# Seizing energy efficiency policy opportunities to improve water and sanitation services in Tanzania

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## Abstract

Tanzania's Ministry of Energy and Minerals (MEM) and GIZ agreed to develop a National Energy Efficiency Action Plan (NEEAP), which will be available by June 2017 and will include four fundamental kinds of action: Quantifiable actions; Legal, Regulatory and Administrative actions; Capacity Building actions; and Awareness actions. One anticipated cornerstone of the NEEAP will be requirements for large energy consumers to prepare, implement and report on Facility Energy Efficiency Action Plans (FEEAP) through an Energy Manager assisted by Certified Energy Auditors. Urban Water Supply and Sanitation Authorities (WSSA) are among the largest energy consumers in Tanzania, and many are challenged with high energy intensity and costs that limit their ability to provide water and sanitation services. To exemplify these NEEAP actions, this paper presents initiatives by GIZ, MEM, the Ministry of Water and Irrigation (MOWI), and the multi-sector Energy and Water Utilities Regulatory Authority to promote energy efficiency in the water sector. Energy audits carried out at two WSSAs in 2016 revealed significant energy-saving investment opportunities and a need to establish both an Energy Management (EM) unit and a FEEAP. To help build capacity necessary to operationalize EE in the utilities, GIZ trained and assisted the two WSSAs in setting up EM Teams and FEEAPs. The experiences from these pilot trainings have been used to raise awareness on the benefits of EM with other WSSAs in Tanzania. The audits also revealed a number of design flaws common among WSSAs, and as a result MoWI requested GIZ assistance to prepare Energy Guidelines. These guidelines will ensure that important EE aspects are considered in initial design and procurement processes. This paper explores the design and impact of these initiatives, and their potential for further implementation in Tanzania and similarly situated sectors.

## Introduction

In 2014, GIZ initiated its Sustainable Energy Project (SENERGY) in Tanzania aiming at improving livelihoods through promotion of energy efficiency, regulatory reform and renewable energy generation. Promotion of energy efficiency is done in cooperation with the Ministry of Energy and Minerals and has as its cornerstone the development of a National Energy Efficiency Action Plan; more specifically an Energy Efficiency Action Plan (EEAP) for designated energy consumers.

As Urban Water Supply and Sanitation Authorities (WSSA) are among the largest individual energy consumers in Tanzania and many are challenged with high energy intensity and costs that limit their ability to provide water and sanitation services, the first large consumer target of GIZ SENERGY, pursued in close collaboration with GIZ's water program were the water utilities. Water supply and sanitation currently represents some 1,5–2 % of electricity consumption in Tanzania, and is expected to grow rapidly with improved supply coverage, sanitation and waste water treatment[1]. Furthermore there are significant en-

1. Ernedal, Vauvert et.al., eceee 2015, Energy efficiency in action: GIZ tackles the water-energy nexus in Tanzania.

ergy efficiency opportunities to be harnessed as will be seen later in this paper.

Additional key targets are industries and large buildings where strong collaborations are being forged between GIZ, the Confederation of Tanzanian Industries (CTI) and the EU. Industrial electricity consumption constitutes more than 50 % of all electricity distributed in Tanzania, with large buildings currently representing some 25 %[2] of the total. The share of buildings is lower than in most developed countries, but is expected to rise quickly on account of strong economic growth, rapid urbanization, and booming construction sector.

This paper will provide a brief description of the NEEAP which is under development and, using examples from GIZ SENERGY activities towards the water-energy nexus and industries, explore the potential for its implementation in Tanzania.

## An energy efficiency action plan for Tanzania

In December 2015, the Government of Tanzania finalized a new National Energy Policy[3] with a significantly strengthened emphasis on promotion of energy efficiency, and in May 2016 MEM announced[4] that together with GIZ it is developing a National Energy Efficiency Action Plan for Tanzania, addressing energy usage of large consumers, capacity development and accreditation for energy managers and auditors, energy consumption in large buildings and awareness.

The Energy Efficiency Action Plan is a document that lists actions in support of energy efficiency measures and its conservation; actions whose impact can be clearly determined qualitatively or quantitatively. Archetypical measures such as replacing old inefficient pumps with new efficient ones which can be quantified in terms of its impact have been termed "quantitative actions".

However, in order to underpin and promote the implementation of such measures it is generally necessary to put in place various supportive legal, regulatory and administrative (LRA) provisions. This could be documents which guides the national targets and priorities, strategic approaches, and allocation of resources through budgets; regulatory documents requiring certain energy users to undertake specific efforts to improve energy efficiency; or requirements for skilled professionals (e.g. energy managers and energy auditors) that are required to identify and implement energy efficiency measures.

A third type of action is capacity development, such as developing national curricula and certification procedures for energy managers and energy auditors. Finally, the fourth group of actions is concerned with the promotion and awareness raising amongst consumers, decision makers, professionals and others so as to pave the way and ensure proper understanding of the costs and benefits of energy efficiency actions, and thus build support for the implementation of the EEAP actions.

The proposed EEAP concept for Tanzania[5], as illustrated above, focuses on actions that can be grouped as the following main work packages:

- Requirements for designated consumers to undertake energy management and energy efficiency measures in accordance with a "Facility Energy Efficiency Action Plan" (FEEAP) that has to be prepared by a certified energy manager with support from certified energy auditors (#1 in Figure 1 @ "12 o'clock").
- Minimum Energy Performance Standards (MEPS), and labelling (#2 counting clockwise in Figure 1).
- Capacity development and certification for energy managers and energy auditors (#3 ,4 and 5 in Figure 1).
- Energy efficiency certificates for large buildings (#6 in Figure 1).
- Awareness raising (#10 in Figure 1).
- Monitoring and evaluation (#7–9 in Figure 1).
- Targeted incentives (#11 in Figure 1).

In the following sections illustrative examples of the four main groups of actions shown in Figure 1 are given. The examples are taken from activities supported by GIZ SENERGY with regard to WSSAs and Industries.

## Quantitative actions

Quantifiable actions are measures whose impacts can be measured and quantified. Typically they would arise as a consequence of the requirement for designated consumers to perform energy audits and implement those that are viable from a financial and technical point of view, and have been incorporated in the facility energy efficiency action plan (FEEAP). Designated consumers would be large energy users from industry, buildings or utilities, and to illustrate the processes involved, as well as typical savings measures, GIZ SENERGY has been working with two Tanzanian water and sanitation authorities[6]; Morogoro Urban Water and Sanitation Authority (MORUWASA) and Singida Urban Water and Sanitation Authority (SUWASA).

At both locations, a detailed energy audit was done (February-March 2016) resulting in a number of proposed energy efficiency measures. The utilities were selected in order to represent two typical set ups; one pumping water from deep wells (SUWASA) and one sourcing it from a catchment dam with gravity feeding the water (MORUWASA). The resulting energy conservation opportunities are therefore also expected to be broadly representative of what one would expect to find in the majority of WSSAs throughout Tanzania.

Energy savings opportunities at MORUWASA[7] are linked to replacement of old and inefficient pump motors; pump re-

2. Tanesco, personal communication, 2014–16 electricity consumption data for large (T3) consumers.

3. Ministry of Energy and Minerals, Dec 2015, National Energy Policy.

4. Prof. S. Muhongo, Minister for Energy and Minerals, May 2016, Budget speech to Parliament.

5. GIZ SENERGY, April 2015, First Exemplary Draft of National Energy Efficiency Action Plan (NEEAP) of Tanzania, Concept Note.

6. Ernedal, Vauvert et.al., ECEEE 2015, Energy efficiency in action: GIZ tackles the water-energy nexus in Tanzania.

7. GIZ SENERGY, March 2016, Energy Audit of Commercial Water Utility Morogoro (MORUWASA).

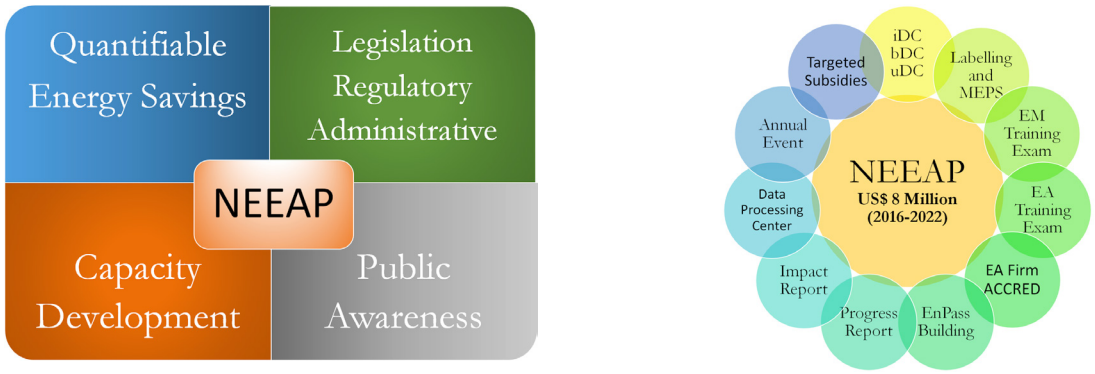


*Figure 1. The four principal types of actions featured in the National Energy Efficiency Action Plan, and the principal work packages proposed.*

habilitation; better control and management of variations in water demand by installing VSDs; and savings opportunities arising from improved management and maintenance procedures that will identify poorly performing equipment (motors, pumps etc) earlier and thus avoid losses. To give an idea of the relative weight of the opportunities, the energy audit at Moruwasa estimated that VSD's would be able to save around 15 % of electricity consumption, pump rehabilitations and motor replacements another ca 10 %, and energy management/good housekeeping around 2 %; in total around 27 %.

At SUWASA[8] similar opportunities were uncovered, and additionally significant issues with the pump and systems design were uncovered as well as apparent problems with the supply capacity of the aquifers used. The borehole pumps were operating at very low efficiency due to changes in the yield of the boreholes meaning that more than 50 % of the energy used for the well pumps is lost on account of the pumps no longer being correctly sized and designed. Furthermore, booster pumps turned out to be more than 100 % oversized in the design stage, and a water storage facility is being supplied at significant excess water head. The causes of these design deficiencies are mainly related to the procurement process and it is expected[9] that better guidance and control in the design and procurement stages could avoid many of them (cf. section below on LRA actions).

Altogether the energy audits identified energy savings potentials of between 25 and 35 % at both utilities.

Following the energy audits, both utilities went through a training program (completed in August 2016), with the aim of capacitating and establishing an energy management team supported by an energy policy, and to develop an energy efficiency action plan approved by the utility's management.

While MORUWASA have already established and approved an energy efficiency action plan (November 2016)[10], SUWASA is still in the process which has been delayed not only by urgent technical issues uncovered by the energy audit, but also by recent changes in management.

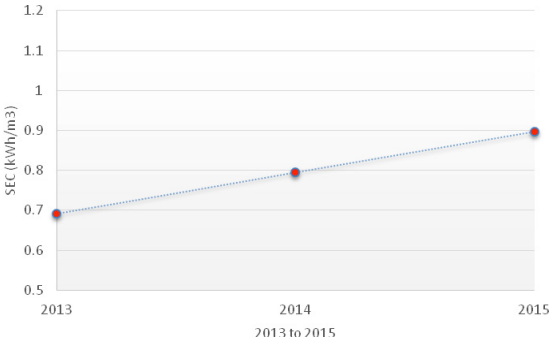


*Figure 2. Plotting the kWh/m³ water pumped shows that there could be a significant issue with the technical installations causing an increase year on year in the energy intensity.*

A key indicator for the utilities will be to track their specific energy consumption (kWh/m³). As is shown in Figure 2, looking at this indicator immediately tells the energy auditor that there is potentially a serious problem at SUWASA given the fact that the specific energy consumption had been increasing year on year without any clear reason. Such trends are not in themselves evidence of losses[11], but they strongly suggest that there is something to investigate, and that is very valuable information for the energy manager.

If we imagine that all WSSAs could save 25 % of their electricity consumption that would in itself amount to between 0,25 and 0,5 % of all electricity consumed in Tanzania[12]; a significant impact, especially considering that the current share by WSSAs of national electricity consumption is on the low side and that an increased share can be expected in the future as the utilities increase their supply coverage and as more of them install waste water treatment facilities[13].

8. GIZ SENERGY, March 2016, Energy Audit of Commercial Water Utility Singida (SUWASA).

9. There is abundant anecdotal evidence for similar, albeit less extreme, design problems from other utilities.

10. Morogoro Urban Water Supply and Sanitation Authority, October 2016, Energy management policy and action plan for Morogoro Urban Water Supply and Sanitation Authority.

11. It could for example be that the water supply system had undergone major technical changes resulting in higher energy intensity. At SUWASA that was not the case, and the trend thus pointed to other problems causing an increase in energy intensity.

12. Ernedal, Vauvert et.al., eceee 2015, Energy efficiency in action: GIZ tackles the water-energy nexus in Tanzania.

13. Currently most of the larger WSSAs only have stabilization ponds for waste water treatment. Smaller WSSAs generally do not have sewerage networks. Energy consumption is therefore low compared to e.g. Europe where various active treatment facilities contribute significantly to energy consumption. Cf. EWURA, 2015, Water Utilities Performance Review Report 2014/2015, Regional and National Project Water Utilities, and EWURA, 2015, Water Utilities Performance Review Report 2014/2015, District and Township Water Utilities.

*Figure 3. Elevated and ground mounted tank at a water storage facility at Singida.*

## Legal, regulatory and administrative actions

Almost all work packages under the EEAP rely on some LRA Actions for implementation. For designated consumers it is for example necessary to clearly identify and notify them, as well as to stipulate their responsibilities as designated consumers[14]. Other LRAs are for example concerned with the training and certification of energy managers and energy auditors. The development of these LRAs is supported by GIZ SENERGY as part of the development of implementation tools for the EEAP.

As an illustrative example of another LRA document, GIZ SENERGY has developed guidelines on Energy Efficiency (EE) for design and procurement of water supply facilities in cooperation with the Ministry of Water and Irrigation. The objective of the guidelines is to strengthen and capacitate MOWI and WSSAs to procure more energy efficient water supply installations. In particular the guidelines provide guidance on energy efficiency for procurement specifications and on relevant design procedures that impacts energy performance of water supply installations in Tanzania – including the application of least life cycle costing when procuring new equipment.

As mentioned in the previous section there are many instances of water supply systems being designed and constructed without taking into account the associated energy costs over the technical life of the installation. One example of this is the water storage facilities at SUWASA (shown in Figure 3 below). The storage facility consists of a large ground mounted and a small elevated tank. These are supplying water to the consumers by gravity, and are themselves fed by means of booster pumps located approximately 8 km away.

While roughly 75 % of the water is supplied to consumers from the ground mounted tank, all the water supplied from the booster station has been pressurized so as to be able to fill the elevated tank. This means that most of the water is supplied at a pressure greatly exceeding[15] the need for filling the ground mounted tank, leading to massive energy wastage. Had the cost of this waste been taken into account when choosing the technical solution, it is likely that the booster pumps had been sized differently and that a complementary pump had been installed at the water storage site to lift the relatively small amount of water needed for the elevated tank.

Through the development and use of such guidelines on Energy Efficiency (EE) for design and procurement of water supply facilities, it is expected that such energy wasting designs can be effectively avoided comparatively inexpensively[16].

## Capacity building and awareness actions

In general it is necessary to support the implementation of especially quantitative actions and LRAs by further developing capacities and awareness of experts[17] supporting the implementation of the EEAP, those overseeing and administering the implementation of the EEAP[18], and those subject to the actions of the EEAP[19].

As an illustrative example of capacity building for designated consumers GIZ SENERGY conducted comprehensive training of energy management teams at MORUWASA and SUWASA. A team consisting of representatives of all levels of the organization, from top management to technicians, was given training on how to organize themselves into an effective energy management support team. After the conclusion of the training one of the team members was appointed by management to be the energy manager responsible for implementing and pursuing the agreed energy policy and energy efficiency action plan[20].

The participants were trained in key aspects of energy management, and through interactive sessions an energy management team was gradually built around the drafting of an energy policy for the utility complemented by more technical aspects such as developing key indicators and a monitoring system for keeping track of progress. A comprehensive reference manual[21], tailored for the participating WSSAs, was also prepared.

Following the initial comprehensive trainings given at the two pilot WSSAs, a broader introductory training on energy management was offered to all regional WSSAs in cooperation with ATAWAS. The interest was high, and it is planned to follow through on the introductory training with a more in depth session later in 2017 so as to gradually spread the knowledge and awareness on the benefits of energy management amongst all WSSAs.

Presentations at conferences, workshops and through professional networks is important for creating awareness amongst the WSSAs on how to initiate their own energy management effort, and is an important step towards improving energy performance in the water sector.

Towards industries an important step towards increasing awareness around energy efficiency has been the introduction

14. Such as to employ a certified energy manager, to conduct regular energy audits using certified energy auditors, to prepare and implement FEEAPs, and to report back to the authorities about measures and initiatives undertaken.

15. At least 20 m of water column excess – i.e. the height of the elevated tank.

16. Costs will mainly be for training of design consultants, for MOWI and WSSA procurement staff, and for enforcement of the guidelines.

17. Such as energy managers, energy auditors, engineers, architects etc.

18. Ministry staffs (eg MEM), professional organizations (eg CTI).

19. Such as representatives from designated consumers and building owners.

20. Morogoro Urban Water Supply and Sanitation Authority, October 2016, Energy management policy and action plan for Morogoro Urban Water Supply and Sanitation Authority.

21. GIZ SENERGY, August 2016, Tanzania Water Authority Energy Management Handbook – Trainee Manual.

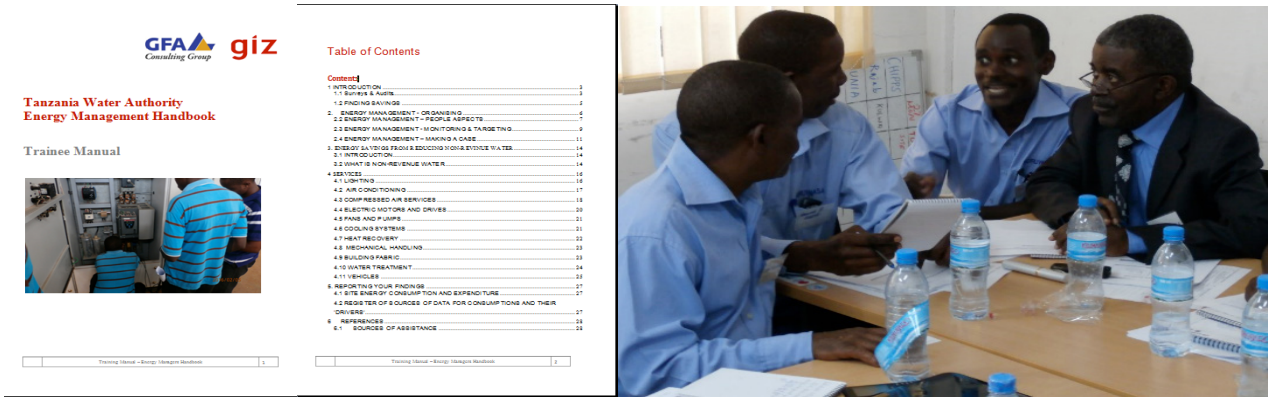


*Figure 4. Reference manual and WSSA staff during the energy management training.*

of a new energy efficiency award under the annual President's Manufacturer of the Year Award under the Confederation of Tanzanian Industries. A wider outreach towards the public in general, and in educational contexts, will be important to address in future.

## Conclusions

In conclusion, the development of a National Energy Efficiency Action Plan for designated consumers is a complex and wide ranging undertaking. The NEEAP is made up of four types of actions: quantitative, LRA, capacity development and awareness. The brief illustrative examples presented of what such actions can be, are mere glimpses of the full scope of an NEEAP. Furthermore, the water-energy nexus is but one of several important sectors that is targeted by the NEEAP. Although arguably industries and large buildings constitute bigger targets, the work done to improve energy performance in water utilities illustrate many of the same aspects as will be encountered in the other sectors as well as having significant energy savings potential in its own right.

Energy management capacity building and energy audits are key instruments to push energy efficiency forward and are necessary in order to build convincing technical cases and capable implementing organizations that decision makers (management) can entrust resources to, and get the promised financial returns.

## List of abbreviations

| | |
|---|---|
| ATAWAS | Association of Tanzanian Water Supply Authorities |
| CTI | Confederation of Tanzanian Industries |
| EDPG | Energy Development Partner Group |
| EEAP | Energy Efficiency Action Plan |
| EWURA | Energy and Water Utilities Regulatory Authority |
| FEEAP | Facility Energy Efficiency Action Plan |
| GIZ | Deutsche Gesellschaft fuer Internationale Zusammenarbeit |
| GIZ SENERGY | GIZ Sustainable Energy Programme in Tanzania |
| LRA | Legal, Regulatory and Administrative |
| MEM | Ministry of Energy and Mineral |
| MOWI | Ministry of Water and Irrigation |
| TANESCO | Tanzania Electric Supply Company Ltd |
| WSSA | Water Supply and Sanitation Authority |

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