eTap for handpumps

The security of drinking water supply is not guaranteed for part of the population in Tanzania. In cities like Dar Es Salaam, large parts of the population have access to a water supply. This is mostly managed by public and private operators. Centralized distribution networks are supplied by water sources such as wells, rivers, or lakes. Many households and businesses have their own household connections, allowing billing either via water meters or a basic fee.

In the rural areas of Tanzania, however, water supply largely takes place through decentralized groundwater wells. Most of these wells are managed by a local water committee. The responsibilities of these committees include ensuring both technical support and the financially sustainable operation of the system. Committee membership is a voluntary role, often undertaken by individuals without relevant professional background. Collecting a small fee for water withdrawal is hardly feasible, as no committee member can be present on-site full time. As a result, water is often drawn without any fee being collected. When a well fails due to a technical defect, efforts are made to raise sufficient funds for repairs through community fundraising. These unexpected additional expenses pose significant challenges for many households. If alternative water sources are available in the surrounding area, there is often a lack of motivation to support such fundraising efforts.

In the preceding project a technical system was developed that established an automated link between fee collection and water withdrawal using a prepaid card. The regulated income enables the water committees to build financial reserves. However, this system is only suitable for public water points that are connected to a water supply with a minimum pressure of 0.1 bar.

The development of the eTap for hand pumps is intended to be a follow-up project. It is specifically aimed at supporting the interests of water committees who consider the eTap for pressurised systems a very helpful tool but only have access to a well with a hand pump. The functionality is illustrated in Figure 1.

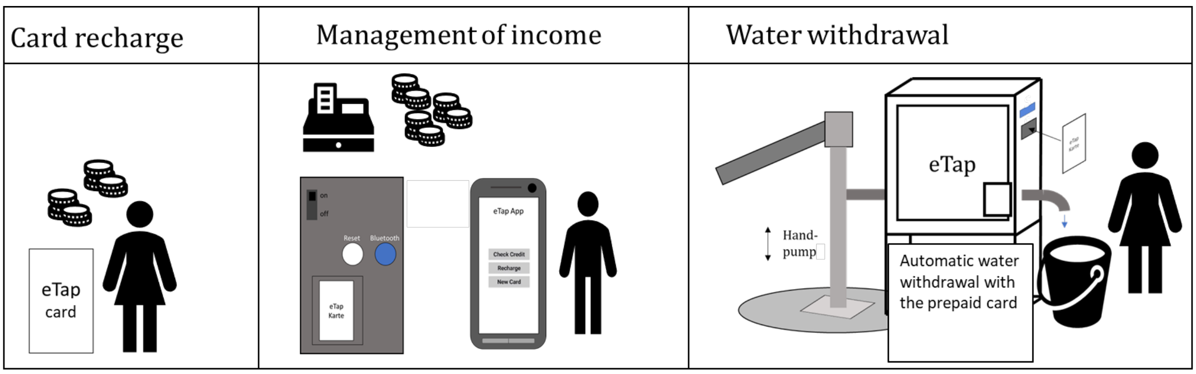

Figure 1: Conceptual sketch: Fee-Linked Water Withdrawal at the eTap for Hand Pumps

Working principle: Water users are provided with prepaid cards that can be recharged at official sales points (e.g., kiosk shops). This can be done by a member of a water committee or delegated to a kiosk operator. A specially developed app allows the operator to connect via smartphone to the so-called recharger. The connection is established through an encrypted Bluetooth link. A password is set to ensure that only authorized individuals can connect to the recharger to top up the card. The water user pays the desired recharge amount in cash, which is then credited to the card and recorded in a transaction history for tracking collected funds. The connection between the card and the recharger is made via an RFID sensor.

Water withdrawal is initiated by simply holding the card against the designated area on the eTap. An RFID sensor checks whether the required credit is available on the card. If the fee can be charged, a voltage is applied to the magnetic valve, causing it to open. While the water flows, the flow rate is measured using a magnetic-inductive flow meter. Based on the proportional relationship between flow velocity (v) and the cross-sectional area (A), the flow rate (Q) can be determined.

Technical structure of the eTap

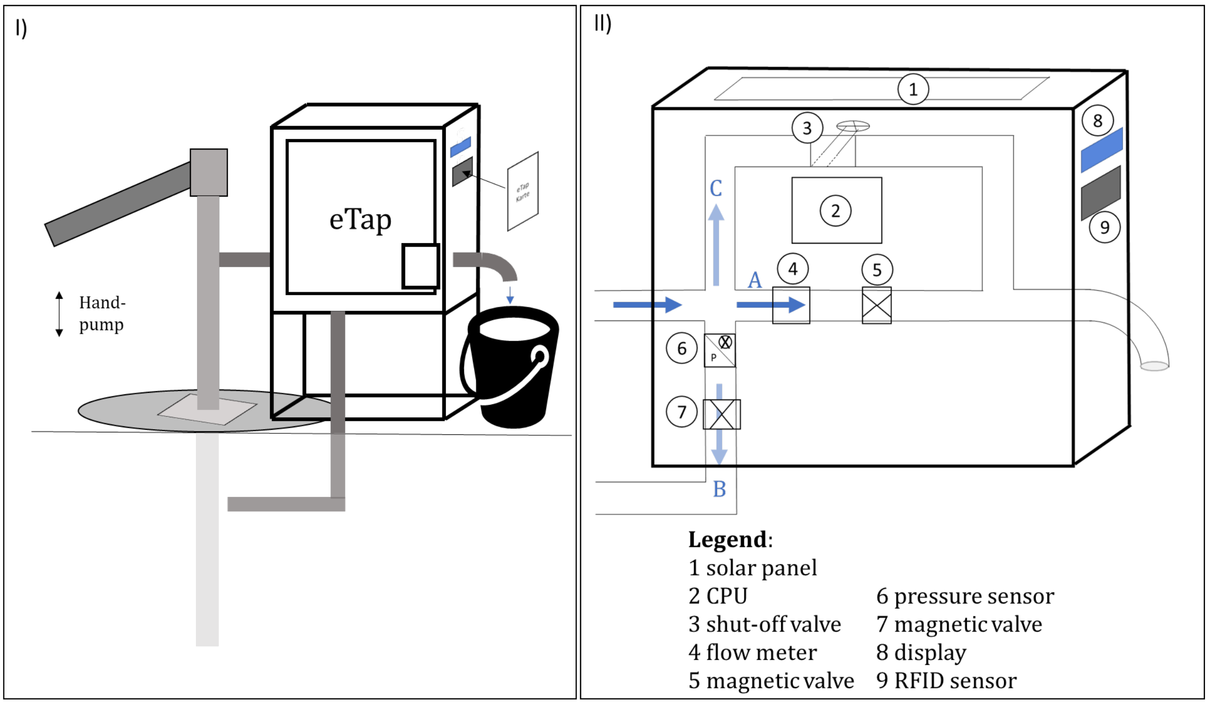

Figure 2: Technical structure of the eTap: I) Overview; II) Details of the eTaps incl. varies flow paths

In Figure 2 I), an overview of the eTap system for hand pumps is shown. By operating the hand pump, groundwater is pumped through a riser pipe. An additional pipe is installed alongside the existing riser, which connects the eTap and is laid back into the ground. Figure 2 II) lists the flow paths in detail:

Flow Path A: By holding the prepaid card against the RFID sensor (9), the water fee can be electronically deducted from the prepaid account. This information is communicated to the user via an LCD display (8). The CPU (2) sends an electrical pulse to the magnetic valve (5). Now, 10 litres of water can be pumped. After the 10 litres have been dispensed, the flow meter (4) sends the information to the CPU, which then closes the magnetic valve. The power supply is provided by a solar panel (1). If pumping continues without (re)payment, Flow path B is used.

Flow Path B: If pumping is done against the resistance of the closed flow meter (4), the pressure within the water pipe increases. This is detected by a pressure sensor (6). The CPU then sends a pulse to the magnetic valve (7) to open it. As a result, only Flow Path B is available. The water is pumped back into the riser pipe area. This prevents water withdrawal, and further pumping only creates a recirculation flow. It needs to be clarified whether a direct connection to the riser pipe is possible.

Flow Path C: In the event of a defect or other issue, water can be pumped manually by opening the shut-off valve (3). In this flow path, no fee is charged. The shut-off valve is accessible through a closed maintenance hatch on the eTap housing.

The technical setup of the eTap for hand pumps described here is a proposal for solving this technical challenge. Other implementations are also possible. An evaluation of the best technical system, taking into account the different types of hand pumps, will be conducted on-site. The objective is to develop a universally retrofittable system for the transparent collection of water fees as a tool for local water committees.

The following section defines the work packages for the development of the eTap for hand pumps. Additionally, a testing phase of the eTap from the previous project is also included. The required duration to complete the work packages can be found in Figure I of the appendix. The completion date is indicated in brackets behind the work packages (e.g., M = Month 3). The project will begin in July 2025, and completion is expected by the end of 2026. The goal is to develop a robust prototype that can be tested in the field for several months.

Work Packages:

Work Package 1: Further development of the SmaWa and resolution of potential issues. Conduct a test phase at the Malya Farm of the Diocese in the Mwanza region, Tanzania. (M 3)

Work Package 2: Assess the feasibility of the proposed technical system, including the types of pumps used on-site. Develop the best technical solution for universal applicability. (M 6)

Work Package 3: Development of the first prototype: Construction of the housing; procurement and installation of the electronic components. (M 8)

Work Package 4: Development and installation of an operating software. Adjust the app for cross-compatibility between cards and the recharging system of the eTap for hand pumps and eTap for pressurized systems with supply lines. (M 9)

Work Package 5: Testing phase and further development of the prototype. (M 18)

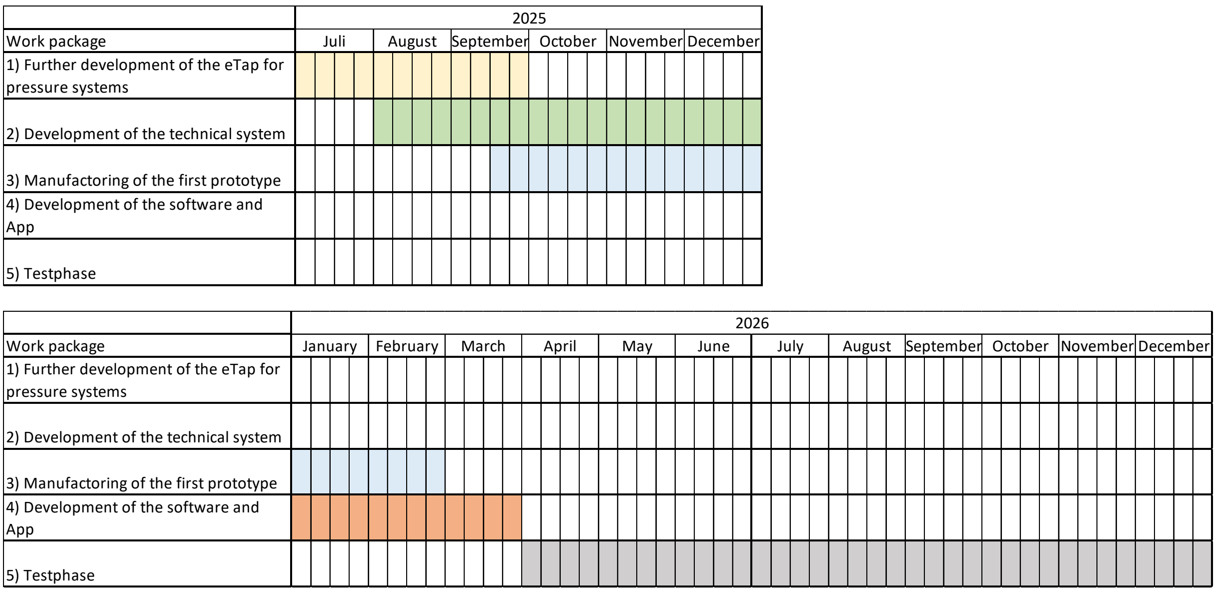

Figure I: Time table for the development of a prototype for the eTap for handpumps