Energy efficiency in action: GIZ tackles the water-energy nexus in Tanzania

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Abstract
Tanzanian utilities struggle to ensure an adequate and reliable supply of water, and face increasing pressure from a rapidly growing demand for water. High energy intensity of operations and related high energy costs for water supply systems in Tanzania further compounds these challenges. A significant number of the country's water utilities are financially weak and have difficulty paying their energy bills. Consequently, end users frequently suffer supply interruptions. Contributing to high energy costs for water production is the old and poorly maintained equipment, generally very high water losses, and the use of expensive diesel generators to cover frequent power outages. The high energy intensity, however, also gives the utilities a significant opportunity to reduce costs and capitalize on savings through increased energy efficiency. Based on earlier studies and energy audits in Tanzania and comparisons to international best practices, the achievable energy efficiency gains are expected to be 20–40 %. However, a lack of awareness of EE opportunities and benefits, and of effective project implementation and financing structures, within Tanzania underscores the need for incentive mechanisms to boost investments and facilitate implementation of energy efficiency in the water sector through public-private partnerships. The regulator for energy and water in Tanzania is therefore adopting a holistic approach, including tariffs, improved data, incentives and disincentives, aiming at securing the long-term supply of affordable and sustainable energy and water. GIZ supports these efforts through the water utilities and the regulator by identifying energy saving opportunities and assisting with implementation of projects by the utilities and private sector partners. GIZ's support also includes capacity building for utilities and service providers, and a strengthening of the dialogue between the regulator and water utilities on development of mechanisms to incentivize investments in energy efficiency. The project aims to leverage synergies from similar efforts in Uganda, and more widely in the water sector throughout the East African region.

Introduction
Through the Sustainable Energy Programme, GIZ is working with Tanzanian Water and Sanitation Authorities (WSSAs or utilities for short) and the Energy and Water Utilities Regulatory Authority (EWURA) to demonstrate the business case for improving energy efficiency in the utilities, and to develop a mechanism to sustainably scale up energy efficiency investments in the water sector.

Based on available information from EWURA[1], the total water production in Tanzania in 2014 was around 220 million m^3 for the production of which it can be estimated that around 100 million kWh was used, or in the order of 1–1.5 % of all electricity in Tanzania[2].

With a population of 47 million that corresponds to around 5 m^3 water annually per capita. To put this in perspective the consumption per capita in many developed countries is as much as 20–50 times higher[3]. With continued high population

1. Majis database, EWURA, accessed January 2015.
2. EAC facts and figures, East African Community, 2014 and www.tanesco.co.tz.
3. World Business Council for Sustainable Development, 2006, "Facts and trends, water".

growth as well as a steady economic growth of around 7 % per year[4] the demand for water will be expected to grow significantly over the next decades. A report by EWURA[5] indicates that total water produced by regional utilities in the year 2012/13 was enough to cater for only 56 % of total water demand.

Although electricity consumption is still very low at around 124 kWh per year per capita[6], where less than 20 % has access to electricity[7] the electricity price is comparable to most regional neighbours (EAC facts and figures 2014, and EWURA tariff evolution discussion paper, November 2012). As it is shown later in this paper that investments in energy efficiency are expected to have good financial payback times.

The overall long-term goal of socio-economic development for Tanzania by the year 2025 is to attain sustainable human development with all the prerequisites for achieving a fully developed economy. The objectives of the Water Sector Development Programme includes enhancement of equity of access, water management capacity and proper maintenance. Likewise aims are to promote use of environmentally sound technologies, effective water tariffs, and billing and revenue collection systems. Despite these good intentions it is still clear that water utilities have a long way to go, as will be clear in the following.

The Water Supply and Sanitation Authorities in Tanzania are autonomous public water utilities established by the Water Supply and Sanitation Act, 2009. The Ministry of Water has categorized the WSSAs into three categories; A, B and C based on their ability to cover their operational costs on their own (such as salaries, electricity bills, maintenance etc.). Essentially category A is self-sustained whereas categories B and C depend on subsidies from the government. The utilities are furthermore divided into groups depending on their governance structure: regional, district and township utilities as well as a handful of 'national projects' under the Ministry of Water. Currently only 13 out of 30 regional WSSAs are placed in category A[8]. For district and township utilities the fraction is significantly higher.

The material in the following is based mainly on data for regional utilities drawn from EWURA's Majis database, which contains information reported by the utilities to the regulator in the context of annual performance reports. The performance data are also presented in two annual reports published by EWURA; one for regional WSSA's and one for small district and township utilities.

Rationale – Why energy efficiency?

THE HIGH ENERGY INTENSITY AND LOSSES IN WATER SUPPLY

Energy intensity in Tanzanian water supply, as shown in Figure 1, is comparable to that of many other developing countries such as India, Brazil and Egypt[9]. Consumption for the regional water utilities shown is mostly between 0.4 and 1.4 kWh/m^3 of water billed[10]. Furthermore the percentage of non-revenue water is very high; typically for most regional utilities it is between 30 and 55 %[11]. This is indicative of a significant energy savings potential although some caution must be applied in drawing conclusions since energy intensity is highly dependent on the specific conditions in the water supply systems[9]. Although the high percentage of non-revenue water to some extent covers commercial losses from water theft and poor revenue collection, it is clear that energy losses through physical losses in the old and often poorly maintained pumping systems and distribution pipes are significant and that energy efficiency can therefore be improved significantly.

It must also be noted that comparisons using such benchmark data are also complicated by for instance variations in quality of water supply, such as taking into account the frequent supply interruptions occurring in water utilities in Tanzania. In 2013 regional utilities had an average of 15 h of service per day, ranging from 4 to 23.5 hours a day. This obviously affects energy consumption, which expectedly would be significantly higher if full service had been provided.

THE POOR ECONOMY OF THE WSSAS – WATER AND ELECTRICITY PRICING

One of the factors making energy efficiency an important consideration for the water utilities is the generally high share of operation costs that is taken up by energy. As can be seen in Figure 2, on average 31 % of the operation costs are for energy alone. The variation from utility to utility is high and for some of them energy cost is as much as 75 % of operation costs. This variation is to some extent dependent on geographical and hydrological conditions where some rely on energy intensive pumping of water from deep boreholes whereas others have gravity-fed systems using little external energy.

Apart from high energy costs as shown in the following, the high share of energy could also in some cases be due to limitations in funds due to poor revenue collection and high losses. This could result in other, but less critical, expenses such as preventive maintenance being cut down to lower levels than what is necessary to sustain a stable supply. Since the problem of poor revenue collection and high losses is persistent this leads to a negative feed back where maintenance costs and already overdue replacements are postponed, leading to further deterioration in energy efficiency.

The water tariffs are generally considered to be too low to cover the operating costs[12] and energy costs are very high. The average energy cost per kWh is shown in Figure 3. The averages have been obtained after removing some outliers in the data, such as one – clearly erroneous – entry stating a month-

4. African Development Bank, Africa Economic Outlook, 2014 Tanzania country report, www.africaneconomicoutlook.org.

5. Regional WSSAs performance report, EWURA, 2013.

6. EAC facts and figures, East African Community, 2014.

7. SE4ALL 2013 rapid assessment and gap analysis, 2013. Same assessment in an update of this document prepared by the consultancy IETS in November 2014.

8. Majis database, EWURA, accessed January 2015.

9. ESMAP, 2012. A Primer on Energy Efficiency for Municipal Water and Waste Water Utilities, Technical Report.

10. Some utilities have seemingly very good energy performance, i.e. an eergy intensity less than 0.2. This is mainly attributable to the high degree of gravity fed water that some utilities benefit from. It may in a few instances also be due to incomplete data records. Other utilities suffer from dysfunctional (or nonexisting) water treatment facilities, which will of course result in lower energy consumption. HTM (Handeni Trunk Main) national project have for instance for more than 20 years operated without their water treatment plant which has been out of operation in 1996. Therefore customers receive untreated river water directly in their taps!

11. For the smaller utilities in the townships the performance reports from EWURA shows NRW up to 98 % (!), with a median of around 40 %.

12. Ministry of Water and HTM Water Supply and Sanitation Authority Workshop, Public-private stakeholder workshop, 27 Nov 2014, Dar Es Salaam.

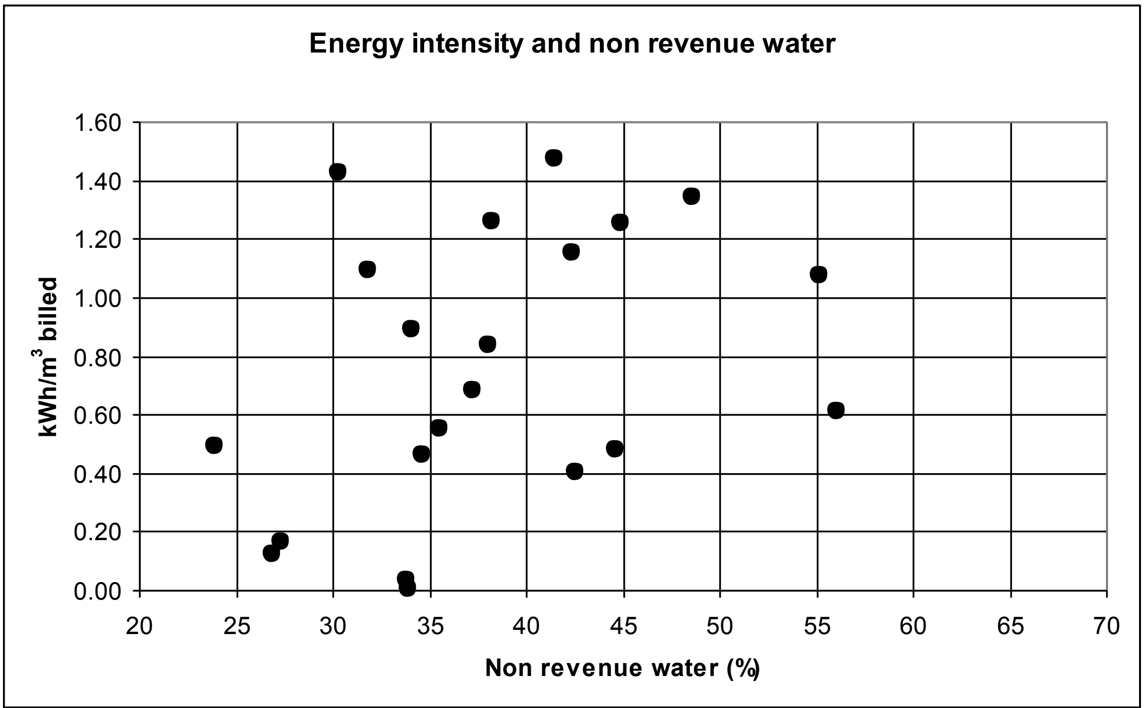

Figure 1. Energy intensity and non-revenue water plotted for a number of regional water utilities in Tanzania. Data from EWURA's Majis database, accessed January 2015.

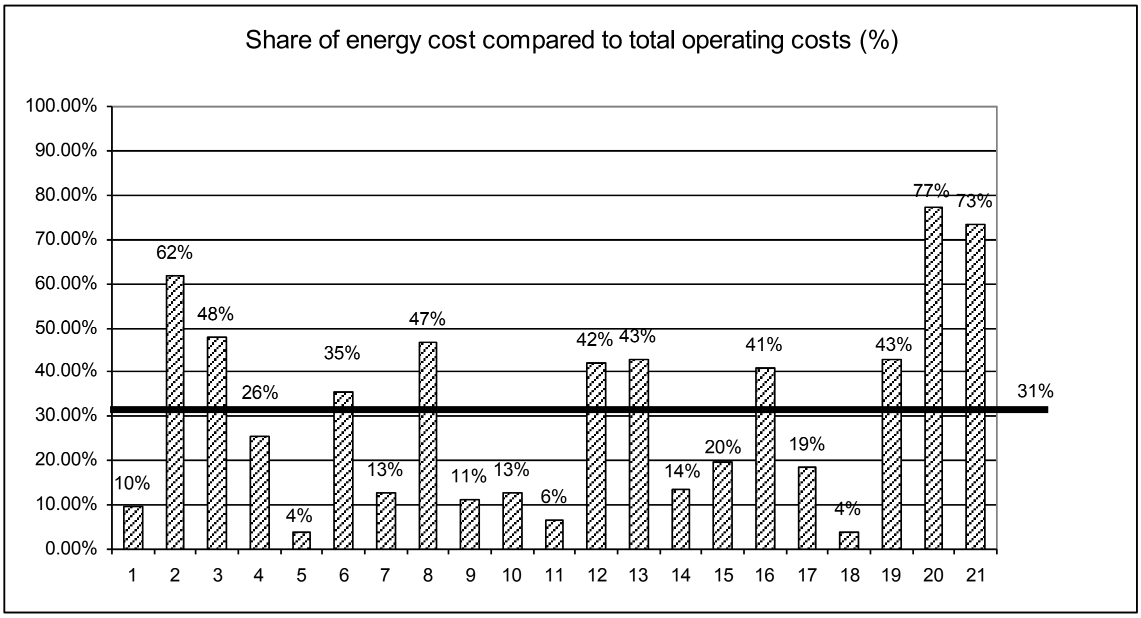

Figure 2. The share of energy out of total operation costs for regional utilities in Tanzania. Data from EWURA's Majis database, accessed January 2015.

ly energy cost of more than 150,000 TZS/kWh (~75 EUR/kWh!).

The average energy cost calculated from the reported operational data is 970 TZS/kWh (~0.48 EUR/kWh)[13]. As can be seen the variation shown by the data is also very large, and it is a matter for further investigation to clarify what is causing these very high energy costs and variation[14].

Based on the data reported to the regulator[15], only a few of the utilities are actually covering their operational costs through the water tariffs. This is shown in Figure 4 where it is

13. In calculating this some outliers in the data, such as one – clearly erroneous – entry stating a monthly energy cost of more than 150,000 TZS/kWh (~75 EUR/kWh!) have been removed for the sake of realism and to eliminate the influence of clearly erroneous data from the results.

14. The average energy costs calculated based on reported data from utilities is more than twice the normal electricity tariff from TANESCO.

15. Majis database, EWURA, accessed January 2015.

also seen that there is no systematic connection with the energy intensity.

The average percentage of the operational costs covered through the water revenue is for the regional utilities only 82 %, which has been calculated based on the same reported figures for water production, non revenue water, water tariffs etc. Furthermore the data reported by utilities to the regulator also bear clear witness to the instability and irregularity of their cash flows.

This will need further investigation through the utilities and the regulator, but the overall result that many of the utilities are operating at a net loss is consistent with statements from utilities and local experts. A part of the explanation for the lossgiving operations is likely the significant amount of outstanding payments that are owed to the utilities by various large customers. It has in particular been a problem that large government institutions have not been paying water bills regularly. That was

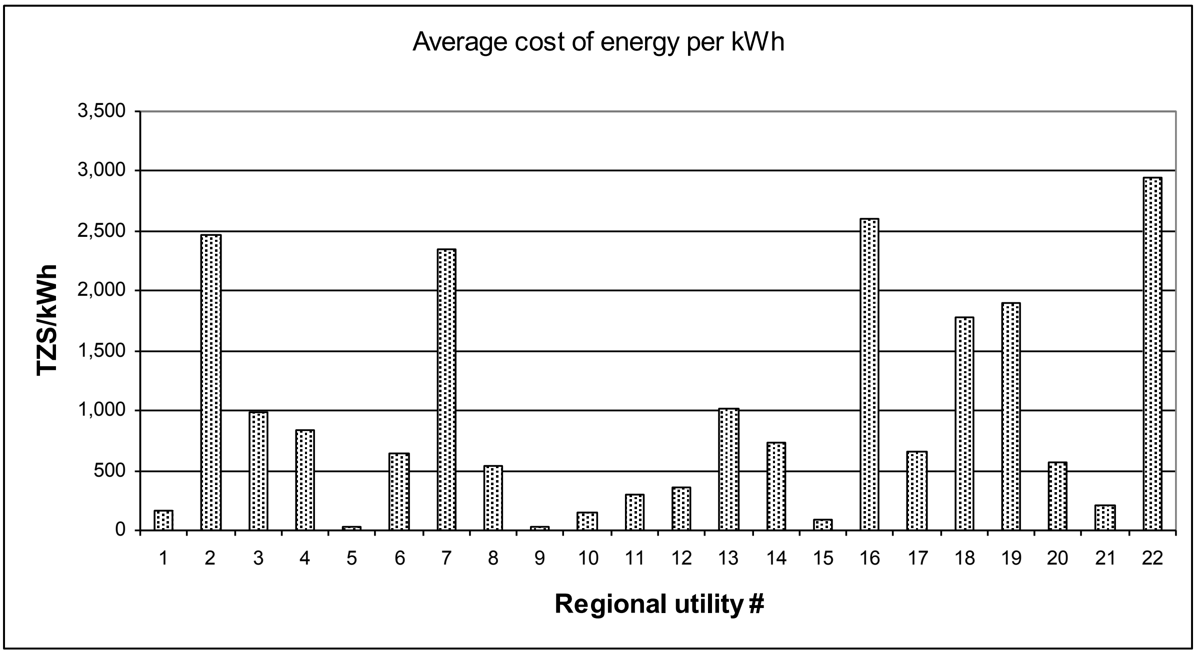

Figure 3. Averaged energy costs per kWh electricity consumed by the regional utilities in Tanzania. Data from EWURA's Majis database, accessed January 2015.

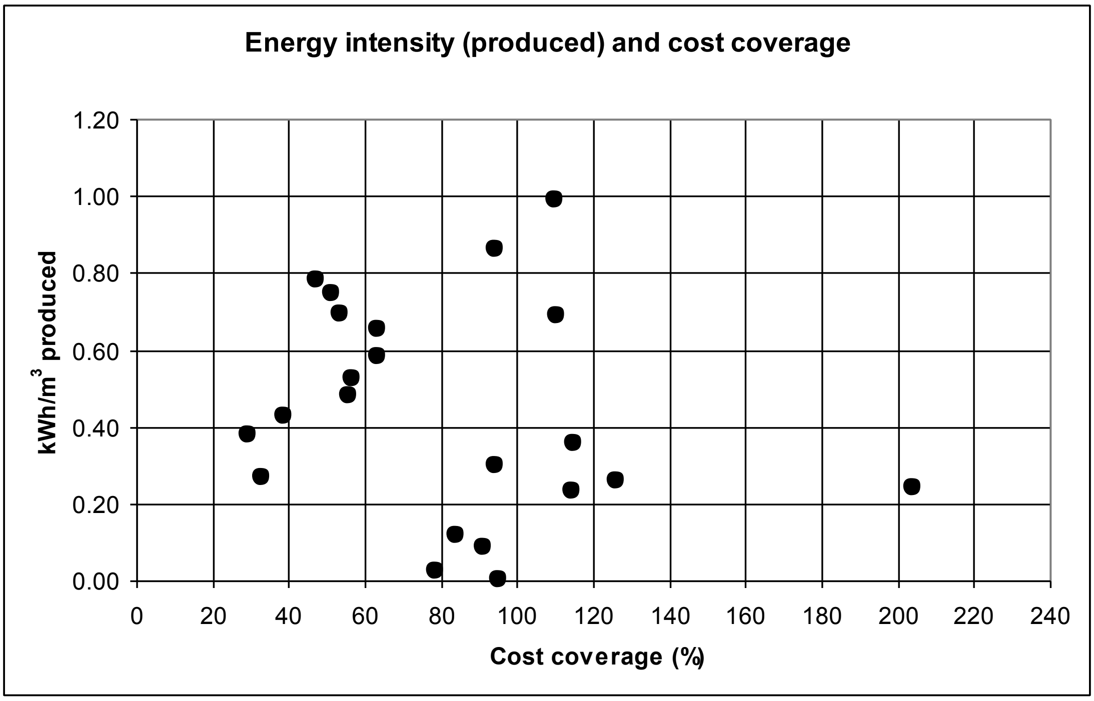

Figure 4. The degree to which water revenue covers operational costs is shown together with energy intensity of water produced. 100 % is break even. Data from EWURA's Majis database, accessed January 2015.

also reflected in a statement by the Minister of Water[16] to the effect that he would endeavour to put pressure on those state institutions to pay their outstanding water bills.

That the many outstanding payments are one of the contributing causes is also reflected by calculating the degree of cost coverage using the estimated consumption and the water tariffs. Doing this, results in an average coverage of operation costs (from estimated water sales revenue due), that is above 100 %[17] although a significant number of utilities still fall below the break even point. This is likely why more of the regional utilities are classified as "A" than the reported actual operational data should lead one to believe. Since individual water meters are still rare, actual consumption can be hard to document which further complicates revenue collection efforts.

Nevertheless, the current situation is that most of the utilities operate at a de facto deficit and therefore have difficulties not only to make ends meet, incl. carrying out appropriate maintenance, having the required staff and so forth, but also in raising capital for required investments in expansion of their distribution and water pumping systems.

The situation is reportedly much worse for the smaller (district and township) utilities and the situation depicted therefore shows only the tip of the iceberg. The boards governing these utilities are made up mainly of locally elected representatives. Since many in their constituencies are very poor they are seen as being unable to carry the burden of higher water tariffs. Therefore utilities often do not apply to the regulator for increased tariffs to cover their operational costs for more or less political reasons.

Further work will be done to quantify this also for the smaller utilities, as well as investigating in more detail the causes.

ENERGY EFFICIENCY WILL MAKE A DIFFERENCE

To gauge the magnitude of the effect that energy efficiency could have on the operational finances we first note that a countrywide reduction of 10 % of the energy used for water supply, at 0.2 EUR[18] per kWh, would correspond to a saving of around 2 million EUR annually. That would go a long way to provide a much needed capital injection for energy efficiency upgrades of pumping equipment and distribution systems.

To gauge the effect that improving energy efficiency could have on the operational economy of the utilities, we have compared a 20 % improvement in energy efficiency to a 20 % reduction in non revenue water and a 20 % increase of water tariffs. Each saving is assumed to be done independent of the other, even if in practice such a decoupling would be difficult to achieve – both for technical reasons and also because e.g. reduction in NRW would in itself also reduce energy consumption. Nevertheless, in order to get a sense of the relative importance of different interventions and therefore how water utilities would likely prioritize their efforts to improve their financial standing a simplified comparison is done. The result is not surprising in that it is clear that the impact of e.g. water loss reduction and revenue shortfalls is greater than energy efficiency. The reason for this is of course largely that commercial de facto losses are very high. Such a comparison – all else equal – based on utility data from the regulator is shown in Figure 5 as resulting degrees of cost coverage compared to the "business as usual" situation of today. This may also contribute to an understanding of why energy efficiency has in general not been addressed by the utilities, despite considerable potential and opportunity to reduce energy costs.

The results are not surprising and in general it is clear that the first priority of the utilities must be to improve revenue collection from non-paying institutions. That would result in reduction of the NRW. Similarly it is clear that increasing the water tariffs would improve operational economy, but as mentioned before this would be politically sensitive and also difficult to argue until revenue collection has been improved so as to effectively reduce non revenue water to technical losses.

The cost of improving revenue collection is unclear, but would of course be facilitated by installation of consumer water meters. Once revenue collection has been improved to a normal situation where the majority of water consumed is paid for, the operational economy could be improved by technically reducing water losses and by improving energy efficiency.

The relative cost effectiveness of reducing water losses and of improving energy efficiency of water pumping and distribution will have to be compared in detail, but first two things shall be noted. Firstly, efforts towards reducing technical water losses are already underway and well understood in the utilities. Conversely, awareness and knowledge of opportunities for improving energy efficiency is generally not high and therefore not well understood[19]. Most utility managers are well aware of the high energy costs though, and are also clearly aware of the connection between reduced water losses and reduced energy consumption. It is therefore logical that efforts to reduce technical water losses receive most of the attention and most of the investments. Energy efficiency measures in for example pumping equipment would further improve matters and it is therefore our intention to initially prioritize utilities with low water losses.

The effort and investment needed to improve energy efficiency is – all else equal – likely to be lower than the comparable effort needed to reduce energy consumption by the same amount through reductions in water losses. This is because most of the water losses are in pipes that are buried underground or in the large number of valves and joints in the user installations connected to the distribution system. With more widespread metering of water consumption the cost of these losses would to some extent be shifted from the utility to the end users however. On balance detailed calculations are therefore expected to yield shorter payback times for energy efficiency improvements in pumping installations (which use the bulk of energy in operations[20]).

16. At the Annual General Meeting of District and Township utilities in Dodoma, November 2014.

17. As it should be in order to also be able to set aside funds for investments and expansion of the distribution system.

18. Around 400 Tanzanian Shillings (TZS). The average energy costs calculated based on reported data from utilities is more than twice the normal electricity tariff from TANESCO. The more conservative figure is therefore used here.

19. Reference is made to stakholder inputs at the Annual General Meeting of District and Township utilities in Dodoma, November 2014, at Ministry of Water and HTM Water Supply and Sanitation Authority Workshop, Public-private stakeholder workshop, 27 Nov 2014, Dar Es Salaam, and to personal communications from Dr F. Lerise, and Eng. Munisi under GIZ's Water Sector support programme in Tanzania, Nov–Dec 2014.

20. Cf. For example ESMAP, 2012. A Primer on Energy Efficiency for Municipal Water and Waste Water Utilities, Technical Report.

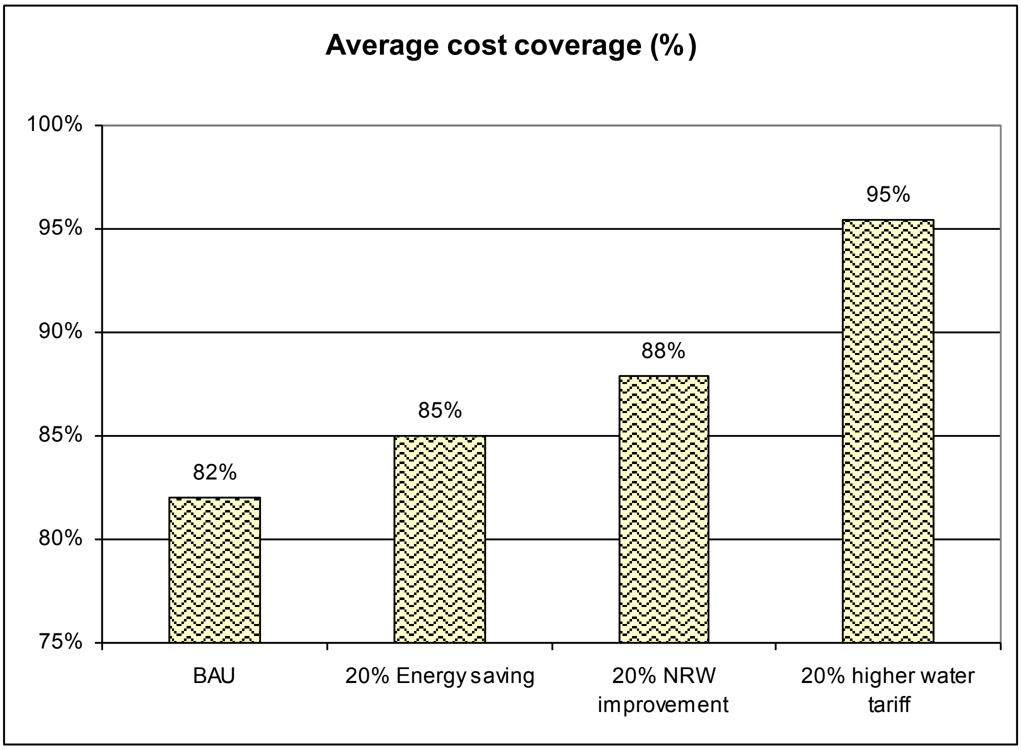

Figure 5. Comparison of the impact that different efficiency and revenue improvement measures would have on the operating economy of the utilities. Based on Data from EWURA's Majis database, accessed January 2015.

Earlier and current energy audits and energy savings assessments for water utilities in Tanzania[21] show that energy savings of 20–40 % should be comfortably achievable with payback times of 1–3 years. These calculations are based on the electricity tariffs of TANESCO, but if the high energy costs reported above reflect actual costs[22] then of course resulting payback times will be correspondingly shorter. Investments for refurbishment of pumps and related equipment are according to these studies typically in the order of 20,000–100,000 EUR.

Therefore, energy efficiency improvements distinct from reduction of water losses are in themselves very attractive as investment objects.

THE DIFFICULTY OF SCALING UP INVESTMENTS IN ENERGY EFFICIENCY

Although individual investments in improvements of energy efficiency of pumps and related equipment show good returns and short payback times there are several factors hindering widespread implementation.

There is a lack of project management capabilities and knowledge of energy efficiency in the utilities. This lack of knowledge and awareness is also characteristic for with many potential investors, including commercial banks who tend to overestimate the risk of energy efficiency investments, and who also generally see water utilities as high risk recipients of loans on account of their poor operational economy and unstable cash flow[23].

The – real or perceived – lack of capacity for management and energy efficiency in the utilities reduce the trust of investors that investments and projects will be carried out professionally, and therefore increases the risk that the savings will be lower than projected. It has indeed been seen many times that poor installation of equipment has led to premature breakdowns and higher than expected running and maintenance costs[24]. Conversely, many investors also further inflate that risk by their own lack of knowledge of energy efficiency technologies and opportunities.

A further indication of the lack of management capacity is the frequent lack of reliable operating data. This is in particular a problem for the district and township utilities, but even the larger regional utilities seem to have some difficulties in this regard, as is indicated by the many inconsistencies in the data they report to the regulator[25].

When combined with the poor operational economy and erratic cash flows of many utilities such weaknesses lead to

21. Nindie, R., Wilson, L., Nanyaro, A.P., Manege L., 2011. Energy Efficiency for Sustainable Water Supply Systems. Energy Optimization Seminar, May 2011, Dar es Salaam Tanzania; Nindie, R., Wilson, L., 2002. "Energy Auditing for Dar es Salaam Water Supply Plants", Energy conservation and efficiency seminar, Ministry of energy and mineral, 14 June 2002; TIRDO, 2002. Final report on energy auditing for Dar es Salaam water supply plants, March 2002; TIRDO, 2004. Final report on energy auditing for Musoma water supply plants, April 2004; and KSB service GmbH, 2013. System analysis of eight water transportation pumps type Ritz 4415, KSB MTC 125/6, Caprari PML 150HMU/B6 and Flowserve 150/500 at Jinja Waterworks, June 2013.

22. The energy audit reports do for example typically not consider demand charges, which could significantly increase the actual cost.

23. Reference is made to stakeholder inputs at the Annual General Meeting of District and Township utilities in Dodoma, November 2014, at Ministry of Water and HTM Water Supply and Sanitation Authority Workshop, Public-private stakeholder workshop, 27 Nov 2014, Dar Es Salaam, and to personal communications from Dr F. Lerise, and Eng. Munisi under GIZ's Water Sector support programme in Tanzania, Nov–Dec 2014.

24. Personal communications from C. Scholz, GIZ integrated experts at Mtwara WSSA, Dr F. Lerise, and Eng. Munisi under GIZ's Water Sector support programme in Tanzania, Nov–Dec 2014.

25. Majis database, EWURA, accessed January 2015.

difficulties in raising capital for energy efficiency investments which are not straightforward to overcome.

Thus in order to scale up such investments in energy efficiency that can currently only be directly pursued by a few utilities, it is necessary to increase capacities of the utilities as well as increasing awareness on energy efficiency opportunities and risk assessments with potential investors and banks. Furthermore, it would also seem to be necessary to create a regulatory mechanism to facilitate energy efficiency investments in the utilities.

For instance, a fund that can provide guarantees or partial financing for investments would seem to be a good solution. Such a fund could offer guarantees to reduce risk and thus provide better financial conditions for loans, and could also per se offer either soft loans or grants to support feasible investments. That would also help overcoming the difficulty that many utilities would have in putting up required equity and security for loans with commercial banks.

In order to secure the sustainability of such a fund it would have to be managed, maintained and regularly replenished. A possibility for this would for example be a regulatory provision for a small levy on for instance water production that are directed into the fund and earmarked for energy efficiency investments. Given the amount of water produced annually even a small levy of say one TZS (~ 0.05 Eurocents) per m^3 would generate around 220 million TZS (~ 100,000 EUR) annually – a significant influx of money to such a fund.

Putting the levy on the water production would have the additional benefit of giving the utilities a direct incentive to reduce non-revenue water.

Finally, in the long term it will also be necessary to look at the capacity in the private sector in general to provide services and expertise for energy efficiency in water utilities; such as energy audits, measurement and verification of implemented measures and innovative financing models.

The way forward: approach

In pursuit of the objective of promoting energy efficiency investments in water utilities GIZ Sustainable Energy Program is following a two-pronged approach in collaboration with partners from the public and private sector as well as with the broader donor community in Tanzania:

- Working together with selected water utilities to develop projects to pilot technologies and implementation modalities for energy efficiency, as well as to document the business case for energy efficiency investments in the Tanzanian context.
- Working together with the Ministry of Energy and Minerals, EWURA and water utilities to develop a mechanism that can promote and facilitate scaling up of energy efficiency investment opportunities in water utilities in Tanzania.

Furthermore, capacity building for the water utilities is part and parcel of a parallel GIZ water sector program[26] which among others has given trainings on energy efficient pumping technologies for regional water utilities. Additionally, GIZ Sustainable Energy Program will provide targeted training on energy management in conjunction with implementation of energy efficiency implementation together with the pilot utilities.

Experiences from the region, in particular from Uganda, will be used to leverage discussions and guide implementation efforts. GIZ is working with the water utility in Kampala to demonstrate a business model based in part on supplier financing. That will be interesting also to look at in Tanzania and if a similar model is feasible in Tanzania it would strengthen the utilities in their efforts to secure capital and expertise for implementing energy efficiency improvements.

Aspects related to the capacity of the private sector in general to provide energy efficiency related services will also be pursued by the GIZ Sustainable energy program through efforts towards establishment of frameworks for capacity building for energy management and energy audits.

At the present time, selection of suitable partner utilities is moving forward and discussions with EWURA are set to commence shortly. The support from GIZ will run until the end of 2016 and we expect to be able to report further progress on these matters within the next half year, and have been very encouraged by the strong interest in energy efficiency shown from the entire spectrum of stakeholders in the water sector here in Tanzania.

Conclusion

In conclusion, we have in the present paper presented the potential and strong rationale for promoting energy efficiency in the water sector in Tanzania, and have charted the way forward over the coming years. Awareness and knowledge of opportunities for improving energy efficiency is generally low and therefore not well understood in the utilities. In order to scale up investments in energy efficiency that can currently only be directly pursued by a few utilities, it is necessary to increase capacities of the utilities as well as increasing awareness on energy efficiency opportunities and risk assessments with potential investors and banks. Furthermore, it would also seem to be necessary to create a regulatory mechanism to facilitate energy efficiency investments in the utilities, for instance in the form of an earmarked fund from a levied on water production. We will be looking forward to presenting further lessons learned and successes of this joint effort with our Tanzanian partners in the future.

List of abbreviations

EE	Energy Efficiency
ESMAP	Energy Sector Management Assistance Program
EWURA	Energy and Water Utilities Regulatory Authority
GIZ	Deutsche Gesellschaft fuer Internationale Zusammenarbeit
MEM	Ministry of Energy and Mineral
MoW	Ministry of Water
NRW	Non-Revenue Water
TANESCO	Tanzania Electric Supply Company Ltd
TWSSA	Tanzania Water Supply and Sanitation Act of 2009
TZS	Tanzanian Shillings
WSSA	Water Supply and Sanitation Authority
WSDP	Water Sector Development Program

26. "Capacity development for water supply and sanitation authorities in Tanzania", which is part of the broader GIZ water sector program.

References

African Development Bank, Africa Economic Outlook, 2014. Tanzania country report,
www.africaneconomicoutlook.org.

Annual General Meeting of District and Township utilities held in Dodoma, November 2014.

ESMAP, 2012. A Primer on Energy Efficiency for Municipal Water and Waste Water Utilities, Technical Report.

EAC facts and figures, East African Community, 2014.

KSB service GmbH, 2013. System analysis of eight water transportation pumps type Ritz 4415, KSB MTC 125/6, Caprari PML 150HMU/B6 and Flowserve 150/500 at Jinja Waterworks, June 2013.

Majis database, EWURA, accessed January 2015,

Ministry of Water and HTM Water Supply and Sanitation Authority Workshop, Public-private stakeholder workshop, 27 Nov 2014, Dar es Salaam.

Nindie, R., Wilson, L., Nanyaro, A.P., Manege L., 2011. Energy Efficiency for Sustainable Water Supply Systems. Energy Optimization Seminar, May 2011, Dar es Salaam Tanzania.

Nindie, R., Wilson, L., 2002. Energy Auditing for Dar es Salaam Water Supply Plants. Energy conservation and efficiency seminar, Ministry of energy and mineral, 14 June 2002.

Regional WSSAs performance report, EWURA, 2013.

SE4ALL, 2013 Rapid assessment and gap analysis, 2013. Same assessment in an update of this document prepared by the consultancy IETS in November 2014.

TIRDO, 2004. Final report on energy auditing for Musoma water supply plants, April 2004.

TIRDO, 2002. Final report on energy auditing for Dar es Salaam water supply plants, March 2002.

World Business Council for Sustainable Development, 2006, ”Facts and trends, water”.

www.tanesco.co.tz, accessed January 2015.

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