

Use of Water Consumption Metering as a Tariff Policy Tool: Moldova's Experience

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This report was developed by "Moldova Apă-Canal" Association of Water Supply and Sanitation Utilities, incorporating 37 water supply and sanitation utilities of Moldova. The Report highlights the major trends of laws and regulations, underlying application of consumption-based billing in the recent decade, as well as technical and institutional issues, pertaining to installation and use of water counters.

Our analysis was based on two typical water supply and sanitation utilities (from the point of view of water metering arrangements and their relations with consumers) - i.e. water utilities that serve Chisinau municipality (the capital of Moldova, 706 thousand residents) and Orkhei municipality (37 thousand residents). We have analysed the growth of measured water sales in 2 recent years and impact of water meters on their consumers (first of all, urban residents).

The report reflects the range of problems, associated with reliability of consumption-based billing of water consumers at the level of individual apartments. These problems should be addressed in the course of development of underlying draft laws and regulations for metered billing, as well as for development of tariff policies, forecasts, and water demand management.

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I. Introduction

A sound tariff policy is a necessary precondition for long-term and stable development of water supply and sanitation utilities. However, development of such a policy is impossible (or at least is would be substantially hindered) without measuring of actual water consumption of a utility's consumers. Otherwise, different groups of consumers will bear all water supply costs regardless their actual consumption levels.

Broad application of water consumption metering instruments is of major importance for transition from the old tariff formulae (Costs plus), being applied now in the Republic of Moldova to new tariff policy principles, providing real opportunities/incentives for improvement of efficiency of water supply and sanitation utilities. This is especially true for the sphere of water distribution. Metering allows to improve fair pricing and transparency of utilities' operations, moreover, metering allows to ensure real control of service quality and regulation of these services, depending on demand and affordability.

At the same time, notwithstanding apparent simplicity of introduction of water consumption metering, underestimation of all associated aspects (underlying laws and regulations, technical and institutional problems, etc.) often result in inadequate reflection of actual consumption, moreover, potentially it might cause substantial losses of water utilities.

Individual NIS seek to develop efficient water metering systems independently (especially in the sphere of household water supply). However, this analytical report, developed by "Moldova Apă-Canal" Association and Water and Sanitation Utilities to reflect some particular features of the process in the Republic of Moldova, might become useful for other countries, that face the need to choose between introduction of individual (household-based) metering and group (apartment block-based) metering.

II. Water Consumption Metering: Underlying Laws and Regulations

For a long time, Construction Standards and Rules (SNiP) 02.04.01-85 "In-door Water Supply and Sanitation Installations" represented the key and the only relevant regulation. SNiP specified, that water counters should be installed at entry point of water mains leading to a building and provided methodology for selection of necessary types of water counters. Based on provisions of the SNiP, that water counters are considered as components of in-door water supply infrastructure of a building, "Operation Manual of Municipal Water Supply and Sanitation Systems in the Moldavian SSR" (the manual was approved as a sectoral regulation by Order No. 66 of the Moldavian Minister of Housing and Utilities of March 1983), clearly specified that "water meters and counters, regardless of their particular installation places shall be considered as property of a client". This definition allowed to identify clear relations between service providers (water supply and sanitation utilities) and consumers (economic agents, budgetary facilities, housing maintenance utilities and private owners of individual housing) and provided for several sanctions against consumers for violation of the due rules of maintenance and use of water counters regardless of particular installation places (e.g. inside a building, in a well (chamber), at out-door water pipes of a water consumer/supplier).

Accounting for the fact, that in 1980-s and 1990-s water counters were in short supply and water prices were stable and set relatively low, counters were installed mainly at industrial facilities, while all other water consumers were billed based on standard water consumption rates. These rates were estimated according to the above SNiPs, based on standards, applicable to design of in-door engineering communications of residential and public buildings and constructions. In practice, these arrangements suited both service providers and consumers.

Starting from 1992, in parallel with initiation of market-oriented economic transformations in the Republic, privatisation of housing and substantial rise of prices of water supply and sanitation services

for households and drastic reduction of water supply quotas for economic agents, the previous system of billing (based mainly on standard consumption rates) increasingly failed to meet demands of consumers. First of all, the system adversely affected household and budgetary facilities (in the transition period, serious expenditure limitations were imposed on budgetary facilities by the state budget and local budgets).

In 1995, Governmental Resolution No. 337 of 25.05.95 "On Introduction of Water and Heat Counters to Monitor Water and Heat Consumption by Households, Public Organisations and Economic Agents", instructed ministries, departments, local authorities and economic agents to install, in 1995-1997, water/heat counters at all sites under their management or in their property. Purchase and installation of counters in residential houses and public buildings was to be made at the expense of service providers, according to the sectoral program, that should be developed by the former Ministry for Municipal Services. The Program stipulated that the above works (installation of counters in residential houses and public buildings) should be financed by relevant ministries, departments and local authorities.

Unfortunately enough, due to lack of clearly defined sources of funds for financing of the above sectoral program (the Ministry of Finance had refused to finance the Program from the State Budget), the Program had not been approved. At the same time, according to different governmental decisions, purchase and installation of counters in different public facilities, was made at the expense of budget allocations of the Ministry of Finance to relevant ministries and departments.

Due to these developments, as well as due to conflicting interpretations of some provisions of Resolution No. 337 and its contradictions with other existing legislative acts (for example, heating facilities use Law on Power Industry No. 1525-XIII of 19.02.1998 and Law on Power Industry No. 137-XIV of 17.09.1998 and the framework legislative acts, pertaining to their operations), the Government annulled Resolution No. 337 by its Resolution No. 1067 of 11.11.1999.

Within the same period of time, the Constitutional Court of Moldova, by its Ruling No. 69 of 14.12.1998, declared clause 14(2) of Law on Power Industry unconstitutional (the clause specified that "energy consumption metering instruments are in property of a supplier"). The same Ruling confirmed legitimacy of clause 4 "a" of Article 35 of Law on Electric Energy, specifying that "a consumer shall bear all connection costs" (i.e. a consumer shall cover all costs, incurred by purchase, testing and installation of a power consumption counter). This Ruling provided the legislative base for application of consumption metering, because rulings of the Constitutional Court prevail over laws, passed by the Parliament of Moldova.

Later, legal competence of Law on Power Industry (and the above Ruling of the Constitutional Court) in the sphere of water consumption metering in residential houses was confirmed by clause (4) of Article 19 of Law on Condominium (No. 913-XIV of 30.02.2000). According to the clause "installation and use of electric energy, heat, gas and water counters in a condominium shall be made according to Law on Power Industry (No. 525-XIII of 19.02.1998)".

In connection with initiation of the large-scale installation of individual cold and hot water counters by residents in 1997-1998, on August 21, 1998, the Ministry for Territorial Development, Construction and Utilities approved "Temporary Rules for Installation of Cold and Hot Water Counters by Residents and Procedures of Payment for the Services Provided" (No. 1230-08-01). The key provisions of the Rules stipulate that consumers (apartment owners) should cover all costs, incurred by purchase, installation, registration, testing and operation of apartment-level water counters, while a service provider should sign contracts on provision of these services with consumers.

Term "service provider" was not formulated clearly - it covered municipal housing facilities, associations of owners of privatised apartments and housing co-operatives (i.e. the ones, that actually operated as distributors) and water and sanitation utilities (i.e. genuine service providers). As a result, many water supply and sanitation utilities started to sign direct contracts with apartment owners on provision of water supply and sanitation services. These contracts incorporated also registration of apartment-level water

counters (or their installation), without accounting for several specific features of metering, that were not regulated by the above "Temporary Rules ...".

The Government attempted to clarify these issues by its Regulation No. 634 of 05.06.2000 "On Some Measures, Pertaining to Regulation of Installation of Water and Heat Counters". However, the Regulation failed to produce expected positive effects, moreover, the document generated new problems.

For example, notwithstanding more clear clarification of issues, pertaining to purchase and installation of water meters at the expense of economic agents and budgetary facilities, issues of operation, maintenance and calibration of these meters still remain unclear. These issues should be regulated by "contracts" between suppliers and consumers - as a result both suppliers and consumers have the legal right to demand maintenance of metering devices at the expense of their counterparts.

From the other hand, the lack of clear delimitation of terms "distributors" and "suppliers", that are used in the Governmental Regulation, does not allow one to specify a party, responsible for purchase/installation of counters in residential houses. The range of potential responsible parties incorporates: "distributors" (i.e. organisations in charge of maintenance of residential housing, including municipal housing maintenance facilities, associations of owners of privatised apartments and housing co-operatives) and "suppliers" (i.e. water supply and sanitation utilities). The Regulation stipulates that service providers (i.e. distributors or suppliers) are responsible for purchasing, installing and operating water counters at entry points of water supply pipes of residential apartment blocks. However, the Regulation failed to identify, who is responsible for installation of water counters in the case of private houses.

Law on Introduction of Changes and Amendments into Law on Power Industry (No. 1135-XIV of 13.07.2000) also failed to clarify the legislative base of consumption metering. According to the Law, installation, operational examination, maintenance, repairs and replacement of energy consumption counters, installed at sites of economic agents and budgetary facilities should be made according to contracts between suppliers and consumers, while in the case of households, these services should be provided at the expense of suppliers.

According to the Ruling of the Constitutional Court, the above Law (No. 1135-XIV of 13.07.2000) excluded provision on purchase of water meters at the expense of a service provider, so after their purchase, water metering devices should become customers' property items. However, the Law generated some legal obstacles for maintenance of water counters in private property, associated with the need to their repairs, calibration (including their dismantling), maintenance of reserve stock of water counters for their replacement (by service providers). Besides that, technical workers of a provider do not have free full-time access to private apartments in order to control use of counters and prevent potential tampering (according to Law on Condominium, it is necessary to notify an apartment owner in advance (5 days) on the need to get access to his/her apartment).

Making interim conclusions, it is necessary to note, that there are substantial contradictions in the due laws and regulations, pertaining to installation and use of water counters. As a result, customers and providers interpret these legal acts differently. At the background of decentralisation of water supply and sanitation services (these services were transferred to municipal property in the second half of 2000), there are different types of relations between service providers and their consumers in different urban areas of the republic.

III. Technical Aspects of Water Metering

According to the list of water counters for cold and hot water, allowed by the Department of Technical Supervision, Standardisation and Metrology for use at the territory of the Republic of Moldova, about 60 different designs of water metering devices might be used for commercial water metering purposes (including propeller and turbine water counters, ultrasound and vortex flowmeters, etc.).

A rather rich assortment of available apartment-level water counters (D=15mm) allowed to increase the share of apartments, equipped with water counters, comparatively quickly. At the same time, their actual use was associated with numerous problems.

According to "Temporary Rules for Installation of Cold and Hot Water Meters for Residents and Procedures of Payment for the Services Provided", apartment-level water metering devices should be installed in compliance with ToRs of service providers. However, inadequacy of relevant regulations, as well as the fact that large-scale installation of these metering devices (1999 - 2000) coincided with the process of reorganisation of water supply and sanitation utilities and housing maintenance utilities, resulted in installation of fairly diverse and cheap water counters by individual households, without accounting for any applicable ToRs (represented mainly by class "A" counters - with average unit price of Lei 190 - 230 and installation costs of Lei 20-30).

Since 1995, service providers (water supply and sanitation utilities) installed apartment block-level water counters at connections with water supply networks at their own expense (according to the Governmental regulations). In parallel, economic agents and budgetary facilities independently purchased and installed water meters in compliance with ToRs of service providers. As a result, water meters of these categories of water users generally comply with requirements to water flow limits and operational rules.

The Department for Technical Supervision, Standardisation and Metrology set 2-year maintenance/calibration cycle for water meters, as a result, in the initial period of large-scale installation of water meters (1995), actual implementation of maintenance, repairs and calibration works was problematic due to the fact that only 2 facilities were able to fulfil these works at that time - JS Company "Apă-Canal Chişinău" and private company "Cocor" (in Belts municipality).

Average costs of calibration works for water meters with $D < 80\text{mm}$ reach about Lei 30 (for organisations), if connection diameters are larger ($D > 80\text{mm}$) the costs become a little bit higher - Lei 40. Repair costs of water meters are also substantial, depending on connection diameters and repair types (current, medium and capital repairs), these costs reach, respectively: Lei 60; 250; 400 for $D = 15\text{mm} \div 40\text{mm}$; Lei 80, 300, 500 for $D = 50\text{mm} \div 80\text{mm}$; Lei 100, 380, 630 for $D = 100\text{mm} \div 200\text{mm}$.

Due to large-scale installation of individual apartment-level water meters and the need to calibrate them every 2 years, 8 additional maintenance and calibration facilities were established. These facilities are mainly represented by economic agents that sell specific types of water meters and provide calibration and repair services for their types of water meters only.

Average costs of calibration of individual apartment-level water meters (D=15mm) vary from Lei 12 to Lei 20, while additional works, performed by housing maintenance services or other organisations (dismounting, mounting and sealing water counters up) increase these costs by extra Lei 30-40.

There were numerous complains of households, associated with high costs of calibration of individual apartment-level water counters and length of these works (usually about a week), inefficient organisation of these works at the local level, the need to calibrate a water meter every 2 years, regardless actual water consumption (this is especially important in the case of hot water meters, because hot water is supplied with breaks.) In this connection, in late 2001, the Government of Moldova authorised the Department for Technical Supervision, Standardisation and Metrology to explore the issue of expanding the calibration cycle for 5 years instead of 2 years. So far, no final decision on the matter has been taken, mainly due to very negative comments of service providers. According to service providers, only a tiny share of operational water meters in the Republic do not need repairs after 2 years in service.

Their conclusions are based on analysis of key causes of failure of water meters, that incorporate the following ones:

- heavy sedimentation of sand and mineral salts at walls of flow passage parts of water meters, clogging of protective wire screen due to inadequate water quality;

- frequent wearing out of point bearings and spindles (especially in the case of water meters, that were assembled in the Republic from imported parts);
- cracks in sight glasses and depressurisation;
- frequent freezing of water meters, installed outdoors (in wells and chambers).

There is a separate problem, that should be addressed legislatively in the course of organisation of water metering at the level of individual apartments (now, the problem is not addressed by any relevant regulation, but it might substantially affect reliability of metering data) - the problem is associated with some design features of cheap water meters of "A" (or "B") class and potential risks of unregistered water consumption.

First of all, it is necessary to note a comparatively high flow threshold of these water meters (i.e. a threshold intensity of water flow, that initiates rotation of inside metering propellers) - in the case of "A" class meters, the threshold flow reaches about 15 litres per hour. Provided poorly functioning plumbingware in residential apartments (a characteristic feature of residential housing in NIS), minor water leaks in individual apartments ranging from 10 to 15 litres/hour are almost "invisible" to individual water meters. However, if an apartment block is equipped with a collective water meter, the latter meter registers overall water leaks - as a result, there are substantial differences between water consumption levels, registered by water providers and individual households.

Water supply interruptions (due to diverse reasons) or scheduled water supply result in frequent (several times in a day) water discharges of internal hot and cold water supply networks of apartment blocks. Moreover, sometimes these water supply interruptions even result in discharge of external water supply mains (depending on local conditions). If these water supply networks are equipped with standard water meters, that do not have internal reverse flow locks, in the case of water discharge these flow meters register reverse flows, reducing thus already accumulated water consumption readings. As a result, metering results become inadequate.

These negative effects might be usually eliminated due to installation of individual apartment-level backwater valves or, alternatively, these valves might be installed next to collective (house-level) water meters. However, these works are associated with additional expenses of both apartment owners and service providers.

Inadequate quality of drinking water, associated with high sedimentation and even large compact impurities (caused *inter alia* by welding works at indoor water supply networks), often force service providers and owners of individual apartment-level meters to install additional filters (up-flow of water meters). These filters are usually equipped with a discharge opening for periodical cleaning, closed with a screw cap. Naturally, these works also require additional expenses of apartment owners. However, these filters create additional difficulties for sealing up of water meters (these filters often lack necessary fixtures) and allow to bypass a water meter using the filter opening.

The most common method of tampering of water meters is associated with use of a permanent magnet - a permanent magnet, placed close to a water meter allows to slow down rotation of magnetic half-coupling of the metering mechanism, because only a tiny share of water meters, allowed for use in the Republic are equipped with non-magnetic devices, preventing these effects (maybe this is the reason why the latter type of water meters is not preferred by the country residents). Besides unpaid water consumption, the use of permanent magnets results in reduction of service life of metering propellers of water meters, that work under impact of deviating magnetic field.

Inadequate consideration of real operational conditions of apartment-level water meters at the background of permanently lacking hot water supply in many cities of the Republic resulted in installation of water meters only at cold water supply connections (in these cases hot water supply connections were closed and sealed up). At the same time, there were numerous cases, when residents of apartment blocks made connections between in-house cold and hot water supply networks, allowing them to bypass water meters and consume free cold water from hot water supply pipes.

There is another opportunity to bypass individual water meters - in the case of scheduled water supply, residents may connect to heads of lock valves installed up-flow to water meters (removing these heads and installing hose connections instead). These by-passing connections might be easily removed prior to a scheduled visit of an inspector (standard valves usually are not sealed up, because their design does not stipulate necessary fixtures).

All the above mentioned technical issues, pertaining to use of apartment-level water meters and potential risks of unregistered water consumption, require comprehensive review in the course of assessing actual water consumption by households.

IV. Institutional Issues and Problems

Besides specific technical factors, that affect reliability of water metering, there are also important factors, associated with arrangements for taking readings of individual/collective water meters and monitoring their use. Water supply and sanitation utilities use different approaches, we can consider impacts of these approaches on results of introduction of water metering in two typical municipalities - Orkhei and Chisinau.

In Orkhei municipality, once in a month, staff-members of the billing department of the local water utility ("Apă-Canal") take readings of individual water meters, process the information and issue water bills to owner of individual apartments and private houses, according to direct contracts between the utility and water consumers. If apartments are not equipped with individual water meters, their owners are billed for water consumption standards, approved by local authorities (depending on particular housing types).

Economic agents and budgetary facilities are also billed monthly, according to metered consumption (100% of water consumers of these categories are equipped with water meters).

In Orkhei municipality, substantial part of local residents live in private houses (50%), that are connected to the municipal water supply network by comparatively long water supply lines, that are owned by residents themselves (including connections and even district-level water mains). Therefore, in 2001, "Apă-Canal" utility initiated installation of monitoring (street-level) water meters at connections between municipal and private water supply networks (because, in the case of installation of individual water meters, costs of out-door water leaks and stolen water should be covered by service providers). Analysis of water consumption data, generated by these monitoring meters, has shown that average monthly water consumption of consumers of called "communal" group (residents of private houses) reaches 3.6m³ per 1 resident (comparatively to 1.6m³/month per 1 resident in the case of installation of individual water meters in private houses). In 2001, "communal" water consumers received 100 thousand m³ from overall municipal water supply of 662 thousand m³.

Active work of personnel of the utility billing department with water consumers and monthly meeting with them allowed the utility to ensure comparatively high collection rate in the municipality - 90% in 2001.

In Chisinau municipality, personnel of customer service department of "Apă-Canal Chişinău" JS Company take readings of collective water meters monthly (in prescheduled days) in presence of representatives of apartment owners and document these readings as so called "data verification protocols". Then, these protocols are processed by a separate specialised municipal data-processing facility "Infocom" (Infocom is an independent entity that issue water bills to the city residents, besides that, Infocom provides billing services to other utilities as well, including heating, hot water supply, garbage collection, housing maintenance, etc.).

In parallel, Infocom receives water consumption data forms from individual apartment owners (based on readings of individual cold and hot water meters installed - these data forms are collected by housing maintenance organisations, that submit them to Infocom every month). Based on "data verification

protocols", provided by housing maintenance organisations and individual water consumption records, submitted by apartment owners, Infocom processes these data and issues water bills for individual consumers. These bills reflect readings of individual water meters or are based on the standard water consumption rate - 9m³ per 1 resident in 1 month). "Apă-Canal Chişinău" bills housing maintenance organisations for the difference between aggregate metered water consumption of individual apartment owners and readings of collective (house-level) water meters (or, alternatively, the difference between readings of collective water meters and aggregate standard consumption).

Infocom is paid for its services by the service provider at flat rate of Lei 0.7 per a bill issued (including data processing, printing of bills for water supply and sanitation services and collecting payments via bank facilities). Housing maintenance organisations are paid by the service provider at rate of 2% of actual payments made by residents (for collection and distribution of water bills to consumers, provision of information on actual numbers of persons served, etc.). Consumers' payments are transferred first to Infocom bank account, then Infocom transfers these revenues (minus the above deductions) to a bank account of the service provider - i.e. "Apă-Canal Chişinău" Company.

The above system of settlements between water suppliers, housing maintenance facilities and residents is rather complicated and allows the service provider to receive its revenues only with some delay (about 35 - 40 days after a reporting month). However, the system has other shortcomings as well - in fact, housing maintenance facilities do not have access to revenue flows, generated by consumers' payments and therefore have no incentives to work with individual water consumers - i.e. to control adequacy of meters' readings (apartment owners individually take readings of their water meters) and to calibrate/control operation of these meters (including installation), as well as to control consumers' payments for water supply and sanitation services.

The sample analysis of water consumption in 22 apartment blocks in different districts of Chisinau municipality, made in August - October 2001, based on Infocom data, allowed to reveal the following: every month, up to 30% of apartment owners fail to submit their water consumption data to housing maintenance facilities, while 10-15% of them report patently unreal consumption in their data forms (lower than 1m³/month per a person, or 30 litres/month) - for comparison, the due standards for these apartment blocks are set at the level of 200-300 litres/day per 1 person). All these factors result in substantial differences between actual water supply and aggregate individual consumption - to be paid by housing maintenance facilities, that, in their turn, do not have necessary funds to cover these costs.

Some attempts were made to find a compromise solution between arranging water consumption reporting at the level of apartment blocks and individual apartments, in order to eliminate losses of "Apă-Canal Chişinău" Company, caused by under-reporting and water theft in apartment blocks. The Municipal Council developed and approved new "Temporary Regulation of Operation of Public (Municipal) Water Supply and Sanitation Systems in Chisinau Municipality". One of provisions of the Regulation stipulates, that the difference between readings of common (apartment block-level) water meters and aggregate water consumption, registered by individual water meters, should be distributed between individual consumers, proportionally to their water consumption levels (after exclusion of water leaks in in-house distribution networks). The above Regulation will enter into force since 2002 and might serve as a model for addressing these problems in other cities of the Republic.

V. Results of Introduction of Water Meters

Our assessment of results of introduction of water consumption metering is mainly based on data of Chisinau municipality - the country's capital with the highest metering coverage (in 2000, metering covered 96% of all water, supplied by "Apă-Canal Chişinău" Company, while the share of apartments and individual houses, equipped with individual water meters reached 59%). In Chisinau, the water utility mainly deals with housing maintenance organisations instead of dealing with individual apartment owners (except individual houses). As a result of these arrangements, it was possible to assess impacts of introduction of water metering on the water supplier "Apă-Canal Chişinău" Company, housing

maintenance organisations (including municipal housing services and associations of owners of privatised housing), individual households themselves (in conditions of scheduled water supply - 22 hours/day).

At the same time, in order to account for specific situation in other cities of the Republic (associated with the fact that, in these cities, in-house water supply and sanitation networks are served by local water supply facilities, that operate according to direct contracts with individual apartment owners), we also analysed relevant data for Orkhei municipality. Orkhei is a medium-sized city with population of 37.2 thousand residents (as in 2000), service coverage of 60%, daily water supply of 11 hours/day. Metering coverage in the city reaches 60% of the overall amount of water supply, while metering coverage of apartments and private houses reaches 39%.

The analysis of water consumption data of these two cities in 2000 and 2001 reveals a clear trend to decrease of water consumption in line with growing metering coverage. Moreover, the above trend is especially marked in the case of budgetary facilities and different categories of urban residents, who try to reduce their real payments for water supply and sanitation services at the background of permanently growing prices of these services.

For example, in Chisinau, at the background of reduction of water sales for all categories of consumers in 2001, comparatively to 2000 (by 16.5%), budgetary facilities reduced their water consumption by 23.5%, while households reduced their consumption by 28.3% (within the same period of time, the average share of municipal apartments, equipped with individual water meters, increased from 65.4% to 70.8%).

Analysis of individual apartments, equipped with water meters, reveals that average monthly consumption of residents of these apartments reached 2.1m^3 /person in 2001 (or 70 litres/day), while in 2000, the relevant figure reached 2.7m^3 /person per month (or 90 litres/day). At the same time, readings of collective meters, installed by the water supplier at connections to apartment blocks, reveal higher figures - 4.0m^3 /month per person (or 160 litres/day) in 2001 and 6.5m^3 /person per month (or 215 litres/day) in 2000.

However, one cannot claim that 28.3% reduction of water consumption by households is caused only by water conservation measures in connection with installation of individual water meters, because to some extents the above reduction might be attributed also to higher incidence of interrupts of hot water supply, observed in Chisinau in 2001.

However, if we assess similar data of Orkhei municipality (there is no centralised hot water supply in Orkhei), we may conclude that higher coverage of water consumption metering (first of all, at the level of individual households) inevitably results in reduction of water consumption by households (in parallel with increase of metered water supply from 88.4 thousand m^3 in 2000 to 294.4 thousand m^3 in 2001, aggregate water consumption of urban households decreased from 856 thousand m^3 /year to 661.6 thousand m^3 /year or by 22.7% (in per capita figures, water consumption decreased from 107 litres/day to 86 litres/day).

The large-scale installation of apartment level water meters in 1999 - 2000 (and natural desire to individual consumers to pay according to readings of these water meters) and inadequate legal base of metered water billing generated many new problems, that were not accounted for earlier and affected (to a greater or lesser extent) both water suppliers and consumers.

Unfortunately enough, nobody paid attention to such factors as: reverse count of water meters in cases of periodical discharge of water supply networks and scheduled water supply, potential opportunities to tamper counting mechanisms of water meters by permanent magnets, high flow threshold of "A" and "B" class water meters (the most common models of apartment-level counters) resulting in unregistered consumption of large volumes of water, "artificial difference" in metering results, caused by the fact, that readings of individual and common (house-level) meters are taken in different days. All these problems were not reflected in standards and regulations, pertaining to design and selection of water meters and to metering procedures themselves.

For example, low sensitivity of water meters of "A" and "B" classes alone (with flow threshold of about 15 litres/hour) at minor leaks in domestic plumbingware of about 10-15 litres/hour results in unregistered consumption of up to 200-300 litres/day. This figure is equal to average daily water consumption of an individual consumer. Therefore, inadequate attention to the above factors, associated with installation of individual water meters, might be considered as the cause of a fairly significant difference between actual water consumption of a residential apartment block measured by a common water meter and aggregate readings of individual water meters. As a result, revenues of water supply companies substantially decreased.

Growing metering coverage of individual households resulted in reduction of the share of apartments, that are not equipped with water meters (usually, these apartments are owned by low income households). As a result, according to "Temporary Rules for Installation of Cold and Hot Water Counters by Residents and Procedures of Payment for the Services Provided", these households were billed for the difference between readings of common water meters and aggregate metered consumption of other apartments. As a result, water bills of households, that were not equipped with individual water meters, often exceeded average water consumption standards for relevant houses in 5-10 times.

In line with growing coverage of apartment-level water metering, the above situation became more and more complicated. In 2000, due to numerous complains of local residents, many municipal authorities were forced to impose limitations on water bills for individual water consumers, who live in apartments without water meters. In particular case of Chisinau municipality, in late 2000, the city Primeria approved its Order No. 23/2 of 15.11.2000, that reduced billed water consumption of these households to the level of 9m³/month per 1 resident regardless particular types of housing. At the same time, the city authorities decided, that the difference between readings of house-level water meters and aggregate metered water consumption of individual apartment owners and the standard water consumption of apartments, that are not equipped by water meters (i.e. 9m³/person) should be paid by house owners or housing maintenance facilities.

The Order was associated with positive effects for those city residents, who lived in apartments without individual water meters (due to elimination of excessively high water bills). However, the same Order negatively affected "Apă-Canal Chişinău" Company, because municipal or departmental housing maintenance facilities actually do not pay for the above water consumption difference (these facilities simply do not have necessary funds).

The comparative analysis of 24 municipal facilities of Chisinau revealed that in the first half of 2000, all municipal houses of the city consumed 12.9 million m³ of water (the whole amount was billed to individual consumers), while in the first half of 2001, the same houses consumed 8.0 million m³ of water. From the latter figure, 5.8 million m³ of water were billed to individual water consumers, based on readings of individual water meters (or 9m³ per 1 resident in the case of apartments, that were not equipped with individual water meters), at the same time, the difference (2.2 million m³) was billed to municipal housing maintenance facilities. As a result, the latter water bills represent actually a bad debt (from November 2000 to January 1, 2002, municipal housing maintenance facilities accumulated unpaid water debts of Lei 13.9 million, while overall unpaid water bills of all housing maintenance facilities reached Lei 16.4 million).

The above data suggest that higher metering coverage results in water consumption decrease, but inadequacy of relevant laws and regulations (as well as some decisions of local authorities), that do not account for specific factors, associated with organisation of individual water metering, result in additional losses of revenues of water supply and sanitation facilities (in the case of Chisinau municipality, these losses reached about 26-27 %).

In the case of water supply and sanitation facilities, that provide their services to households, based on individual metering via housing maintenance organisations, that have direct contracts with apartment owners and serve in-house water supply and sanitation networks, the situation is a little bit different. In

the latter case, introduction of water consumption metering resulted in growth of water losses (because the difference between readings of a common water meter of a house and aggregate individual metered water consumption of all residents of the house is considered as water losses and is registered as lost revenues of water supply and sanitation facilities). This assumption is confirmed by results of operation of "Apă-Canal" facility of Orkhei municipality. Local municipal authorities have failed to issue any applicable regulation for dealing with the above water consumption difference, as a result, the water supply facility bills individual apartment owners of apartment blocks only for their metered consumption (i.e. based on readings of individual water meters, or based on water consumption standards, if apartments are not equipped with water meters). While in 2000 water/revenue losses reached 30%, in 2001 the figure increased to 34%, because in these conditions the water supply facility practically abandoned use of house-level common water meters and even dismantled them.

However, besides direct revenue losses, the above approach is associated with other problems as well. Actual amounts of household wastewater are higher than estimated (based on metered water consumption), as a result, water supply and sanitation facilities face problems in estimating power consumption component of wastewater treatment costs in the course of tariff development/approval processes.

VI. Conclusions

1. Development of metering-based tariff systems should be based on clearly defined laws and regulations, that should be free of contradictions, pertaining to ownership of water meters, responsibilities for their maintenance/operation and control.
2. Water consumption metering might generate positive effects (i.e. reduction of domestic water consumption) only if we abandon "costs plus" tariff formulae. Otherwise, these positive effects will be inevitably hindered by growing tariffs, because under these circumstances water suppliers will be forced to cover their substantially decreased water sales by higher tariffs (at almost the same production costs and the same rates of return).
3. The choice between installation of individual water meters in individual apartments and houses or installation of 1 common water meter in an apartment block (or both) should be based on comprehensive assessment of all positive and negative aspects of these approaches. The assessment should incorporate consideration of such factors as: costs of works associated with purchase and installation of water meters; arrangements for taking readings of these water meters, their maintenance and calibration; billing for water losses; potential opportunities for water theft; the need to increase allowance for water losses, etc.
4. In the course of developing schedules for periodical checking and calibration of water meters, one should account for: technical characteristics of commonly used types of water meters and their actual operational conditions (water quality, service interrupts, etc.)

Annex No. 1

Water metering in Chisinau municipality

No.	Parameters	Units of measure	Year	
			2000	2001
1	2	3	4	5
1.	Population (total):	thousands	706	
1.1.	inc. connected to centralised water supply	thousands	580	583
2.	Water production	millions m ³	102.47	98.81
3.	Billed water:	millions m ³	64.58	53.95
3.1.	inc. - households	millions m ³	47.9	34.4
3.2.	- budgetary facilities	millions m ³	5.76	4.41
3.3.	- economic agents	millions m ³	10.92	15.14
4.	Water, supplied to households	millions m ³	47.9	34.4
4.1.	- municipal apartment blocks	millions m ³	23.97	16.90
4.2.	- housing associations	millions m ³	11.97	9.29
4.3.	- departmental houses	millions m ³	7.64	4.74
4.4.	- private houses	millions m ³	3.54	2.99
4.5.	- residents of other urban areas served	millions m ³	0.78	0.43
5.	Water, supplied to municipal apartment blocks	millions m ³	23.97	16.90
5.1.	- metered by common (house-level) meters	millions m ³	21.6	16.21
5.2.	- metered by individual water meters	millions m ³	6.03	5.13
6.	Residents of municipal apartment blocks with common water meters	thousands	277	276
6.1.	inc. apartments, equipped with individual meters	thousands	186	204
7.	Water consumption per 1 resident	m ³ /month		
7.1.	- the city average	m ³ /month	6.9	4.9
7.2.	inc. based on readings of common water meters in municipal houses	m ³ /month	6.5	4.9
7.3.	inc. based on readings of individual water meters in municipal houses	m ³ /month	2.7	2.1

Annex No. 2

Water metering in Orhei municipality

No.	Parameters	Units of measure	Year	
			2000	2001
1	2	3	4	5
1.	Population (total):	thousands	37.2	
1.1.	inc. connected to centralised water supply	thousands	22.0	20.9
1.2.	inc. households, living in private houses	thousands	11.0	10.6
2.	Water production	thousands m ³	1333	1192
3.	Billed water:	thousands m ³	933	788
3.1.	inc. – households	thousands m ³	856	662
3.2.	- budgetary facilities	thousands m ³	29	31
3.3.	- economic agents	thousands m ³	48	126
4.	Water, supplied to households	thousands m ³	856	662
4.1.	- municipal apartment blocks	thousands m ³	386	300
4.2.	- private houses	thousands m ³	470	362
5.	Water, supplied to households	thousands m ³		
5.1.	- metered by individual water meters	thousands m ³	88	294
5.2.	inc. municipal houses	thousands m ³	63	156
5.3.	inc. private houses	thousands m ³	25	138
6.	Residents of apartments, equipped by water meters	thousands	4.3	11.1
6.1.	inc. residents of municipal houses	thousands	3.0	7.91
6.2.	inc. residents of private houses	thousands	1.3	3.19
7.	Water consumption per capita	m ³ /month		
7.1.	The city average	m ³ /month	3.2	2.6
7.2.	inc. individual metering	m ³ /month	1.7	2.2
	inc. residents of municipal houses	m ³ /month	1.7	1.6
	inc. residents of private houses	m ³ /month	1.6	3.6