4-1 shows an example of an overview of different types of costs that can be included in the total cost of ownership approach. The overview shows, in addition to the different types of costs, also in which phases the costs appear and how often they appear.

Table 4-1 Different types of costs in a Total Cost of Ownership assessment

COST	RELATING TO	POINT IN TIME	TYPE
Purchase price of the asset	Purchase	Date of acquisition	One-off expense
Costs associated with the acquisition of the asset	Use	Date of acquisition	One-off expense
Costs of switching supplier or to a new solution	Use	Date of acquisition	One-off expense
Cost of owning or disposing of the asset	Use	Period of use	Ongoing
Consumption-dependent costs	Use	Period of use	Ongoing
Costs associated with the disposal of the asset	Use	Disposal date	Disposable expense / income

As mentioned, the table shows the different types of costs that are included in an overall total cost of ownership approach:

- *Costs associated with the acquisition of the asset:* In addition to the acquisition cost itself, this category also deals with expenses related to the acquisition itself. This can be, for example, expenses for financing, freight, installation, and commissioning. It can also be expenses for writing tenders and selecting suppliers.

- *Costs of switching supplier or to a new solution:* These costs are also called switching costs. These are expenses that result from changing supplier or switching to a new type of solution that has not been used so far. If a new supplier is chosen, there can often be costs associated with this. Switching to a new solution can lead to changes in the organization of the Water Service Provider's internal work. This can lead to some working time being freed up and users being able to become more self-reliant, which ultimately leads to savings. It may also be the case that there is a need for staff and users to be retrained, which entails extra costs.

- *Cost of owning or disposing of the asset:* This is the cost during the period of use, i.e., the running costs of owning or disposing of an asset. It can, for example, be a building, waterworks, treatment plant, pumping station, wastewater, or delay basin, where there are expenses for e.g. licenses, insurance, taxes, and fees. For a longer period of use, there will often also be costs for service, maintenance, cleaning, repairs, etc. In some situations, in connection with the procurement, services can be purchased in the form of an associated service scheme or the like.

- *Consumption-dependent costs:* That is, costs that increase because of consumption is increasing. This especially applies to costs for e.g. electricity, fuel, heat, gas, water, etc.

- *Costs associated with the disposal of the asset:* That is, the expenses or income that the Water Service Provider will receive when the Water Service Provider must dispose of the asset after the period of use. For some types of assets, there may be costs associated with, for example, the disposal of sludge and filter sand. In other cases, there may be income from, for example, the sale of an old cast iron pipe or a building.

4.2.2 Net present value

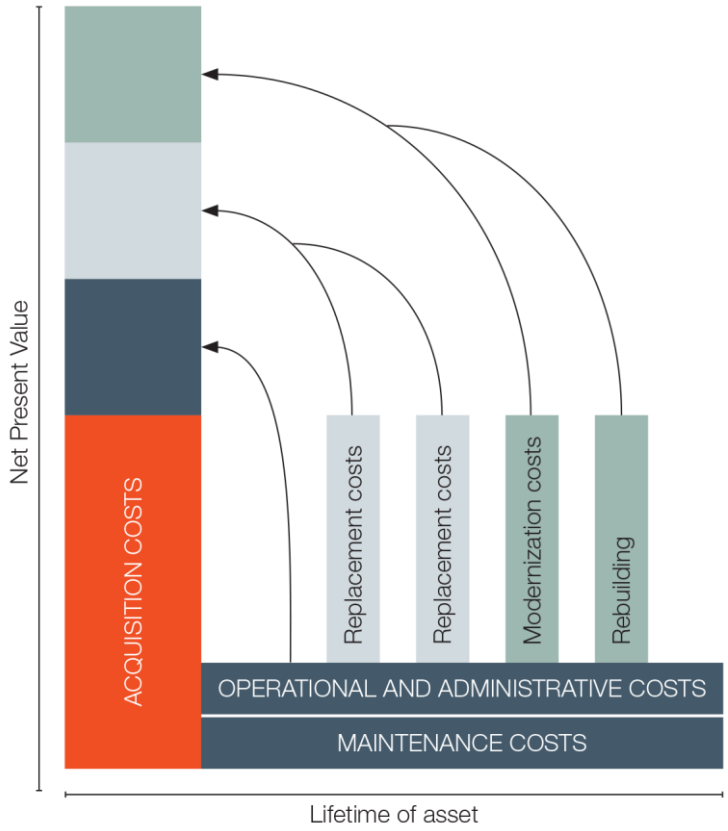
When a Water Service Provider compare different alternative investments based on the total cost of ownership, it will often be the case that the alternatives have different cost profiles over the period of use, including that the costs fall at different times. The length of the investment's period of use (lifetime) may be different or the same between the alternatives. To make the correct comparison of the alternatives, one must calculate the net present value of all the costs.

The method for calculating the net present value depends on whether the Water Service Provider compare alternatives with different lifetimes or the same lifespan.

To make the comparison clear and correct, the net present value of all future payments (e.g. over a period of say 30 or 50 years) for the investment is calculated. Calculating the net present value is equivalent to attributing all future costs to the same time point - which is typically the time of acquisition of the asset.

The conversion of future costs at the time of acquisition is called discounting. Discounting is in principle a simple interest calculation, where the amount is adjusted to another point in time based on an assumption of an annual interest rate for the change in the value of money. The interest rate is called the discount rate. Figure 4-3 illustrates how a present value is to be understood. In this context, it is important to keep in mind that money in the future usually has a lower value than today, which can be described as the time value of money. Therefore, we generally prefer to receive money today rather than in a year, for example.

Figure 4-3 Net present value calculation



4.3 Calculation of net present value

4.3.1 Present value method

In some cases, when comparing alternative investments with the same lifetime, the Water Service Provider will know the actual amounts to be paid at later times during the period of use. In these cases, the calculation of the net present values can be done using the calculation method reviewed in the figure below.

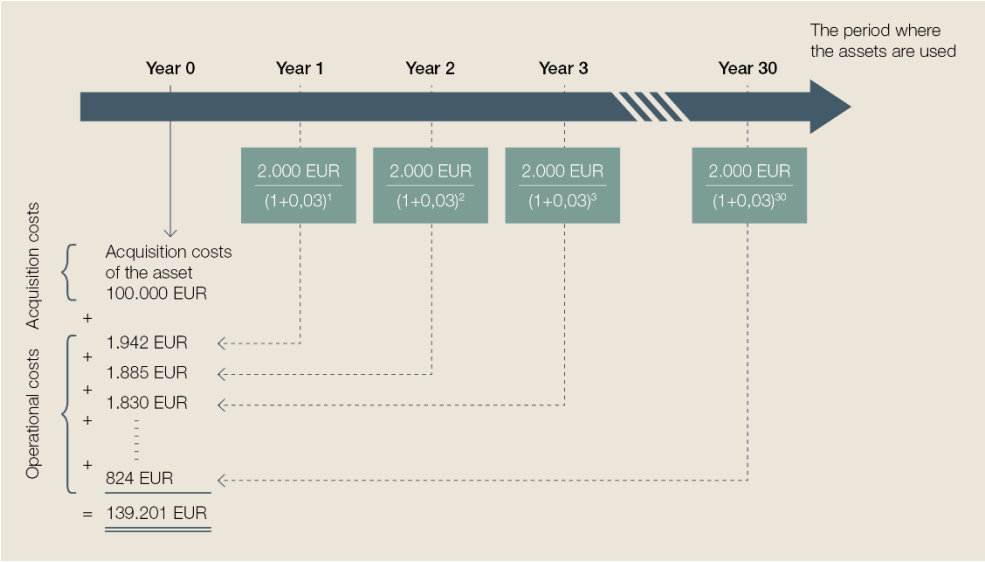
When the Water Service Provider know the actual amounts to be paid during the period of use of the acquired asset, the net present value of the annual payment in year x can be calculated using the following formula:

The present value of an annual payment in year x=$\frac{Amount\ in\ year\ x}{(1+discount\ rate)^{x}}$

The figure overleaf illustrates how the formula works in a specific example of the acquisition of a water treatment plant. The acquisition cost of the treatment plant is EUR 100,000 and has a period of use of 30 years. The operating expenses are EUR 2,000 per year. The discount rate is 3 percent. It is assumed that the plant has no residual value as the economic lifetime of the asset expires after 30 years.

The calculation of the net present value is shown in Figure 4-4 below. As the Water Service Provider can see, the total net present value of the investment will be the acquisition value + sum of future operating expenses = EUR 139,201.

Figure 4-4 Example of calculation the present value



4.4 Key messages in a nutshell

The total cost of ownership approach is key in proper investment planning. The technique behind this is well-developed in many countries. Investments are based on Asset Management and proper costing. It implies:

- Investment decisions are based on financial calculations of investment projects (NPV and IRR calculations); that is, using the total cost of ownership approach.
- Rehabilitation investments in replacement of existing assets are based on an asset register or an Asset Management System
- In the Asset Management System all water assets are registered
  - All assets are registered based on the year of establishment
  - Risk parameters are attached to the status of the asset based on regular inspection
- Given the age of an asset the asset needs replacement, when it reaches the lifetime of the asset
  - The age-based assessment is combined with the risk assessment of the assets determines the timing of the asset replacement.
  - Digitalization matters.

5 Actions towards proper investment planning

Decisive actions must be made to arrive at proper investment planning. These are, at least, eight. They are easy to describe, much more difficult to do.

5.1 Recommended actions

Some actions are to be taken by governments (at different levels). These are the Actions 1-4. They are aimed at ensuring that the appropriate framework conditions are in place providing the correct signals and incentives and that the Water Service Providers operate to deliver the services that the regulatory authorities want the Water Service Providers to deliver.

Other actions may be taken by the Water Service Providers themselves, maybe in cooperation with governments. These are Actions 5-8.

There is no particular sequence in which the actions should be carried out, although it is obvious that Actions 1-4 facilitate the successful launch and execution of Actions 5-8.

The actions are:

- **Action 1: Legal reform**

  Legal reform ensuring, among others, protection of property (there should be no doubt about the ownership of land and infrastructure) and clear division of powers and responsibilities of the Water Service Provider vis-à-vis the municipality (in case of public owned Water Service Provider). It is crucial for the Water Service Providers to have complete autonomy when delivering the service target set by the regulatory authorities.

This includes decision-making power for tariff setting, developing corporate policies, deciding on financial dispositions, prioritization of asset management, and investment decisions. These are all crucial for the Water Service Provider to think in long-term objectives and comply with the regulations of the sector.

Water Service Providers should be legal entities and operate as a company. This implies that the municipal owner should not be able to interfere in the operations of the Water Service Provider and all revenues from selling water services remains within the Water Service Provider (i.e. revenues are ring-fenced). The municipal owner of the Water Service Providers should be able influence the development of the Water Service Provider through its representation in the Board of Directors. Decisions to achieve the targets set by the regulatory authorities are solely made by the management of the Water Service Provider without any interference from the owner. However, some investment decisions must be approved by the Board of Directors if the investments are above a certain threshold.

- **Action 2: Regulatory reform**

Regulatory reform creating national government bodies overseeing the sector (e.g. tariff setting authority) and facilitating policy dialogue (e.g. involvement of water associations in policy making). These national regulatory authorities shall set the service targets regarding drinking water quality, service quality, quality of discharge water, water, and wastewater tariffs etc.

- **Action 3: Tariff reform**

Tariff reform introducing tariffs that cover at least OPEX and part of CAPEX in the short term and both OPEX and CAPEX in the long run – with a view to affordability (specially designed support programs and measures targeting the poor may be introduced; low tariffs is a no go). Tariffs need to be ring-fenced and used covering operational and maintenance costs of the Water Service Provider as well as future investments.

Establish targeted social measures to address affordability constraints and make use of direct household assistance programs targeting the poor (e.g. subsidies to the households or specially designed block tariff systems). Subsidies from the public budget to the Water Service Providers do not constitute a stable and reliable revenue source and should be phased-out.

- **Action 4: Reach out to relevant international fora**

In 2017, the Roundtable on Financing Water was established by the OECD, Government of Netherlands, World Water Council and World Bank. It is a global platform aimed at bringing together a diversity of actors, both public and private, interested in making the best use of available assets and finance in the water sector, thereby facilitating increased financing of investments that contribute to water security and sustainable growth. Even

though the focus is on water-related investments broadly defined, the WSS sector plays a big role. Among its members are governments and regulators in developed, emerging and developing economies, private financiers (e.g. institutional investors), IFIs, donors, academia and NGOs. A number of meetings, some global, others regional, have been held till date.

Currently, the OECD plans launching a Global Observatory on Financing Water Supply, Sanitation and Water Security to, among others, share good practices on financing water-related investments.

- **Action 5: Organizational changes at the Water Service Provider level**

Organizational changes at Water Service Provider level within selected departments (e.g. accounting, contract, and IT departments), including revised job descriptions, new work procedures and task flows, as well as new appointments – and accompanying skills upgrading (e.g. training in new IT management information systems). Not least, digitalization constituting a prerequisite for proper asset management calls for this.

- **Action 6: Asset management**

Increased focus on asset management – at all levels, but, especially, at the Water Service Provider level. Know your assets, make a maintenance plan, as well as an investment plan. It will take a Water Service Provider at least 3-4 years to have an updated asset management register. However, if the Water Service Provider do not have an overview of the assets and the quality of the assets, it is difficult to navigate and prepare the proper reinvestment plans

- **Action 7: Proper investment planning**

The Water Service Provider shall adapt the total cost of ownership approach when assessing investment opportunities.

- **Action 8: Financing**

It is important that the Water Service Provider has access to financing of the investments. Otherwise, the investments will not be implemented.

Develop a mid- and long-term sustainable financing strategy to comply with service goals.

5.2 Key messages in a nutshell

Key messages in this chapter are:

- Make sure that the framework conditions are appropriate and provide incentives to the Water Service Providers to deliver the services that the regulatory bodies want the Water Service Providers to deliver
- Make tariffs right and…
- … focus on Asset Management, including investment and maintenance planning
- … while introducing and implementing legal reforms, regulatory reforms, and organizational changes (at Water Service Provider level)
- introduce proper investment planning based on the cost of ownership approach
- If so, effective, and efficient Water Service Providers will emerge (but not overnight).

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ANNEX 2 TERMS USED

Costing	Estimation of expected costs of an investment decision, covering both capital expenditures and operating expenses
Financing	Coverage of expenditures over time of an action, both capital expenditures and operating expenses
Non-revenue water	Water losses plus water supplied but not paid for
PPP	The involvement of a private company (or companies) in the operation, management and/or financing of an investment of, for instance, a municipally owned Water Service Provider. This can take many forms. The private company may become a co-owner.
Ring-fencing	If revenues of a Water Service Provider are ring-fenced it implies they cannot be used for other purposes than those related to the delivery of water services
Sanitation	Sanitation services (toilets, latrines, etc.), as well as wastewater collection and treatment
Sustainable financing	Sustainable financing is financing provided following a process taken due account of environmental, social and governance (ESG) considerations
Water losses	Physical losses; it is synonymous with water leakages

ANNEX 3 DANISH EXPERIENCE

This annex provides information about Danish experience regarding investment planning and asset management in the WSS sector. The framework conditions, both legal framework and regulatory framework, is dealt with.

A.3.1 Framework conditions for Danish Water Service Providers

The water sector consists of both drinking water and wastewater Service Providers. The size of a Water Service Provider is defined by the annual volume of charged water.

Water Service Providers with an annual charged volume of 200,000-800,000 cubic meters of water are referred to as smaller drinking water and wastewater Service Providers, while Water Service Providers with an annual charged volume of more than 800,000 cubic meters of water are referred to as larger Water Service Providers. The main difference is that only the larger Water Service Providers are benchmarked (see below).

Revenue caps are set for Water Service Providers with an annual charged volume of water over 200,000 cubic meters or Water Service Providers that are municipally owned.

There are approximately 2,500 drinking Water Service Providers of which 87 are municipally owned. The private drinking Water Service Providers are owned by the consumers. There are slightly above 100 Wastewater Service Providers, which are all municipal owned companies.

All Danish Water Service Providers are legal entities and operate as a company. This implies that the municipality cannot interfere in the operations of the Water Service Provider and all revenues from selling water services remains within the Water Service Provider (i.e., revenues are ring-fenced). The municipal owner of the Water Service Providers can influence the development of the Water Service Provider through its representation in the Board of Directors of the Water Service Provider. Decisions are solely made by the management of the Water Service Provider without any interference from the owner. However, some investment decisions must be approved by the Board of Directors if the investments are above a certain threshold.

Water Sector Act

The Water Sector Act (latest version approved in in 2009) regulates the framework for water and wastewater companies. Key features of this act are:

- Water Service Providers are operated in an efficient way that is transparent to consumers and provides the lowest possible and stable prices

- The framework shall support innovative development, demonstration, and export of water technology solutions

- Regulatory bodies and Water Service Providers shall, in cooperation, ensure and develop a water and wastewater supply of high health and environmental quality that considers security of supply, climate, and nature.

The financial regulation requires efficiency of the Water Service Providers operations and facilities, and that the Water Service Provider's income must remain within the established financial framework.

The act emphasizes that it is crucial for the Water Service Providers to have complete autonomy, including decision-making power for pricing, developing corporate policies for financial dispositions, prioritization of asset management, and investment decisions which are crucial for the Water Service Providers to think in long-term objectives and comply with the regulations of the sector. However, prices cannot be set higher than the regulatory set revenue cap; see below. This is the most optimal way to secure that the Water Service Provider can achieve the service targets set by the authorities regarding water quality, service quality, etc.

Water Service Providers with an annual charged volume of water below 200,000 cubic meters operate as non-profit companies. This means that, without further financial regulation, these smaller Water Service Providers are permitted to collect revenue (tariffs) from consumers in their supply area corresponding to the company's costs.

All Water Service Providers are also subject to environmental regulation, which includes safeguarding of water quality. Environmental regulation falls under the Danish Environmental Protection Agency.

Danish Water Regulatory Authority

The Danish Water Regulatory Authority is the Regulator of the water sector in Denmark. This means that they enforce the Danish Water Sector Act, which regulates the financial framework for the Water Service Providers.

The Regulator in Denmark work to ensure that the Water Service Providers become more efficient and that the Water Service Providers supply drinking water and handle wastewater at stable, low, and socially acceptable prices, while ensuring continued high quality and reliability supply.

The water sector is characterized by natural monopolies. This means that businesses and households do not have the option of freely choosing between different suppliers, as they do with other products in a free, well-functioning market. Monopolies can lead to prices that are higher than necessary. The financial regulation is thus designed to strengthen the incentive for companies to streamline, innovate and invest cost-effectively – for the benefit of the budgets of all households and businesses.

The Regulator regulates Water Service Providers by using benchmarking and by setting annual revenue limits (revenue caps) and efficiency requirements.

The Regulator's tasks include:

- Establishing the annual financial framework for the Water Service Providers
- Calculating individual efficiency requirements through benchmarking of Water Service Providers
- Conducting annual monitoring of Water Service Provider compliance with the financial framework
- Handling complaints related to the financial frameworks of the Water Service Providers
- Supporting the Water Service Providers' work to comply with the Danish Water Sector Act with guidance, advice etc.

Revenue caps

One of the Regulators primary tasks is to set revenue caps for the Water Service Providers. This means that water prices are continuously lower than they would otherwise have been. This contributes to growth, higher consumer welfare and enhanced competitiveness for water-consuming companies in Denmark.

The water sector is as mentioned above characterized by natural monopolies and is therefore not subject to the competition that exists in a well-functioning market. Financial frameworks (revenue caps) that contain efficiency requirements and the setting of annual ceiling on Water Service Providers' revenues contribute to an artificial competitive pressure in the sector, which contributes to efficient operation, lower prices, and more innovation.

The Regulator set revenue caps for all municipally owned Water Service Providers as well as consumer-owned Water Service Providers that supply, process, or transport a minimum of 200,000 cubic meters of drinking water per year to consumers and businesses.

The revenue cap is designed to ensure that:

- Consumers and businesses do not overpay for water and wastewater services
- The Water Service Providers have sufficient funds to operate, maintain and develop their infrastructure to ensure continued high quality and security of supply.
- The Water Service Providers are continuously streamlining their operations and systems in line with productivity growth in the rest of the Danish economy.

What does a revenue cap contain?

A revenue cap consists of:

- A financial basis that includes the Water Service Providers' operating, construction, and financial costs as well as so-called fixed costs.
- Correction of the fixed costs in relation to what the actual costs have been in the previous year.
- An individual, benchmarking-based efficiency requirement for the Water Service Providers being benchmarked.
- A general efficiency requirement for all Water Service Providers regardless of size.
- Annual indexation.

Efficiency requirements

The efficiency requirement in the water sector consists of a general and an individual efficiency requirement, which are imposed on the Water Service Providers.

All Water Service Providers receive an annual general efficiency requirement. The general efficiency requirement creates the efficiency pressure, which is created by the productivity growth in a well-functioning, competitive market.

The individual efficiency requirement encourages the least efficient companies to become as effective as the most efficient in the sector. The individual efficiency requirement is based on the Regulators benchmarking model, which compares the cost-effectiveness of the Water Service Providers. In this way, the level of the individual requirement reflects the efficiency of the individual Water Service Provider compared to other Water Service Providers in the same sector. The least efficient Water Service Providers are given a higher individual efficiency requirement compared to the more efficient Water Service Providers. The efficiency requirement reflects the potential of each Water Service Provider to become as effective as the most efficient in the sector. This means that the individual efficiency requirement is intended to promote the use of existing technology.

Obviously not all Water Service Providers agree to the decisions made by the Regulatory Authority. This is specifically so with the determined target for both the general and individual efficiency requirements. However, this is the agreed approach to ensure that Water Service Providers operate more efficiently when there is no market to regulate the Water Service Providers.

There are many examples of the fact that efficiency requirements impact on Water Service Providers and their investment decisions. One example is Aarhus ReWater, cf. Box A-1.

Box A-1 Case, Model to assess the total costs of ownership, Aarhus Water

In selecting the new technology, which is most cost effective over the entire period of the technology, Aarhus Water has developed a model to assess the total costs of ownership of the different technologies over the lifetime of the asset – i.e. using the total cost of ownership approach. Aarhus Water has done this in connection with the construction of Aarhus ReWater, which will become the world's most resource efficient wastewater treatment plant.

According to the present regulation each Water Service Provider must act on long-term objectives and implement a strategy that achieves a solution which are the cheapest and most financially sustainable for the consumers. Hence, to ensure an economically and environmentally optimized wastewater structure for the future, Aarhus Water decided to build a new and large Wastewater Treatment Plant (WWTP) near Marselisborg, Aarhus. The goal is simple but ambitious – Aarhus Water wants it to be the world's most resource efficient wastewater treatment plant, which will be the cheapest for the consumers on the longer term, energy efficient and environmentally friendly, and a facility that contributes to a more livable local community.

Using state-of-the-art technology to enhance its performance, the WWTP will set new standards both nationally and internationally. Their ambition is to not only to meet the current and future requirements within purifying of water, but to be a leading player in securing an optimal aquatic environment in Aarhus Bay benefitting both human beings and nature.

Building a new WWTP, Aarhus Water's ambition is to establish not only a WWTP but a Water Resource Recovery Facility. By this it means that the plant, in addition to the purifying of water, also will produce energy and nutrients from the wastewater. The name of the new plant, Aarhus ReWater is not a coincidence. The "Re" referring to the word's "resources", "recycle", "reuse" and "rethink" allowing for a broader mind-set on how to manage wastewater treatment in the future.

EU taxonomy

EU regulations impact very much on the public management of Water Service Providers. Not least, the EU taxonomy impacts a lot. The textbox below describes the EU taxonomy, which vary large Water Service Providers have to comply with. In a Danish context it is only one utility which is regulated according to the EU taxonomy.

Box A-2 EU taxonomy

The EU taxonomy is a classification system of environmentally sustainable economic activities, i.e., it is a tool detailing specific business activities that are considered sustainable by the European Union (EU).

One of the aims of the EU taxonomy is to bring everyone together with unified definitions, measurements, and objectives.

It has identified six environmental objectives:

- Climate change mitigation
- Climate change adaptation
- Protection of water and marine resources
- Transition to a circular economy
- Pollution control
- The protection of ecosystems

It is a tool for both investors and corporates. The taxonomy is designed primarily to be used as a tool for sustainable investment. By putting everyone on a level playing field, it will help investors understand more clearly where companies stand in relation to one another. It will also play a vital role in guiding business decision-making.

A.3.2 Benchmarking

Benchmarking plays an important role in Danish water management. Water Service Providers are benchmarked on both the CAPEX and OPEX.

Benchmarking by the Regulatory Authority

The overall financial benchmarking made by the Regulatory Authority, which is the basis for setting the revenue cap of the Water Service Providers, consists of benchmarking that compares the operating and construction costs of Water Service Providers to determine their individual efficiency requirements.

The overall financial benchmarking of the Water Service Providers consists of two parts: Capital expenditures (CAPEX) and operating expenses (OPEX). In the

Regulators benchmarking, the Water Service Providers are compared on how efficient they are at running their companies in relation to the others in the sector. That is, both the capital expenditures and operating expenses of the Water Service Providers are compared to the average costs in the industry. Hence, a Water Service Provider will be "punished" if the investments they have undertaken are too expensive compared to the industry average.

Voluntary benchmarking by the Water Association

Benchmarking is also done on a voluntarily basis in the context of the water organization (DANVA) for members of the water Association who want a broader and more detailed overview of their Water Service provider to identify business processes with potential for improvement and subsequently implement actions to achieve the potential.

The benchmarking is built based on selected benchmarking focus areas, which can be annually recurring or one-off surveys. Focus areas can e.g. be:

- Operating costs at process and cost driver level
- Investments
- Finance / accounting
- Operating parameters e.g. Infrastructure Leakage Index (ILI), purification better than requirements and sludge treatment.
- Energy efficiency, energy neutrality, carbon footprint/CO_2.
- Asset management.

The benchmarking is structured in such a way that it is possible to participate in the benchmarking focus areas in which the Water Service Provider has an interest. This benchmarking has nothing to do with the official regulation by the public authorities.

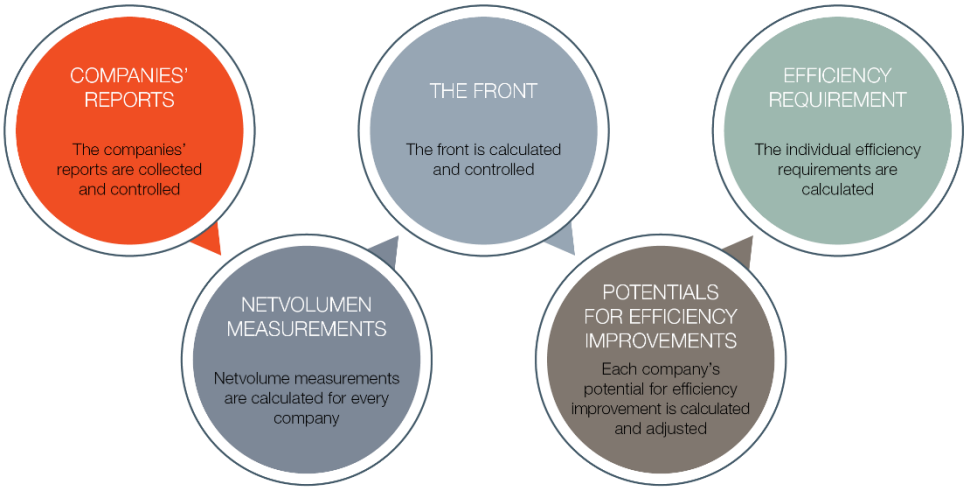
Benchmarking models

The Regulator use a method that includes two different models to determine the efficiency potential of each Water Service Provider. The two models are a Data Envelopment Analysis (DEA) and a Stochastic Frontier Analysis (SFA) model. Both models are recognized and widely used as benchmarking models.

DEA and SFA are two different methodological approaches for identifying the efficiency potential of Water Service Providers. As a precaution, the Regulator combine the results of the DEA model and the SFA model in a best-of-two approach. This means that each Water Service Provider is assessed in both models. The efficiency potential of each Water Service Provider is based on the model that calculates the highest efficiency score, which is therefore the most favorable for the individual Water Service Provider.

The different steps in the benchmarking are outlined in the figure below.

Figure A-1 Steps in benchmarking



The most important steps in benchmarking are:

- The Water Service Providers report information on operations (underlying relationships with cost drivers) and investments (list of assets) as well as actual operating expenses and investments. These reports are quality assured and corrected if necessary.

- Based on the quality-assured information, the two net volume measurements (OPEX and CAPEX) are calculated, which express the Water Service Provider's activities and assets. To correct for any expensive operating or investment costs due to old, fixed assets and/or fixed assets subject to a complex infrastructure, alternative net volume measurements are calculated.

- The Water Service Providers are benchmarked on their net volume measurements and their actual costs to identify the most efficient Water Service Providers. Actual costs consist of the sum of operating expenses, depreciation, and financial costs.

- Immediate efficiency scores are calculated for the Water Service Providers. These are ranked on a scale from 0 to 1 and describe how efficient a Water Service Provider is. The most efficient Water Service Providers have a score of 1, which converges to zero as a Water Service Provider's efficiency fall. Under special circumstances, the immediate efficiency scores are corrected. This adjusted efficiency score is used to calculate the Water Service Providers' efficiency level. The efficiency level is the cost level that each Water Service Provider should have to be among the most efficient. The efficiency potential is calculated as the percentage difference between the Water Service Provider's revenue cap from the previous year and the efficiency level.

The efficiency requirement is the efficiency potential measured in Danish currency. Efficiency requirements are calculated based on the efficiency potential. Efficiency requirements are deducted from the financial framework of the Water Service Providers.

A.3.4 Experience from Herning Water, Denmark

As appears from the above section on the regulation of the water sector, that the Regulatory Authority forces through benchmarking the Water Service Providers to become more efficient and provide water services to consumers at a lower price. Hence, the regulation provides the incitement for the Water Service Providers to focus on becoming more efficient and to prepare investment plans which secures more cost-efficient companies. These framework conditions have "forced" Herning Water to adopt the total cost of ownership approach to prioritize between investments.

What is the experience from asset management and long-term investment planning in Herning Water? The main lessons learned are summarized in the box below.

Box A-3 *Asset management and long-term investment planning - What has Herning Water learned?*

- To know the long-term investment needs with an acceptable risk profile it is essential to obtain an overview of the state of the assets. This enables – based on data- to prioritize investments in an economical and technical optimal way
- Actual conditions (or predicted) and the criticality of the assets enables the company to identify the risks and deal with them.
- Digitalization and trustworthy data support the overview of the state of the assets and subsequently the operations significantly
- It took the company 3 -5 year to get trustworthy data on the operation & maintenance. It is vital to obtain knowledge of which data you need in 3 – 5 years.
- With the lifetime of assets up to 75 years, time for reinvestments +/- 5 - 10 years, often makes no big difference. Hence, there is a need to focus on the long-term perspective
- "Professional peoples qualified guesses are better than an empty cell…."

As part of its asset management system, Herning Water prepares:

- On a regular basis (every 5-10 year) an investment plan;
- This investment plan captures the rehabilitation investment (age/risk-based) of the company's assets. But it also captures proposed new investments;
- Within the same interval the utility analyses the appropriateness of the current WWTP structure
  - Is the present structure the most appropriate or should several WWTPs be merged into a smaller number but having a larger treatment capacity?
  - This exercise is also to save money from the consumers and to deliver the best service to the public as well as to the environment.

No doubt digitalization constitutes an important precondition for – and facilitates the further development of – the asset management system.

The box overleaf provides an example, where the company had to choose between implementing electronically smart meters compared to conventional meters and the consequences of choosing the strategy with the highest acquisition costs.

Box A-4 Smart meters versus conventional meters, Herning Water

Implementing smart water meters, with hourly reedings

- From thought and decision to full operation: 19 month (since 2018)
- Billings streamlined significantly!
- Costumer reports on-line and text message (alarm) service

Technical effects: After just 12 months of operation

- Leaking arears (two) identified within the first year (two arears with a 40 leakage %)
- Monitoring of our water balance by software has increased significantly
- Two one-way valve failures identified: 20 %
- The leakage verified (data now trustworthy)
- Leakage effort can be optimized:
- Leakage in 2018 approx. 8.5 %
- Leakage in 2020 approx. 5.5 %

Administrative effects: After just 12 months of operation

- Cleaning up our consumer database
- Bad payers: Cut off valves approx. 1.800 sites (1 %)
- Owners / renters clean up approx. 2 % of sites
- Tamper is revealed immediately
- Billings streamlined significantly:
- No manual reading of meters = significantly savings
- Yearly settlements and settlements at consumer moving's
- Annual administrative savings: 2.8 % of the investment

Financial effects

- Smart electronic meters 3,3 million EUR
- Standard meters: 1,4 million EUR
- Additional acquisition costs: 1,9 million EUR
- One-time savings: 143,000 EUR
- Annual administrative and technical savings: 300,000 EUR
- Payback time of the additional investment costs: 6 years
- In addition, consumers save on less insurance costs and undiscovered leakages