Unclassified **ENV/EPOC/WPBWE/RD(2013)7**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **04-Nov-2013**

English - Or. English

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

ENV/EPOC/WPBWE/RD(2013)7
Unclassified

Working Party on Biodiversity, Water and Ecosystems

New Modes of Water Supply and Sanitation Management and Emerging Business Models

7-8 November 2013

This paper is being circulated to WPBWE delegates as background information.

ACTION REQUIRED: Delegates are requested to provide comments on the paper by 30 November 2013.

For further information please contact:
Xavier Leflaive, Tel. +33 (0) 1 45 24 92 94; email: Xavier.Leflaive@oecd.org

JT03347791

English - Or. English

NOTE FROM THE SECRETARIAT

This paper has been developed under Output area 2.3.2 Climate Change and Natural Resource Management of the WPBWE Work Programme for 2013-14. It contributes to Project 3.1. Water Policies for Future Cities of the WPBWE Work Programme for 2013-14 as well.

Innovation is one of the major dimensions of green growth, and it plays a central part in the urban water agenda. Previous work by the OECD has argued that the diffusion of innovative ways to supply water and sanitation services is hindered by their poor financial attractiveness: the positive externalities these innovations generate for the society at large are not reflected in operators' revenues. Typically, utilities have no incentive to promote water efficiency, when their revenues depend on the volume of water supplied.

The paper investigates this issue further and explores several options to induce water utilities to contribute to good water management.

The paper characterises the prevalent business model for water utilities and claims that it provides wrong incentives, with regards to water management. It explores several options to help water supply and sanitation services contribute to water resources management. It derives lessons from international good practices.

This paper was developed by Bernard Barraqué, CNRS-CIRED and Jean-Luc Trancart, ENPC (Marne la Vallée), in coordination with Xavier Leflaive (OECD).

The paper is circulated to WPBWE delegates as background information. Some of the main messages have been used in the report on Managing Water for Green growth [ENV/EPOC/WPBWE(2012)5/REV1] and will inform further work on Water Policies for Future Cities. A decision on the public release of the paper will be made at a later stage.

ACTION REQUIRED: Delegates are requested to provide comments on the paper by 30 November 2013.

ABSTRACT

Water supply and sanitation services in developed countries are usually provided through collective, piped systems, and the revenues of utilities often depend on the volume of water sold (through metering or a proxy). This model is being questioned for several reasons, such as the decrease of water consumed per household in a number of OECD cities, the need to take account of more extreme weather events (due to climate change), fiercer competition to access the resource, or the need to finance the renewal and upgrade of water infrastructures.

This new context calls for innovative management of water supply and sanitation services, and new business models characterised by incentives to better manage infrastructures, decoupling the revenues from service operators from the volumes of water sold, or the capacity to operate at different scales (from small-scale, distributed systems, to catchments).

The paper discusses several options and reviews recent developments in this burgeoning field.

Keywords: water supply and sanitation, eco-innovation, water utilities, water tariffs, smart water systems, performance-based contracting

JEL classification: L95, O33, P42, Q25, Q55

RÉSUMÉ

Les services d’eau et d’assainissement dans les pays développés reposent généralement sur des infrastructures collectives et les revenus des opérateurs dépendent des volumes d’eau vendus (que ceux-ci soient mesurés, ou estimés). Ce modèle est remis en question pour plusieurs raisons : les consommations d’eau des ménages tendent à diminuer dans un grand nombre de villes des pays de l’OCDE ; les opérateurs doivent prendre en compte des évènements météorologiques extrêmes plus nombreux (à cause du changement climatique) ; la compétition entre les usagers de l’eau s’intensifie ; les infrastructures doivent être rénovées et améliorées.

Ce nouveau contexte requiert de nouveaux modes de gestion des services d’eau et des modèles d’affaires innovants, caractérisés par des incitations à mieux gérer les infrastructures, à rendre les revenus des opérateurs moins dépendants des volumes d’eau vendus, à savoir gérer ces services à des échelles variées (depuis des systèmes distribués, à petite échelle, jusqu’aux bassins).

L’article évalue différentes options et présente des développements récents dans ce domaine en effervescence.

Mots clés : eau potable et assainissement, éco-innovation, services publics d’eau, prix de l’eau, systèmes d’eau intelligents, contrats liés à la performance

Classification JEL: L95, O33, P42, Q25, Q55

TABLE OF CONTENTS

Boxes

INTRODUCTION

This paper focuses on water industry in developed countries, where water users are usually customers receiving water bills, which also often include sewage collection and treatment costs. The former obligation to connect to sewers in cities was re-considered as a service like drinking water. Metering and billing was progressively adopted, both by private and public operators, because it allowed to cover the costs better, while a growing water consumption was associated with improved hygiene and welfare. The 'virtuous cycle' has however reversed at the end of the 20th century, with declining water sales, combined with ever increasing long term operation and renewal costs (due to stricter environmental constraints) and phasing out of the initial subsidies by Governments.

The resulting looming crisis brings operators to look for new business models and new modes of management, beyond the traditional 'supply-side' and billing policy. In particular, they look for cheaper financing schemes (including the return to taxation and cross-subsidies), the downsizing of technology, the up-scaling of management units and new relationships with water resources (and non-urban water uses), new relationships with customers and additional services related to demand side management (including support to track domestic leaks and incentives to conserve), and social tariffs. Interestingly enough, some of these innovations make water services issues in developed countries closer to those of developing ones. Lastly, regulation of water supply and sanitation (WSS) services is becoming more sophisticated.

The paper explains how the context in which water utilities (be they public or private) operate recently shifted, and explores several avenues for innovative and more adapted business models for urban water services. At places, comparison is made with electricity and gas supplies, which have faced similar challenges in the past (with noted differences), and which reacted by offering additional services to users.

THE RISE (AND FALL?) OF A 20TH CENTURY BUSINESS MODEL FOR WSS

The section explains how pipes, taps and meters (the core features of the prevalent business models for water utilities in developed countries) may need to be reconsidered to match radical changes in the environment where water utilities operate.

Pipes, taps and meters: the rise of WSS services in the 20th century

Initially water supply systems were quite simple: low pressure, distribution to a few public fountains and washing places… They were managed by local communities, with variable rules, usually found equitable by members. They needed mostly initial funding, and operation and maintenance (O&M) was frequently provided in-kind by members. While this situation is still frequent today in developing countries, it can still be found in low density areas in rich countries like in the United States. Larger projects to supply cities with longer distance aqueducts would be funded by government money, and eventually covered by taxes. In any case there was little difference between water resources and water services, since water served was not metered: it was running all the time and leaks were everywhere. It is only in the middle of 19th century that a very significant change took place: the progressive generalization of water taps and meters allowed to quantify the service, and to separate water as a consumptive good from water as a resource. It shifted the status of common pool resource (non-excludability but possible rivalries) of water into a club good, characterized by freedom to adhere, possibility of exclusion, and equality in tariff setting. The invention of bacteriology and subsequently of chemical water treatment facilities reinforced the notion that water was a public good which one had to pay for.

This transformation is largely achieved in Europe and other developed countries, but, even among these, there are many places, including cities, where water supply costs are covered by flat rates, others where sewer services are charged through taxation, and others still where metering is collective (one per condominium). This has stirred controversy: some customers would like every household to have its separate meter and billing. Conversely, in many developing countries, the water meter is rejected, eventually destroyed or by-passed, as being the symbol of an unacceptable commodification. This is of course related to the poor quality of the services: why would one pay for a distrustful service? In turn, if users don't pay, how is it possible to improve this service, all the more so when it is a low priority on the (poor) government's agenda, and subsidies are insufficient?

As mentioned above, even in developed countries, metering is not universal. Consequently, cost recovery takes various shapes. We lack historical syntheses, but it seems that in the middle of the 19th century, water supply systems in England, frequently created by philanthropic business communities, were already in full bloom before metering could be installed. Costs were usually covered by flat rates and even by rates based on renting values of homes. This precedence of water service to metering and early municipal take-over of private companies may explain why meters were not used until the 1989 privatisation (and are still progressing slowly). Possibly domestic water came through sorts of private fountains e.g. in the yards of buildings, by imitation of public fountains. This culture of water as an administrative service remained dominant in Britain and some Commonwealth countries. Today still, 60% of British households (and even more Irish ones) have no meter and pay rates instead. What a paradox seen from France or Germany, since the British water industry was fully privatized, and at the time generalization of metering was scheduled by 2000.

Most continental Europeans pay water through a meter and water bills. In France water supply is a commercial public service (*service public à caractère industriel et commercial*, SPIC): when the authority provides a service, it must do it through a public but commercial institution (EPIC), with separate and balanced budget, and with costs covered through billing and not through taxes. It is also the case of course for electricity and gas. Conversely the activities of public authorities where citizens are compelled to subscribe, like urban drainage or garbage collection, are provided by a public and administrative institution and costs are covered through taxes, since they are imposed. Waste water collection was covered by land taxes, until a decree of October 1967 allowed transferring the sewer charges into the water bills.

But this transfer led to a considerable increase in the water price, in particular when sewer charges had to include the depreciation for heavy investments. In the average French water bill, since 1996 the share of sewerage per m3 is larger than the share of drinking water: in 2008, the price per m3 for a consumption of 120 m3 was 3,57€, in which drinking water represented 44% (incl. 2% for the abstraction levy paid to the *agence de l'eau*) and sewage collection and treatment 52% (incl. 13% pollution discharge levy). With the implementation of full cost recovery, the sewer share in the water bill is expected to increase further. And in Germany, where there is no equivalent charging to the French *Agences de l'eau*, waste water has been above drinking water for many years now…

In several European countries, where about half of the population lives in condominiums, there is a difference between WSS services, and gas and electricity. All are commercial services, but frequently, electricity and gas companies directly serve customers within their apartments, while water companies serve the whole building with only one meter: they send a single bill to the building manager, and do not manage the systems inside the buildings; building managers then allocate the water charges in proportion of the apartments' surfaces, or the number of people. In France however, half of the apartments in condominiums are equipped with sub-meters which serve to allocate the collective bill in proportion of households' consumption. In many cities in Italy, Portugal and Spain, separate meters were installed when water systems were created, at a time when metering technology was developed and more affordable. This is why individual metering was adopted, and today, each family receives its own water bill from the water utility. This apparently makes it easier to adopt progressive tariffs and incentivise customers to use water wisely.

In the USA the picture is contrasted: metering is generalized, in particular on the west coast where most people live in single family houses and where per capita consumption is 3 to 5 times higher than in Europe; this induced an early motivation to conserve water. But there are still many unmetered community and of course non-community water systems; very large East Coast or Midwest cities like New York and Chicago introduced meters only recently, and are still in the process of generalizing them. When they do so, they opt for collective rather than individual metering. New York even adopted a program of financial support to the conversion of condominiums to metering: in case the new bill would exceed the former rates, it is capped for 2 years, so as to give time to the building residents to identify and track the leaks. But the USA are also the place where smart meters were invented: they allow to track residents consumption at zero marginal cost, and to adopt sophisticated tariffs like seasonal or increasing blocks. In Boston smart metering is done at building level only, and the Head of the water and sewer Commission finds it inappropriate to meter each apartment separately; but the progressive tariff takes number of people behind the meter into account… This supposes that people living in condominiums accept to tell how many they are behind each meter; this may be easy in Boston, but would be more difficult in France: our investigations in public housing companies show that tenants are reluctant to co-operate with building managers, and building managers are reluctant to share information with water companies (Barraqué, 2007).

Indeed, there is scope for the water industry to improve the metering-billing side of their business. Metering provides information at a certain cost, and its diffusion should reflect the opportunities to generate gains: it is a matter of optimization.

The elements of a growing crisis

At the end of the 20th century, the prevailing water industry model in developed countries was based on supply side policies, and cost recovery with little subsidies (once the main infrastructures have been built). This model was sustainable as long as water demand was growing year after year, since additional revenues allowed anticipating growing demands with new supplies. Public authorities, and even operators, knew very little about the making of the demand, and they had no relationship with their customers beyond billing. They relied on technical innovation to control the pollution of water resources. The invention of both the water and sewage works gave additional degrees of freedom to cities vis-à-vis their environment: water abstracted from polluted resource could be made potable, and water discharged could have moderate impacts on downstream resources and users. It was only a matter of costs, and for a long period of time it seemed possible to fund WSS from water bills with the support of some mutual funding mechanisms and government subsidies.

This model undergoes a growing crisis:

- Sewage collection and treatment is frequently superimposed on water bills, which progressively led to double the customer charges. Large industrial users and services like hospitals have long reacted to this new situation by dramatically reducing their leaks and even by changing industrial processes for less water-intensive ones. But environmental policies put additional pressure on water and waste water services through the growing levels of water quality standards.

- Pipes were frequently buried under ground, so that decay and leaks grew unchecked for a long time; today ageing infrastructure requires previously unsuspected investments on top of environment control ones. Unfortunately, this comes at a time when the welfare state is put under scrutiny and government subsidies are on the down side. The result is an even faster increase in water charges to customers.

- Drinking water demand is going down. In depth surveys tend to show that, beyond the large customers, reduction concerns households; it not only hits outdoor uses but indoor uses as well (in the USA, chiefly toilet flushing and washing machines, see de Oreo, 2010). It is important to stress here that a price per cubic meter is not a sufficient indicator to evaluate the economic or social performance of WSS services, and not even to set up international benchmarks. Indeed, with the weight of fixed costs in infrastructure, high consumption levels frequently imply a smaller marginal cost, even the long term one. When consumption increases, yearly bill does not increase much, as long as new infrastructure is not needed. Conversely, water conservation may reduce consumption, but not so much the yearly bills, at least on the short run. This is what makes comparisons difficult. To give an example, the Germans pay the m3 of water about 30% more than the French; but their consumption is 20% lower so they pay approximately the same per capita. And since their average household size is smaller, (less than 2.1 vs 2.5 for French households), they end up paying less for their water services per household.

- The reduction in consumption in turn brings operators to increase unit prices, at least where they are required by law to balance their costs with incomes. Then the issue is to choose what to increase between the fixed part and the variable part of the tariff. In any case, rising water bills made rich countries discover the problem of the water poor, starting with England and Wales after privatization: the amount of water payments in arrears increased a lot, in particular after Tony Blair's government banned cutting off water to non-payers. Even though the larger part of bad payers are 'won't pay', it could be shown that they also included 'can't pay' people. The issue also rose in France, that is in another country with important participation of the private sector to WSS services provision; in a context of global opposition to the World Bank's previous support to privatization and meter-based cost recovery, the OECD discussed this issue in a special report (OECD, 2003).

- Last but not least, a growing number of operators are facing an additional decrease in consumption due to households finding alternative water supply solutions, like rainwater harvesting and private well drilling. The driver can be ecological (local solutions to reduce the energy footprint), or economic (water bill considered too expensive). Frequently however, these households remain connected to the main infrastructure, and in some cases discharge in the sewers water they have not purchased, thus free riding on the expensive sewer service. When authorities are encouraging people to conserve indiscriminately, they add to a confusion that might be detrimental for public services and induce a 'third world-ization'. Conservation, alternative water supplies and distributed water systems should be experimented first in areas where water scarcity or growing water needs have brought existing infrastructure to full capacity, and additional water supply would be very costly.

Of course various WSS services do not face the same problems, and they are now looking for tailor-made solutions. All these elements taken together however point the potential unsustainability of WSS services. The question is: is there a technical, economic and financial reform that would allow to:

- Control the evolution of water demand and anticipate potential decrease or growth, so as to optimize the relationship with the environment and public health contexts;

- Maintain the needed but eventually evolving infrastructure in good condition in the long run;

- Keep WSS services affordable in particular for the low income groups, and more generally make the tariff system fair and reasonable in terms of redistribution;

- Optimise the territorial governance and regulation of WSS through a new combination of up-scaling – downscaling and technology mix?

This question has been discussed in a research project funded by the French National Research Agency's programme on sustainable cities. Even though there is probably no magic and ready-made solution to the whole sustainability issue that could be implemented everywhere, it is clear that new solutions are being sought by water operators and authorities to find new sustainable paths. There are three broad categories of solutions: improving internal management and performance; downscaling and outreach to citizens and customers; and up-scaling management units and linking with water resources management. the following sections explore practical (although partial) responses to this challenge.

SMARTER TARIFFS

Tariffs, Transfers and Taxes

The OECD has established that there exists three ultimate sources of finance for water supply and sanitation, meaning three sources of finance that do not need to be paid back: tariffs (revenues from user tariffs), taxes, and transfers from the international community (such as structural and cohesion funds in Europe, or aid finance in developing countries). Financing strategies ought to combine the three sources of finance in a realistic and sustainable manner (see OECD, 2010). In this respect, new business models in developed countries should also consider how to best combine these 3Ts, all the more so that some mechanisms (such as revolving funds in the USA, or structural and cohesion funds in the EU) are supposed to be limited in time.

Water policies of some Mediterranean European States were financially supported by US subsidies in the 1960's (cf. for Spain, Swyngedouw), at a time when their policies focused on economic development through hydro-electricity and irrigation. WSS services were not a real priority. Once they joined the European Union, 4 new member States (PIGS: Portugal, Ireland, Greece and Spain) were made eligible to cohesion funds on top of structural regional funds. An important share of these transfers was devoted to improving WSS services. Since 2007 these transfer mechanisms are turned towards new incoming Eastern European member States. They could be available only in a temporary manner. Another transfer possibility is between public services: this could be the case for instance in Germany, where cities have long developed multi-utilities between electricity, gas, district heating, water, transportation systems etc. (the well-known *Stadtwerke*). However, usually each of the combined utilities keeps a separate budget which has to be balanced, and the major advantage of this integration lies in the capacity to obtain cheaper loans (given its larger equity) and to pay less taxes to the Government (because public transportation is usually in deficit, which reduces the total profits at the end of the year to almost nothing). WSS services are usually covering their costs and do not benefit from internal transfers.

Now in the case of separate budget for water and/or wastewater, if a given WSS utility wants to reduce the price of water, the basic solution is to reintroduce earmarked taxes to cover part of the costs. This might be particularly interesting in areas where water consumption is going down sharply, reducing the revenues needed to invest in long term infrastructure reproduction and also in improved sewage collection and treatment. The case of Britain illustrates this very well: today only a rough 40% of customers are metered, with a higher proportion in south-east areas experiencing water scarcity. On the whole, water companies are financially less affected by water conservation programs mandated by government than on the European continent; yet in recent Waterwise UK conferences, Ms Pamela Taylor, head of Water UK, expressed concern that water companies would be losers in supporting water conservation, and suggested Government to give them tariff bonuses to compensate their efforts. This is not significantly different of other European companies trying to sell 'beyond-the-meter' services to customers to make up for consumption decrease attached to leak control.

Alternative funding to full cost pricing

One of the important issues in modernizing water management modes is full cost pricing. This includes not only operation and maintenance costs plus a fair share of depreciation of the infrastructure, but also the integration of environmental costs and resource costs. A task force addressed this complex issue after adoption of the WFD in Europe.

The French *agences de l'eau* levies provide an example. There are in fact two levies paid by water users: a larger pollution discharge levy, and a smaller abstraction levy. The first one creates a fund in the

Agence budget to finance the construction of sewage works, so it can be considered as a proxy for the environmental cost (one pays in the water bill for the social cost generated by pollution discharge). The second one corresponds to situations of relative scarcity, and therefore represents a proxy for users' costs and opportunity costs. The abstraction levy is (about 5 times) smaller than the pollution discharge levy because there are yet few situations of water scarcity in France. Of course the two levies are not representing exactly the environmental and resource costs respectively, since they are not high enough to match the problems which can be anticipated today. However, on average, the waste water charge plus the pollution levy together are now above the drinking water price plus the abstraction levy. The end result is similar to Germany where utilities internalize the environmental and resource costs themselves: waste water tariff is now clearly above water tariff.

But this situation is not generalized, and there are many countries where waste water services are still directly provided by local authorities and funded through taxation.

The case of the Netherlands is both specific and interesting, because WSS services are separated in three: drinking water is provided by only 10 commercial companies owned by municipalities and provinces together, and it is paid through metering and billing; sewerage is provided by municipalities and has remained traditionally covered through local taxes. But sewage treatment is done by the famous *Waterschappen* or water boards, which were originally in charge of flood protection and drainage, and were operating like communities, i.e. on common pool resource funding mechanisms. Even though they underwent a dramatic concentration process (from about 2600 at the beginning of WW2 to only 24 today), they still cover their costs through uniform rates paid per household: each household pays for a family of 2.5 or 3, no matter which number of children; only single persons pay for 1. As a result, water charges are split. To give an example, the owner of a house in Delft would pay a total of 556€/ year for a consumption of around 100 m3 (i.e. 5,71€/m3), including:

- drinking water: 177€ or 1,82€/m3
- sewerage: 165€ or 1,70€/m3
- waste water treatment: 214€ or 2,20€/m3

According to Erik Mostert (River Basin Administration Centre, Delft University of Technology), this separation of WSS services' payment in 3 tiers makes the total cost more acceptable. And if the French or the Germans would follow that example (for the sake of making water bills more affordable), they would remove the waste water treatment costs from water bills and fund them separately through local taxation. But would local politicians in turn support the corresponding increase in local taxes?

To conclude this section, the motivation for transferring waste water cost coverage into water bills was clearly an advantage for funding waste water services, but it did not necessarily lead to merging both services into one water + wastewater service. Italy chose that solution with the 1994 reform, to rationalize and adopt a clear industrial approach to water services through consolidation at the level of provinces. But the change ended up so brutal, that when the government decided on top of it that private capital should have larger shares in WSS utilities, a popular referendum turned down the whole reform with an overwhelming majority. In all developed countries, removing all government or tax funding for the sake of economic rationality might be dangerous: the potential impact of resulting price increase might make this change unsustainable on the long run (see section on social tariffs). Additionally, there is a problem to pay sewer charges within water bills in all cities equipped with combined sewers. Yet this is frequent in downtown areas which were served first, even in France which later opted for separate networks (influence of the Corps of Engineers). In case of combined sewers, municipalities should contribute reasonably to the (separate) sewer budget from the main budget, and raise local taxes accordingly. But usually they do not do it enough to match the cost impounded on the sewer system.

Tariff sophistication and potential perverse effects

An important innovation in the water industry is refining the customer relations through adapting the tariff to meet their aspirations and also to give them incentives to use water efficiently. The best known example is the suppression of traditional tariff rebates for large customers (which were based on the idea of economies of scale) and the introduction of progressive tariffs, with either free initial allowances (like in Belgian Flanders), or lower first tiers (including basic allowances included in the fixed part to be paid anyway). While the previous section described new business models involving "external governance", this one is dealing with internal governance. The idea is to send price signals to customers but also to take their specific situation into account. In other cases the innovation consists in seasonal tariffs, with higher prices to cover higher costs during peak demand. It must immediately be pointed though that seasonal tariffs first request the introduction of smart meters, so as to allow reporting the consumption immediately after the tariff change.

Additionally, utilities can set up what is called budget rates, i.e. rates that are tailored to the situation of individual customers: a perfect example of this is the tariff of Los Angeles, which is progressive (two blocks), seasonal (higher in the 3 summer months, and also all year round in case the council decides it is a drought year), and related to lot size (large properties are considered having larger 'essential' needs for their gardens and they have a larger first block).

In Europe this rate budgeting is not frequent, but some water companies in England propose variable tariffs, with either high fixed parts and low volumetric prices (for customers who have regular water uses) or low fix parts and high volumetric ones (for people who may have low consumption but some peaks). However, experienced economists of applied water regulation are suspicious that these smart tariffs end up having paradoxical and 'disconcerting' effects (Beecher, 2012).

In France, where individual water abstraction is possible below a relatively generous threshold, a potentially serious consequence of progressive tariffs is the temptation for single family home owners to drill wells or harvest rainwater. This entails negative consequences for utilities (in particular, lowering their income, and free-riding for waste water discharges, see section I) and for themselves (investment costs are high and make this individual water far more expensive than the public supply one) (Montginoul, 2005). In Wallonia, a study by the water supplies association showed that all private cisterns and wells in the region were responsible for a decrease of 7% in public water sales (Prevedello, 2011). The author was particularly concerned that large industrial customers were quitting the public service and drilled their own wells, at the risk of over-drafting the resource.

WORKING BEYOND THE METER

Economists usually think that demand side management equates the design of a tariff inducing water conservation, and indeed, this kind of tool is frequently adopted, if only for moral reasons. However, in practice, the issue is not so clear since utilities are usually mandated to balance their expenses with income from customers. So that in the end, a reduction of water demand may urge the utility to increase the unit price, reversing the causal link that underlies elasticity analyses. The result is the need for utilities in search of innovation, to establish new, more in-depth links with their customer-citizens. They can develop alarm systems to warn customers about leaks, door-to-door information and collective learning, evolution of technical standards, and even water services based on decentralized technologies (OECD, 2009). In doing so, they may benefit from the experience of energy suppliers, which compensate lower unitary demand with additional services which add value to consumers (such as stable energy bills, consumption optimising, or green energy certificates).

Smart meters

Smart meters, initially installed in American cities, are meters equipped with real-time information transfer to the utility, which can become sophisticated indeed. They allow developing a new, pro-active relationship with water users. In Boston Mass., meters registering an unusual water consumption ‘automatically warn’ the operator, who can in turn call up the customer to check whether this unusual consumption is due to a leak or else. This is possible even though there is only one meter per building (but Boston Water and Sewer Commission has access to the crucial information of the number of persons behind a collective meter). This allows developing interesting statistics about per capita water use and analysing its determinants. There are now many econometric studies going beyond traditional elasticity to price and income, and taking into account climate variations, irrigation need indexes, family sizes, availability of pools, etc.

More broadly, smart meters are one of the main tools that innovative utilities can use to develop refined demand forecasts. Traditionally utilities were only concerned with securing funds to build infrastructure so that supply would always exceed a growing demand. But now that demand can or must be curbed, and infrastructure has to be renewed with no more subsidies, it becomes much more important to know how the demand is formed, how it could evolve spontaneously, and how this evolution could be accompanied and controlled. Smart meters are also a prerequisite to set up budget rates or consumer categories with equitable tariffs.

Reaching inside the customers’ property

Smart meters can be coupled with ‘flow trace analysis’ software, which breaks down water consumption by various types of indoor-outdoor uses. This can be very helpful for utilities willing to refine their foresight on water demands, but also to better target the customers and/or the appliances that should be replaced. Water saving household appliances are important innovations. Some utilities support their diffusion, proposing subsidies for water conservation. Pro-active utilities should then be able to better know residential demand and to improve forecasting. In California for instance, several water districts formed the California Urban Water Conservation Council, which uses the funds gathered from members to provide subsidies to residents changing their washing machines, dishwashers, toilet flushes etc. for water-efficient ones. They also have incentives for services like restaurants, car washes etc. This is really helpful to curb the demand in a serious scarcity situation. Additionally, the California case illustrates that conservation is the cheapest way to meet the needs of a growing population.

Additional innovation in water scarce areas leads to changing gardens' vegetation cover, reducing the space devoted to thirsty lawns, and in arid cities, even shifting to 'xeri-gardening', plus adopting community pools rather than individual ones. This is crucial, as in these cities, two thirds of water uses or more take place outdoors.

If economists and water managers admit that a water tariff and meters alone cannot suffice to induce more efficient use of water, and there remains important transaction costs in WSS provision, then new business models should involve outreach to customers, e.g. setting up specialized teams of water advisers, to induce water conservation practices, on top of checking leaky or wasting appliances. In Los Angeles for instance, a simple software using GIS calculates the nominal water consumption of any single family house; when real consumption significantly departs from nominal value, a warning is sent with the water bill, with an invitation to let the utility's water conservation team come visit and help find where water wastage or leaking takes place.

In England and Wales, some water companies set up new plumbing departments to propose customers additional 'post-meter' services. In Germany, the multi-utility structure generates economies of scope in meter reading, reporting and subsequent billing. In France, a few water departments propose social housing managers to read the sub-meters in large condominiums as a marginal task when they read the collective meters.

Water operators could be inspired by innovations which took place in the energy sector: an increasing number of energy providers help customers to diagnose their consumption and control their expenses, which is an additional source of revenue compensating the loss in direct energy sales . Electricity companies also sometimes propose customers to buy a 'clean' or 'ecology friendly' energy at slightly higher price to include pollution rights or off-set services. This will probably be much more limited in the case of water, given the difficulty to create water markets. However, many utilities have industrial or commercial customers, or services like hospitals, which are often large customers. It might be wise to develop policies to help these to reduce their water footprint, even though the utility will eventually loose income. Yet it is better to anticipate the decrease of consumption rather than suffer from large customers altogether leaving the public service (e.g. sea-side resorts choosing private desalination…).

IMPROVING AND REWARDING PERFORMANCE

Now that WSS utilities have become a mature business, they cannot any more plan on increased water sales and revenues year after year, thus limiting business risks. Conversely new communication and information technologies can help to know better the real shape of the infrastructure, and the needs for funding for renewal, expansion or adaptation. A rigorous infrastructure management is possible, leading to sustainable financing schemes, precise contracts between the authority and the operator, fiscal optimization, and performance based contracts.

Improving sustainability through infrastructure management

Increasingly, urban utilities in developed countries develop computer tools based on inspection robots and GIS to gain a much more precise knowledge of the state and performance of their systems, in particular the buried parts. This knowledge in turn allows a better phasing of maintenance and renewal investments to improve the systems' reliability (in particular the pipes' breaks which can disrupt also economic activity in the above streets). Due to the long life expectancy of infrastructure, many authorities and operators underestimated the need to replace the ageing parts, and did not depreciate their assets correctly. Innovative tools help enlarge the scale and scope of infrastructure monitoring, extend the time horizon and budgeting needs for asset management. Civil and environmental engineers develop software like PARMS (CSIRO, Australia), KANEW (Dresden Germany, and AWWARF, United States), WARP-NRC (Canada), ENCOMS-MACOMS (Halcrow, U.K.), CASSES and CRITICITE (Cemagref, France), MOZARE and VISION (Veolia), Renouv'Eau and PREVOIR (Suez), etc. European funded research allowed to compare several tools (CARE-Water and CARE-Sewer projects) and resulted in improved software (AWARE, Portugal). Supported by a task force of the International Water Association led by Helena Alegre, a double movement takes place towards advanced asset management methods, combined with an increasingly multidimensional definition of performance, from basic physical condition to service quality, business risk and sustainability. Tools to assess the state of infrastructure are followed by decision support systems to decide financing strategies taking into account the impact of costs on water prices, the environmental, social and economic consequences of disruptions, etc.

Better financing and reducing legal and economic risks

When the operator and authority manage to get a clearer vision of their assets, and renewal needs, together with improved forecast on water demands, they can develop more rigorous planning of O&M together with investment, and sign more precise and more secure contracts. Rigorous asset management entails better depreciation, which in turn leads to improved self-financing capacities, reduced debts, and access to cheaper loans (because the utility is more creditworthy).

A related problem is that infrastructure life cycle is usually much longer than the duration of on-going contracts (in case of delegation) . Poor knowledge of the state of infrastructure leads to over-risky contracts, as was exemplified by several 'privatisation' failures in developing countries (and also in cities like Atlanta). Operator and authority together must develop a vision of WSS sustainability beyond the time span of the contract.

Debt financing and fiscal optimization

Because depreciation of assets and provisions for renewal are very specific in WSS services, inflation and interest rates play a relatively important part in the financial balances. One can assume for instance that important inflation rates between the two World Wars made the price of water services apparently cheap for customers, while money lenders were clearly the losers. Today, inflation is low, and since the crisis it is possible to get cheap loans. Many utilities are then wise to renegotiate their debts and take new loans.

Depreciation and provisions are also under scrutiny by fiscal administrations, because they reduce the taxable profits. Additionally, it may not be wise to set aside too much money given the long life time of infrastructure. Some experts propose to opt for progressive depreciation.

Fiscal optimization is also linked to the institutional set-up of some countries. In Germany for instance, the *Stadtwerke* run several services together, and they are formally private companies. Therefore they pay local taxes in proportion of their turnover, which brings financial support to local authorities. Additionally, they are more creditworthy because they own multiple assets, so they can in theory access cheaper bank loans. But since public transportation is usually in deficit, the *Stadtwerke* profits at the end of the year are minimal, so they pay minimal taxes on profits to the *Länder*. In France on the contrary, one of the alleged motives for returning to public provision of service is that in-house services do not pay local taxes to the local authorities, which entails a potential price reduction for consumers (e.g. Paris water is supposed to save €30 million/year).

Performance indicators and performance based contracts

With the growing crisis and potential spiralling down for WSS, several countries supported the development of refined information allowing either local authorities, or national/regional regulators to control the quality of the operator's work. When privatization took place in England and Wales, a 'quality-price' regulator was installed in England. OFWAT had to develop a set of indicators to assess the performance of privatized water companies at the end of each 5-year contract period.

Performance indicators can be followed regularly in which case they monitor the fulfilment of the contract almost permanently. They also allow water companies in a given area or country to benchmark their performances. In France, when the WSS authorities were forced by the Sapin Law of 1992 to open the renewal of finishing delegation contracts to competition with other private companies, a taskforce designed a double battery of performance indicators: a long one to allow local authorities and their consultants to assess the performance of the operator; and a short one to allow the larger public to follow the quality of the provided services. Operators are now requested to send a yearly report to the authorities, and the latter in turn are obliged to put out a yearly report to inform the citizens about water contract. Additionally, it is now mandatory for utilities above 10,000 inhabitants to set up a 'public service consultative council' to allow organized citizens to discuss WSS services provision publicly.

Given the important difficulties faced by private sector participation as advocated by the World Bank in the 1990's, this effort to better assess the infrastructure and the service resulted in designing new types of contracts based on performance. The OECD has reviewed experience with these contracts in several countries and has derived some lessons (see OECD, 2010, for more details):

- Risk mitigation measures should be tailored to the objectives of the contract, the type of contractual arrangement, the risks undertaken by each of the parties and the regulatory environment in which the contract will operate.

- Experience shows that bonuses are best applied with management contracts; penalties are mostly suited for lease contracts while regulating risk through tariff adjustment can be the preferred option in both lease and concession contracts.

- The rules and procedures for determining contract incentives as risk mitigation measures (tariffs revisions, bonuses and penalties) need to be clearly specified in the contractual arrangements.

> Methodologies for calculating bonuses and penalties need to be agreed upon by the parties early in the process, to prevent future costly disagreements. The lack of a clearly defined methodology for the calculation of the bonus level of the management contractor in Armenia, for example, resulted in lengthy disagreements between the parties and in delays in contract implementation.

In considering implementing performance-based contracts, the public authorities should be aware of all costs, both direct and indirect, that such contracts may entail to the public sector. Apart from traditional “costs” (overheads or expenditures inherent to the contract), there are costs incurred due to indirect “losses” (e.g. costs of hiring consultants to help prepare the contract or hiring a technical auditor to monitor performance indicators, or dealing with performance targets that cannot be monitored). Usually, the contract does not include provisions related to indirect costs. However, during the negotiation stage, the parties should always consider all actual and potential costs inherently and indirectly associated with performance contracting.

In France, when the contract for the largest water supply in the country was renewed in 2010, the incumbent operator won the bid, and then negotiated a sophisticated performance based contract , so as to promote compliance with ISO 24 512. The contract is based on a few financial indicators (operations balance, and capacity to reduce operational expenditures) and up to 136 technical performance indicators (user services, technical management, sustainable development, water quality). All indicators can give rise to penalties below a certain threshold, and 40% can induce a positive impact on operator’s remuneration (above another threshold). The operator’s remuneration is based at 2% of wholesale water revenues, minus eventual penalties, but can reach up to 9% in case of good performance.

Various other forms of improved regulations and smart governance have been discussed in February 2013 in a European workshop organized by the French *Office de l’Eau et des Milieux Aquatiques* (ONEMA), and the Chair of Economics of PPPs of Sorbonne university (Salvetti, 2013).

WSS ADAPTATIONS THROUGH UP-SCALING / DOWNSCALING

The international trend for public policies to develop multi-level governance solutions trigger reorganisation of water utilities in two directions: up-scaling, to generate economies of scale and scope; down-scaling to manage distributed technologies and cope with the risks associated with voluntary disconnection of customers.

Up-scaling services at supra-local level

In many developed countries, the initial appropriate territorial level for developing WSS services was the city level, and later the municipal level also in rural areas, eventually supported by possibilities offered to neighbouring municipalities to form joint boards (*Zweckverbände, syndicats intercommunaux, consorzi idrici*). More recently however, due to heavy investment costs and phasing out of government subsidies, local utilities turned towards concentration at upper levels of government, for part or all of the tasks to provide and deliver WSS services.

In France, due to the historically small size of the communes, which were entrusted with drinking water provision, it became quite common to form joint boards, and most of them were developed for technical reasons, i.e. a few municipalities joining to tap and distribute the same resource. In cities however, larger joint boards were formed for several reasons:

- to group suburbia with the centre city and cross-subsidy rural zones;
- to balance the power of the centre city with the suburban towns;
- to improve their balance of power with the operating private company (initially around Paris and Lyon);
- to reach the critical size needed to afford growing expertise.

This eventually led to more sustainable contracts between public authorities and private operators: while the latter were in charge of operation and maintenance of the systems, plus bills recovery, the former retained responsibility to make the heavy investments (for which they obtained subsidies and low interest loans); tariffs were set jointly by both parties. The typical management formula for water supply in France is a joint board with a delegation contract to a private operator (lease or management contract, less frequently concession). Because the size and cost of sewer pipes is usually higher, concentration of sewerage units is more limited, but in some cases it takes place for the sole sewage treatment, for which there is a supra-municipal board and a contract with a private operator. In Ile de France, there is even a 3-tier management system: street sewers are municipal, interceptors and storm sewers are run by the counties (4 *départements*), while sewage treatment is operated by a joint board between counties (almost regional level).

This kind of mixed formula separating the production of water or treated waste water from delivery of the service to customers can be found in other countries; it is the case for instance in Boston, Mass., where a metropolitan authority consolidates water production and sewage treatment, leaving member municipalities in charge of the systems' management. In Portugal, where municipalities are quite large (280 on the mainland for a territory of 100 000 km2 and a population of 10 million), but where a lot of investments were needed to upgrade the services at European standards level, in 1994 the government created a national water company, which in turn proposes municipalities in the same area to form mix economy companies in charge of *agua alta* (treatment plants), while member communes keep the water and sewer mains operation (*agua baixa*). In Australia, the 1994 reform planned by the COAG (Council of Australian Governments) mandated the unbundling of former urban water monopolies, with bulk water production plus sewage treatment organised at regional level (one public company) and retail water services at more local level (several water distribution companies). This choice also allowed giving a chance to alternative water supply technologies (recycling, desalination) to find their market.

Up-scaling can also be the product of top down centralizing policies. Examples of centralization can be found first in England and Wales, with the creation in 1974 of 10 RWAs (Regional Water Authorities), which merged WSS services together with water planning and police powers (the water industry was already undergoing a concentration process, with less than 200 water providers in 1993). This centralizing integration policy was criticized for various reasons, giving way to nationalization of water planning and licensing, and full privatization of the water industry. This model was followed a few years later by the Italians, with the Galli law of 1994, proposing to suppress the small local direct management units for the sake of WSS centralisation at the scale of ATOs (*Ambiti Territoriali Ottimali*), where integrated water and sewer utilities would adopt a commercial status and professional management. Most frequently, the ATOs matched the territories of the Province (counties, equivalent to the French *départements*), resulting in only 92 new management units (three of them being organized at regional level). This rapid systematic centralization and commercialization stirred much controversy and was somewhat halted by the anti-privatization referendum of 2011.

In Germany centralization of water utilities remained limited: only in Baden Wurttemberg, where water is already scarce, a regional water supplier was created at the time of the Empire in the early 20th century. Interestingly enough, it was later decentralized, and transformed into a joint board of concerned municipalities after WW2. In the eastern part of Germany, during the separation and the Soviet control, Water supply was reorganized at supra-local level, in 15 'popular water undertakings'. After unification West Germany imposed the return to municipal control plus development of joint boards, and also brought financial support to upgrade the services to western standard levels. There are controversies associated with these choices, among others because West German engineers did not anticipate that water consumption would collapse after unification and industrial crisis in the east (Naumann, 2012)

Developing new links with water resources management

Another form of WSS up-scaling directly derives from traditions of catchment-based water resources management. In the Germanic tradition, water is a thing not to own but to use reasonably, within a community of users which sets the rule. This rule can be quite restrictive, e.g. the riparian rights doctrine in England. But in some cases, the community is a vital institution to manage water in case of scarcity or floods. This is why in Europe, such communities have existed across centuries to irrigate the *huertas* in Spain, the mountain prairies in the Alps and Pyrenees (still active in Swiss Valais, Aosta and Roussillon), and in the Lowlands along the North sea (the *Boden-und-Wasser Verbände* in Germany). But while they usually remained small and rural, in the case of the Netherlands, the famous *Waterschappen* (water boards) not only developed their tasks but also concentrated and institutionalized to become fully functional institutions: today they maintain dikes and canals, hasten the drainage of winter rain, treat waste water from cities, and even get involved in biodiversity recovery. They offer a clear case of joint waste water and water resources management, even though in this area, apart from the Maastricht zone, there is quasi no marked watershed. Interestingly, they get funded not by water bills, but by taxes on families (Mostert, 2011).

While the common handling of water resources and services is ancient, rural and based on water quantity policies in the Netherlands, there is an exceptional experience of WSS services taking over water resources management for water quality purposes in North-West Germany. It is the well-known Ruhr cooperative boards born at the beginning of the 20th century: the *Genossenschaften* manage rivers in their catchment so as to meet the needs of urban and industrial users. The rapid industrialization and urbanization process had had catastrophic consequences on water quality, and resulted in the rise of epidemics. Municipal and industrial actors decided to specialise 3 parallel rivers: the Emscher in the centre was lined with concrete and became the collective sewer, with a primary treatment system at its mouth on the Rhine; the Lippe in the north was devoted to industrial and agribusiness uses; and the Ruhr in the south became the noble river with freshwater storage, leisure activities, and collective management of wastewater discharges through sewage works (Barraqué 1995). Local actors were authorized by the imperial government to become institutions i.e. to make financial contributions mandatory, and yet to keep their boards where various water users would be represented qualitatively (not one man – one vote, but seats for each stakeholder type). This model was exported around, so that today there are 11 such institutions in North Rhine-Westphalia, but not in other *Länder*. Today their boards include representatives of territorial and local governments, industries, consumers and environmental protection associations. This type of institution inspired the creation of the French *Agences de l'Eau* born 60 years later. Today, they do more than run water and waste water infrastructure: they undertake programs to recover the aquatic environment quality (*Emscher renaturierung* project), to fight emerging micro-pollutants, and to turn rainwater from a nuisance into a resource. In Paris southern suburbs, a couple of sewerage joint boards which were formed around small tributaries to the Seine, later decided to include river quality management and landscaping in their operations (Essonne, Orge). And it is now quite frequent that storm water control in large metropolis leads waste water utilities to look for territorial solutions, i.e. making room for water in the surface of cities, therefore participating in water resources management.

Water utilities and catchment protection

In Germany there are also many on-going experiments of cooperative agreements between water supplies and farmers, based on the notion of payments for ecosystem services. These projects are usually voluntary, and go further in terms of environmental recovery than the agro-environmental measures supported by the second pillar of the Common Agricultural Policy of the EU. They indeed involve a small increase of water tariffs to cover the farmers' compensations. This is controversial in France, where subsidizing farmers beyond CAP payments is considered as breaching the European rule limiting 'Government subsidies'. But payments to farmers are not considered as Government subsidies in Germany (which would contravene the equal opportunity principles of the European Common Market), as such *Wasserpfennig* policies were initiated 10 years before the adoption of agro-environmental measures in 1992, and remain local, are limited in time to the conversion to organic farming or extensification of dairy farming, and are provided by companies which are formally private.

Similar cases can be found in the Netherlands, but in much smaller numbers due to the concentration of water supply industry (only 10 companies) and to the smaller size of the country. Yet water utilities do run cooperative agreements with parties of 15 to 20 farmers, including training to reduce the use of inputs, and stimulation through the principle of 'payments by results' (i.e. proportional to the reduction of nitrates content in water pumped in the end).

In the United States and in Australia, biodiversity protection and erosion programs such as the CRP (Conservation reserve Program) include payments for ecosystems services. In cases where a water utility is involved, a good bargain is possible because a tiny increase in water bills can support farmers' conversion to sustainable agriculture at a cost usually lower than treating water to remove nitrates and pesticides. The case of New York's Catskill mountains and Upper Delaware is a frequently quoted example (Salzman, 2002)

In France, small municipalities are often unable to develop such partnerships with local farmers. Large water companies innovate by taking control over land use and reaching out to farmers to either change their practices, or to reinstall other farmers with strict fertilisation conditions on the land they have acquired. There are also a few cases similar to the German-Dutch approach. For instance Grenoble developed cooperative agreements with the few farmers active on the well-head area of Rochefort back in the 1970's, under the same conditions as Munich in Germany: in mountain areas, intensification of agriculture occurred later than in the plains, so the problems with diffuse pollution from agriculture was handled early enough; the needed efforts and funding to stop the progression of contamination remained moderate. In Grenoble also, the farmers still active in the wellhead area are only part time farmers and have other revenues (so they can accept to abandon intensive agriculture projects); and some others are employed by Grenoble water services.

In a country where water and sanitation services are small and fragmented, there is of course an excessively high number of wells and boreholes for public supply (around 30,000). European and national pressure on well head protection results in French counties (*départements*) being mandated to set up drinking water production plans, which should help concentrate intake points on a limited but better protected number of wells. In turn this will probably stimulate a concentration process at least in rural areas, with expected enhanced sustainability.

Controlling/Managing de-centralized technologies

One of the important challenges faced by some utilities is the 'unplugging' of some water users, be it for ecological or for money saving reasons. In the first case, innovative sustainable neighbourhoods in cities partly or fully replace traditional public systems by decentralised technologies. The aim is to reduce the energy and water footprint, and to turn waste into new resources as much as possible. Paradoxically, these innovations take place in the richer and high density European member states, while in many peripheral regions in Europe (but also in the USA, Australia, New Zealand etc.), significant fractions of populations are not connected to sewers, and even depend on private wells or traditional group water schemes for their water supply.

Alternative and distributed water supply systems have been advocated as part of the 'soft path' for water by Peter Gleick and others. OECD (2009) mentions four opportunities that this path offers to adjust the investments and make infrastructure more sustainable: change in scales (and in fact adopting multi-scales); demand management; competition under Government regulation to make investments more creditworthy; and public involvement.

In some German areas, demographic decline combines with the decrease of per capita consumption to induce such collapse in water demand that public systems end up being largely oversized. Some public operators admit that it won't be possible to sustain the present infrastructure; since it would need rebuilding anyway, why not redesign them with room for distributed technologies at single family, block or community level, in particular at the urban fringe? On the other hand, green innovators better understand that the disordered development of decentralised solutions might undermine even more the sustainability of centralised systems, which they yet do not want to phase out for security reasons. In the Netherlands for instance, after some failures of water recycling projects, law forbids re-using water indoors. There is then a possibility, and even a need, to bridge water footprint reducers and *Stadtwerke* or Dutch water companies (and any public utility in developed countries) into a common systemic approach. This is, among others, the aim of the NetWORKS project co-led by DIFU and ISOE, and many other innovations (Fraunhofer Institut, Kluge, 2010).

In France, there are 5 million septic tanks, which are now considered as technologies to be kept and upgraded. The implementation of the Urban Waste Water Directive led to a zoning of networked – non networked areas, the latter being served (or at least controlled) by SPANC (public services for decentralised sewerage). This provides an additional business to utilities: collective management of decentralised technology. There are also several urban areas where land use based management of rainwater is developed to reduce stormwater discharges (‘water–in-the-city’ programmes). There is indeed a basis for innovations recombining technologies and territorial governance.

This is relevant all across Europe, since the proportion of households not connected to sewers is higher in low density or low revenue countries or regions like Portugal and Spain, southern Italy and Greece, eastern European and Nordic countries, Ireland and even in some German *Länder*. In these areas, the connection of populations to public water systems is not fully achieved, and in such cases, experimenting decentralised water production could be tested, once the concerned populations’ feeling of being left out is reversed. There is room for creating public services operating non-networked systems, and more generally for WSS authorities at local level to address the issue of the limit to centralised technologies in the periphery of cities. Planners and urban water specialists now report on ‘distributed water systems’, which propose to recombine various scales of water and particularly waste water management to improve overall performance, while reducing impacts on environment and making a nuisance into a resource (VEIL, 2009; AWWA-WERF, n.d.). Ireland has officially kept a large number of group water schemes, providing water to 8% of the population at community scales that are much smaller than the 34 public water supply systems. An evaluation by Brady and Gray (2013) shows that, despite their difficulties to meet the standards now imposed at European level, they operate sometimes better than public water systems, and the population they serve remains largely in favour of keeping them.

Now interestingly enough, large and rich countries with large metropolises but also average low population density, like Australia and the USA, still have significant populations served by private individual or community systems. There is on-going research to serve these with robust treatment and simplified systems, but equipped with real-time information and communication technologies, to precisely help set up community services operated from distant centres (e.g. work by Yoram Cohen, UCLA IoES).

Such a reflection on sustainable services and the limits of networked technology can enrich decentralised co-operation with developing countries.

SOCIAL SUSTAINABILITY

While the issue of the ‘water poor’ and the right-to-water was considered as a past problem in developed countries and only an on-going problem in developing ones, a sort of backlash occurred after the debate roared between supporters and opponents to ‘water as an economic good’, privatisation and full cost pricing: starting with England and Wales, and soon afterwards in France, the question of water charges/bills affordability was raised. However, this area remains the least studied among the domains to be covered for sustainable water management.

The first rationale for introducing volumetric payment of water, and additionally increasing block tariffs (IBTs), is efficiency in use and demand management. But there is another argument: equity. One can indeed argue that even if elasticity of consumption to price is small and IBTs have complex consequences, they may still be justified in terms of utilities getting higher revenues from users who generate a costly peak demand; and, on moral grounds, most people support that water wasters should pay: metering and IBTs would be advocated in terms of consumer justice. Some also consider social justice: initial cheaper volumes would make water less expensive for the poor.

Mention must be made of the Organisation for Economic Co-operation and Development (OECD) survey on social issues in water pricing (OECD, 2003). Among other things, the OECD reviewed various methods to cover bills in arrears or to support bills of the poorest families in various countries. The OECD then supported full-cost pricing of water services, and its commercial or private law status (OECD, 2003). But most of the book is devoted to the affordability of water services. Indeed, water prices rose drastically in the 1990s, and this trend is estimated to continue, so that the social issue will necessarily remain. The OECD taskforce tried to develop an indicator of what it called macro-affordability, based on the ratio of average water charges to the mean aggregated household revenue, or to the mean aggregated household expenses. It also developed an indicator of micro-affordability, this time looking at the impact of water expenses on various income groups, family sizes, and regions. Priority remained economic rationalisation:

> The trade-offs between efficiency and equity objectives in the provision of household water services typically occur when moving from an unmeasured to a metered charging structure, when rebalancing tariffs away from fixed charges towards volumetric charges, and when increasing fees and tariffs towards full cost pricing. There is considerable experience in OECD countries with policy measures to address water affordability for vulnerable groups, while attempting to make water pricing reveal the full economic and environmental costs of water services. (OECD, 2003, p.12)

Supporting measures for the poorest families can be grouped in two broad categories: those supporting revenues of targeted households, and preferential tariffs. The first group of measures includes social subsidies, vouchers, fractioned payments, and debt forgiveness. In the second group, preferential tariffs are meant to keep water bills below a certain fraction of revenue (e.g. 4 %). They include keeping water charges under a threshold, and increasing block tariffs. Though the OECD acknowledged that some metering plus IBTs may have regressive effects on large poor families, it claimed that “the design of increasing block tariffs can be adjusted in several ways to make the sizes and prices of tariff blocks deliver the intended distributive effects” (ibid.).

Some researchers challenge this claim, in particular in a developing country context. Boland and Whittington think that “this type of tariff deserves more careful attention. Even at first glance, the consensus appears somewhat curious because, although IBT structures were first designed in industrial countries by providing revenue-neutral cross-subsidies, only a small minority of water companies in countries like the United States now use them. Water and sanitation conditions may help explain the fact that IBTs are increasingly popular in developing countries… but this is not obvious. In many cities in developing countries, most poor households do not have private metered connections to the water distribution system, and thus IBTs do not help them" (Boland and Whittington, 2000, pp. 215-216).

After careful examination, they conclude, "IBTs introduce inefficiency, inequity, complexity, lack of transparency, instability, and forecasting difficulties…. Every claimed advantage of an IBT can be achieved with a simpler and more efficient tariff design: a uniform price with rebate" (ibid). They argue that rebates can be targeted to low-income customers, provided the information is available. Komives et al. (2005) also draw from their experience in developing countries that IBTs have, in fact, regressive effects, because poor households are often large ones, so their consumption ends up in the upper blocks.

One however could argue that these conclusions may not be valid in developed countries. Indeed, in parts of Europe, almost all households are connected to water supply systems, so that issues identified by Boland and Whittington regarding charging for collective consumption (e.g. villages depending upon stand pipes, or connected subscribers reselling water to poorer neighbours) do not occur. There are, in fact, three situations in Europe. In England, Wales, and Ireland, there is no tradition of metering, and until recently all households paid flat rates linked to the renting value of the homes. In Mediterranean countries like Portugal and Spain (and also Belgium), each household – including those living in condominiums – is metered and billed separately by water utilities; in such cases, IBTs can be introduced. In France, parts of Germany and northern Italy, metering was installed at the building level; building owners or managers can opt for sub-metering at apartment level, to allocate the total bill; they can alternatively spread the bill in proportion to the number of household members, or (more frequently) to apartment sizes. In that case, it is difficult to introduce IBTs, though not impossible. In the United States, metering is widespread, but some very large metropolises like New York and Chicago (which have a large proportion of condominiums) are only introducing metering now, and they do it at the building level.

Where metering is collective, and indoor water use is both moderate and inelastic, IBTs may well end up as a useless complexity.

This debate calls for a more important involvement of water utilities in the social dimension of water charges, and a general reflection on the distributive effects of tariffs levels and structures. This is still a relatively unexplored territory. Now that the water poor notion is acknowledged, utilities are more or less forced to find alternative ways to address the situation.

One first potential tool is to build upon the seminal approach developed by Fitch and Price: their indicator for water affordability is the percentage of people who pay more than 3% of their income on water services. This indicator can be supplemented by another one: those who pay less than 1%. In turn these two indicators can be calculated for a three dimensional matrix, with deciles of income, number of persons behind the payer, and a proxy for water consumption habits (thrifty-average-hedonist). A similar approach has been used by Rajah and Smith in the UK, and by P. Van Humbeeck in Belgian Flanders. It would be very useful for water utilities and authorities to use such tools to simulate and anticipate the potential impact of tariff changes.

Many utilities argue that the social dimension of water services should be handled separately or, as AWWA wrote 'think outside the bill'. In down town areas in particular, when water is paid in addition to the rents, it is much easier for tenants to pay a fixed charge for their water every month with the rent than a randomly sent variable bill. And when they cannot pay, they may need a global support for the rent and general charges rather than for water alone.

One option is to get water suppliers, as well as electricity or gas suppliers, to give a small percentage of their turnover to a social housing fund, as is the case in France. The fund operates at county level, since county councils are in charge of social and sanitary affairs. One of the problems is that this funding can only help people who are temporarily unable to pay. It is more difficult to support people who are in need but do not receive bills directly.

Another option is to identify poor water users and offer them rebates or vouchers. This is the case in France with 'personalized water Checks' (coupons). They are experimented in the largest water supply utility in France, the suburban SEDIF. A similar scheme is used in Chile.

Several cities experiment the combination of increasing block tariffs with social rebates. In Dunkerque, the first block of 75 m3/yr is supplied at 0.80 €/ m3, and for families on benefits (CMUC in French) the price goes down to 0.30 €/m3. The second block up to 200 m3 costs 1.50 €/ m3. Additional consumption above that threshold is billed 2 €/ m3. There are no social rebates for upper blocks. Since it was considered illegal to use data on family sizes and to set the blocks per capita, these figures are multiplied by the number of apartments behind a meter, irrespective of the number of residents in each apartment. It remains to be seen how this social tariff will perform in terms of social redistribution.

CONCLUSION

Water supply and sanitation services in OECD countries face multiple challenges. The time of expansion of services (when technology allowed utilities to become more autonomous from water resources and to limit interaction with customers to the meter) is now coming to an end. New business models, and even more so, modes of management, are needed to face the growing structural crisis described at the beginning of this paper. Authorities and water utilities might explore several options to address some of these challenges and put water supply and sanitation services on a more sustainable path.

Sophisticated tariffs can contribute to policy objectives. However, there are limits to what they can achieve. In any case, smart metering is a prerequisite to develop a real-time communications network on top of the infrastructure, like the pilot-fish with the shark or whale. It can generate opportunities to better understand what drives demand for water and to deliver additional services to consumers.

Rationalization of infrastructure management has become a must in a period when utilities cannot indulge in relying on yearly revenue expansion. New technologies can provide utilities with accurate knowledge of the state of the infrastructure, therefore contributing to better planning renewal/expansion/shrinking investments. In turn, this can facilitate self-financing and debt control. Financing and fiscal optimization however requests new forms of collaboration between authorities in charge of services and operators, in a vision of the WSS future that goes beyond the duration of the contract. New management models should also include the possibility for citizens and independent experts to review the on-going policy.

New sources of revenues can be explored more systematically, based on new functions (urban drainage, water efficiency, additional services to water users), performance (through contractual arrangements that reward performance), or tax bases (for instance, land-based taxes). Social issues will require well-designed and targeted measures, possibly outside the water bill, based on thorough analyses of water consumption, water uses and affordability. Lessons can be learned from energy suppliers, which have faced similar issues related to energy saving and control over energy bills.

Water utilities should take advantage of opportunities related to both up-scaling and downscaling water services: working upstream to protect catchments and downstream to supplement wastewater treatment with natural solutions; going beyond the meter to influence water consumption in the home; combining economies of scale and scope with distributed technologies and unplugging. This calls for reinventing a concept of public service eventually able to rely on non-central infrastructure.

An issue for future consideration is to better manage the frontier between dense urban areas with centralised systems and low density rural areas with decentralised technologies. The suburbia should be the locus of experiments combining centralised and distributed systems.

The discussions above indicate that innovative business models call for a revision of well-entrenched categories: they better articulate water supply and sanitation with water resources management; central infrastructure with distributed systems; ICT with water technologies; management of public infrastructure with control of assets on the customers' side of the meters; technical with social innovation; city centres with suburbia... They will influence the structure of the industry and the way we think and live in cities. In these domains, developing countries may have more room of manoeuvre. Developed countries are faced with the additional challenge of injecting flexibility in inherited technologies.

More work is needed to imagine institutions and policy frameworks that facilitate exploration and diffusion of such multifaceted innovations. There is a role for governments to facilitate and control the transition towards improved modes of management and business models, because, at least in developed countries where WSS services are working well, the historical operators are protected by the weight of infrastructure they manage, and have little incentive to adapt their economic model. It is then difficult for incoming innovators to develop their market.

Governments could first refine standard setting to allow new modes of management to develop in specific areas or niches, and gain the time needed to benchmark traditional *versus* innovative practices through a comprehensive set of criteria (OECD, 2009). They can for instance call for tenders on eco-neighbourhood or smart cities projects (Germany has a long experience through International Building Exhibitions). This is a way to publicise innovations and evaluate them. This follow-up is all the more needed that, in the last decades, the possibility to offer premium services in well-off areas has resulted in rising inequalities in access to networked services, giving rise to a 'splintering urbanism' (Graham & Marvin, 2001).

Governments should also devote much more attention to existing infrastructure: given the rising issue of ageing systems and the expected high renewal costs, their sustainability must be assessed, and alternative solutions could then be decided and supported at national scale.

Implementation of innovation also implies to encourage WSS operators to better think in terms of multi-level governance and to accept the combination of technologies which are embedded in these various territorial scales. Real-time information and communication technologies help make non-conventional water technologies more reliable, and research and innovation should be supported in these domains. And it becomes crucial to involve users in the preparation of policies. Governments can mandate the communication of information and the consultation of the public, but direct implication is certainly more difficult to develop. Another issue is to encourage operators to support water conservation by their clients. The potential loss of revenues could be alleviated in the context of performance-based contracts that reward performance in this area.

Governments should also develop rules to control and support payments for ecosystems services (replacing technology investments by territorial solutions) so that stakeholders understand and accept such schemes.

In any case, there is a growing need for a sort of 'governmental reflexivity': before changing a regulation or mandating innovations, as typically occurs in tariff setting or in rainwater harvesting, an assessment of the global impacts of the new regulation should be made. For instance, in many cities in developed countries, domestic rainwater harvesting is over-costly, while public services have plenty of water available with little impact on the environment. In these places, other improvements in WSS management can be promoted. The complexity of WSS services, illustrated in this paper, leaves no room for dogmatic and 'one-size-fits-all' solutions.

Water and Energy services: differences

Water and electricity are two basic and universal services in developed countries. They are considered a basic need, and are subjected to the same kind of support policies for poor people access. Also both services follow seasonal and daily variations in consumption, and consumption is regulated by tariffs and a price signal on quantities. New technologies of information applied on metering provide new perspectives on tariff modulation.

They are confronted to similar challenges. On the one hand, there is a push to minimize consumption per capita, thus threatening the revenue streams of suppliers. On the other hand, investment needs are daunting, to upgrade infrastructures and services. Meanwhile, innovation in the distributed production and supply of water and electricity challenges the initial conception of centrally designed and managed networks. Both industries are looking for efficiency gains and new sources of revenues. New entrants coming from other fields (ICT, for instance) are potentially challenging incumbents.

However significant differences between both industries should not be underestimated and limit opportunities for cross-fertilisation.

Market access

There is a fundamental difference in household access to both markets: for electricity there is competition in the market, while for water there is competition for the market. In the first case consumers can choose among several suppliers, and opt for one among several tarif formulas, depending on their consumption profile. For water this is much less frequent, and tariffs are usually uniform.

Network scales

Electricity systems are usually regional, national and eventually internationally connected, with a very short term search for a supply/demand balance. In addition to technical infrastructure, the electricity sector uses tools like the spot market, and incentives to waive some peak demands. Water systems are much smaller, local or sub-regional; interconnections are only needed for sanitary reasons, in case of incidents on a vulnerable supply.

Consumption cycles

Daily and seasonal consumption cycles are different for water and electricity. Primary electricity demand peaks are in the evening and secondary ones in the morning, and it is the revers for water. Seasonal electricity peak is in winter, while water scarcity is likely to occur in the summer.

Coping with consumption tensions

- Daily peak demands are no real problem for water supply, due to availability of storage capacities in local reservoirs. Conversely electricity demand must be instantly followed by supply, in which case short term demand waiving is much more useful. It can be considered as a passive storage capacity at the final consumer's home (thermal inertia, hot water balloons).

- Seasonal electricity peak demands create an issue for transport capacity and secondarily for available power. Insufficient production is a smaller risk, since demand peaks can be anticipated with temperature 5-day forecasts. Water shortage risks are local and generated from outside: typically it is irrigation demand which might cause apparent scarcity. Anticipating summer droughts and shortages is possible but calls for a monitoring of aquifer levels. Cases where hydroelectricity and potable water supply compete for water resources are not frequent, but exist typically in São Paulo and Rio de Janeiro.

Potential of daily/seasonal tariff adaptations

In the power sector, and particularly in areas of insufficient transport capacity, tariff modulations and economic incentives to waiving (thanks to storage of heat in buildings and water balloons) help reduce the daily late afternoon peak demand in winter. This is particularly important fort operators given the very high electricity peak price on the spot market.

In the water sector, the permanent storage capacity reduces the scope for modular tariffs. It is obviously better to use them in the irrigation sector. Altogether, the cost of sophisticated meters and tariffs frequently exceeds the benefit expected from modulation. In other words, water is not expensive enough to justify a refined tariff, conversely to electricity. It interesting to give a price signal with a seasonal summer tariff only in areas where there is an important summer tourist population or important garden irrigation (e.g. California). Regulatory tools are sufficient to curb non-priority water uses like irrigation and car-wash.

Interactions between water and electricity exist but the only way they are eventually related in terms of tariff is when there is a single operator for both services or at least a single system of meter reading (economies of scope in metering administration and litigation costs). This is the case in some developed countries like Germany or Switzerland and in developing ones like Morocco. Joint management of both services however requests a specific institutional set up and is not encouraged everywhere. But water and WSS services are usually large electricity consumers and therefore can participate in energy conservation, by operating pumps and electric machinery at night, and through pumping the heat in waste water systems. In terms of joint technology, waste water treatment can be combined with co-generation and with generating biogas through anaerobic operation. Some sewage works generate all their electricity and beyond, can re-sell biogas to the gas network. Overall, water conservation is also the best way to reduce energy consumption by WSS services.

BIBLIOGRAPHY

Barraqué Bernard (ed.) *Les politiques de l'eau en Europe*, La Découverte, 1995 (313 p.)

Beecher Janice, The ironic economics and equity of water budget rates, *AWWA Journal*, February. 2012. Accessible on http://editiondigital.net/display_article.php?id=964244

BIGGS Che et al. (VEIL) D*istributed water systems. A networked and localised approach to sustainable water systems*, report of the Victoria Eco-Innovation Laboratory, University of Melbourne, 2009. see: http://www.sustainable.unimelb.edu.au/files/mssi/Biggs_2009_Distributed%20water%20systems_0.pdf

Brady J., Gray N.F., 2013: Analysis of water pricing in Ireland and recommendations towards a more efficient water sector, in *Water Policy*, IWA Publishing, 15, 435-437

Graham S. Marvin S., *Splintyering Urbanism. Networked Infrastructures, Technological Mobilities and the Urban Condition*, Routledge 2001.

Kluge Thomas, *NetWORKS II – Transformation Management for a Sustainable Water Infrastructure*, Institute for a social Ecological Infrastructure, Frankfurt, 2010. Access: http://www.isoe.de/en/projects/recent-projects/wasserinfrastruktur-und-risikoanalysen/networks-ii/

Montginoul Marielle & al., Simulating the impact of water pricing on households behaviour: the temptation of using untreated water, in *Water Policy* 7 (2005) 523-541

Naumann M. & Wissen M., Water infrastructure between commercialization and shrinking: The case of Eastern Germany, in Barraqué B. (ed.) *Urban Water Conflicts*, UNESCO-IHP & Taylor and Francis, 2012

OECD, *Social Issues in the Provision and Pricing of Water Services*, 2003

OECD, *Alternative ways of providing water. Emerging options and their policy implications*, 2009

OECD, *Guidelines for performance-based contracts between utilities and municipalities. Lessons learnt from Eastern Europe, Caucasus and Central Asia, Almaty, Kazakhstan*, October 2010. Accessible : http://www.oecd.org/countries/kazakhstan/47425194.pdf

Prevedello Cedric, . *Etude relative à l'impact sur les usagers des réformes en matière de tarification de l'eau et à l'estimation de l'emploi généré par le cycle anthropique de l'eau en Wallonie*, Aquawal report, 2011. http://www.aquawal.be/fr/etudes/

Salvetti Maria, Dupont P. Saussier S., *Workshop on smart governance & regulation of water and sanitation services*, ONEMA, and EPPP chair, Florence school of regulation, 2013. Access: http://chaire-eppp.org/smart_governance_and_regulation_water

Salzman J. (2005). Creating markets for ecosystem services: Notes from the field, *New York University Law Review*, 80 (3), 870-941.

Swyngedouw E., Techno-natural revolutions: the scalar politics of Franco's hydrosocial dream for Spain, 1939-1975, in *Transactions of the Institute of British Geographers*, vol.32 (1), Jan. 2007, pp. 9-28

WERF, *When to consider distributed systems in an urban and suburban context* (nd) Accessible on http://www.werf.org/i/c/Decentralizedproject/When_to_Consider_Dis.aspx

WERF, *Distributed Water Infrastructure for Sustainable Communities. A Guide for Decision-Makers*, presentation of V.A. D'Amato & al. research n° DEC3R06. Access on http://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CEEQFjAB&url=http%3A%2F%2Fwww.werf.org%2Fc%2FDecentralizedproject%2FDistributed_Water_In.aspx&ei=lS6aUeCGNpCwhAfRg4C4CQ&usg=AFQjCNEC-yhtUkED8oKEvYFtZBPTJ7UqUA&sig2=IvnEgjAX4i7cI5iZ1RFZ7Q&bvm=bv.46751780,d.ZG4