DAIAD

DAIAD@home software for trials

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Abstract

This report presents an overview of the Prototype Deliverable D4.2.1 "DAIAD@home software for trials", which includes all software developed in the context of WP4. DAIAD@home consists of a web and mobile application, which convey to consumers water consumption information, as well as stimuli aiming to increase awareness and induce sustainable changes in water use. The current version of DAIAD@home is under evaluation in the context of our real-world trials.

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Executive Summary

This report presents an overview of the Prototype Deliverable D4.2.1 "DAIAD@home software for trials", which includes all software developed in the context of WP4. DAIAD@home consists of a web and mobile application, which convey to consumers water consumption information, as well as stimuli aiming to increase awareness and induce sustainable changes in water use. This version of DAIAD@home comprises the second major iteration of the system and is currently under evaluation in the context of our real-world trials.

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1. Introduction

This report presents an overview of the Prototype Deliverable D4.2.1 "DAIAD@home software for trials", i.e. the DAIAD@home software which will be use in DAIAD trials. DAIAD@home is the integrated system that manages the whole lifecycle of consumption data at the household level. It comprises all the subsystems for gathering consumption data and metadata (e.g. amphiro b1), the storage engines for storing and managing consumption data, the algorithms for analyzing them, the messaging framework, and interventions for providing information and stimuli to consumers.

We first provide an overview of the integrated DAIAD@home system and describe the data gathering and management flow. Then, we present a walkthrough of the various features offered by DAIAD@home, providing select screenshots and explanations regarding the system's intended use and operation.

2. Integrated System

In deliverable D4.1.1, the architecture of the data management system is described in detail. Here, we briefly enumerate the key features of the data gathering and management functionality of DAIAD@home software. Figure 1 illustrates the data lifecycle within DAIAD@home.
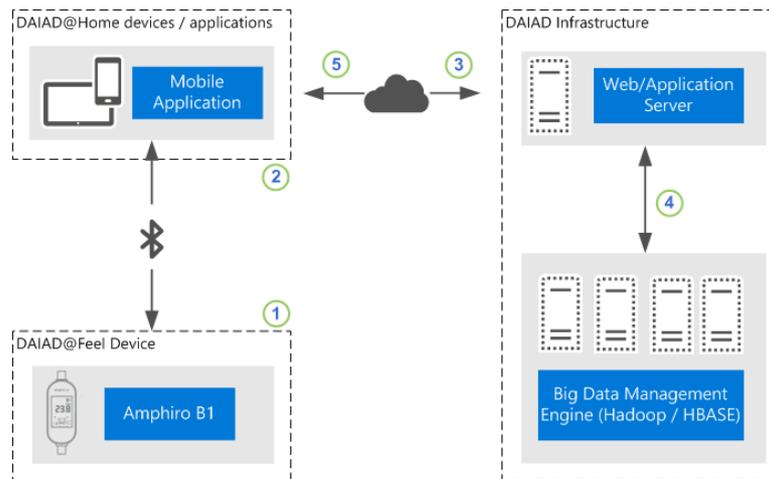

Figure 1: Data Lifecycle

2.1. Data source integration

In its current version, DAIAD@home is able to connect to an arbitrary number of amphiro b1 devices via Bluetooth 4.0. On the other hand, several mobile devices are able to connect to the same amphiro b1. Data from smart water meters (SWM) are pulled from the water utility's ICT infrastructure (*if available*) and stored locally at the DAIAD cluster. The uploaded data is paired to an existing DAIAD@home user based on the *unique* customer identification number supplied by the water utility, and become available to the DAIAD@home application. Consequently, DAIAD@home supports three (3) operations modes depending on the available data:

- *Amphiro b1-only*. The consumer only has access to amphiro b1 data from one or more devices. This operation mode will be tested in Trial B (St Albans), which studies the bottom-up deployment of the system without data from the water utility.
- *SWM-only*. The consumer only has access to her SWM data. This operation mode has originally been planned to be tested in our trials. However, given the great consumer interest in the city of Alicante, we plan to expand the pilot to more consumers that will not be provided with Amphiro b1 devices.
- *Amphiro b1 and SWM*. The consumer has access to Amphiro b1 data from one or more devices, as well as her SWM data. This operation mode will be tested in Trial A (Alicante), which studies the top-down deployment of the system with the cooperation of the water utility.

2.2. Storage engine integration

Within the mobile device, an SQLite[1] relational database handles the storage of specific types of data gathered from amphiro b1 devices and users. Specifically, it is responsible of storing and managing data about users, devices and measurements. User data are stored as relational tuples that contain information about the user account such as authentication and identification data, as well as demographic characteristics (*e.g. gender, residence, age*). Device measurement data are also stored as relational tuples, with the corresponding table having *a fixed schema* (*see D4.1.1. for details*).

The data engine is also responsible for uploading profile and measurement data to the DAIAD application servers. Moreover, when measurement data is transferred, it is augmented with user profile and device information. This redundant information simplifies data storage operations at the server side and also helps data analysis, since it reduces the need for additional *join* operations. Finally, the application server executes batch processing on the collected data on predefined intervals and stores the results to the DAIAD cloud infrastructure.

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[1] https://www.sqlite.org/
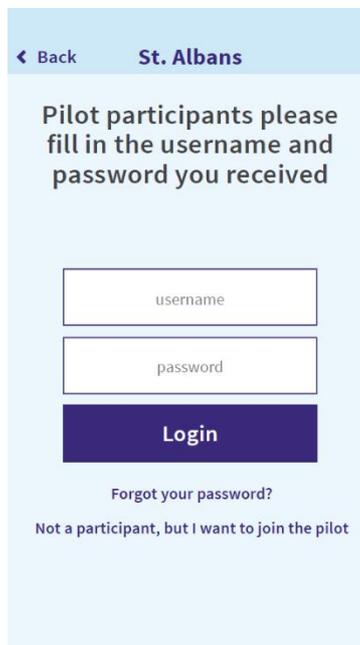
3. DAIAD@home walkthrough

In this section, we present a walkthrough of the various features offered by DAIAD@home, providing select screenshots and explanations regarding the system's intended use and operation. In our presentation we follow the common lifecycle of the application, starting from initial installation to every-day use.
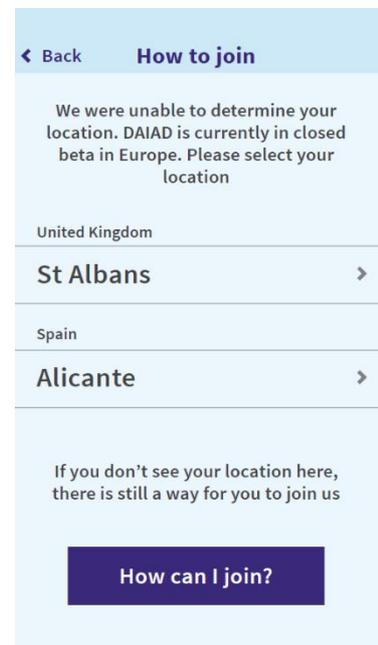
3.1. Installation

The user downloads and installs the application from the mobile app store (iOS, Android) as with any other application (Picture 1). When the application is opened for the first time the user is greeted with a welcome screen that serves to filter-out users *not belonging to our trials*, but also raise interest for DAIAD for expanding its use in other locations. Specifically, the welcome screen provides information on DAIAD and allows users to sign up. The user location is automatically detected and if she is in the geographical regions of Alicante or St Albans, she can create an account using her white-listed email address (*i.e. the list of selected pilot participants*) as presented in Picture 2. In case the use location is not detected (*i.e. Location service off, or not allowed*) the user can pick from a list of locations where the DAIAD system is trialed (Picture 3). If the user is in Alicante or St Albans, she follows the above sign up process. If not, the user is encouraged to discover how she can use DAIAD in the future, by informing her water utility about DAIAD, purchasing a compatible device, or using an open hardware water meter.
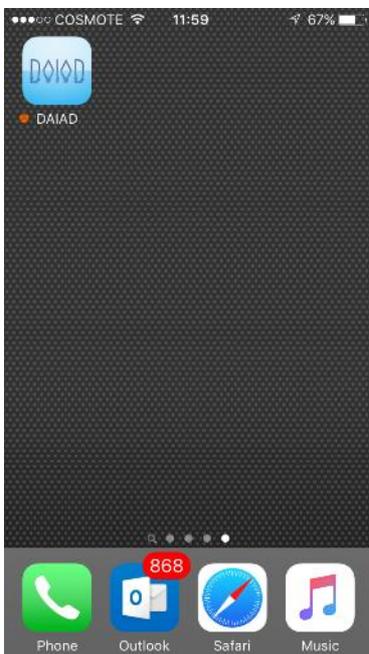
|		
Picture 1: DAIAD installed	*Picture 2: Sign up form*	*Picture 3: White-listed locations*

3.2. Initialization

After the sign up processes is completed, the user is presented with a step-by-step guide for installing and initializing the DAIAD system (Picture 4). This guide can be completed at any time, i.e. right after sign up, or when the user has time. As such, the user can exit the application and when she opens it again, she can continue.

The initialization process involves a number of steps depending on the supported operation mode. These are presented automatically by the application in order to simplify and speed-up the process. In particular:

- *Amphiro b1-only*. The application first checks if Bluetooth is turned on (Picture 6). If not, the user is instructed to open it. In the next step, the user is instructed to install the amphiro b1 device and turn the water on (Picture 7). The application is automatically set in pairing mode and is waiting for the user to enter the pairing code presented in the LCD (Picture 8). With the successful code entered, the initialization process is complete.

- *Amphiro b1 and SWM*. The application follows exactly the same steps as in the previous case. Only an additional step in the guide is provided, where the user is simply informed that her SWM data are indeed available to the application (Picture 5). While this is not technically necessary as we already have access to this data, we consider this *verification* important for conveying a sense of interaction with the water utility.

- *SWM-only*. The application only informs the user that her SWM data are indeed available to the application. No other extra step is required.

To install new b1 devices, the user can follow the relevant subset of this guide through the Settings sub-menu.
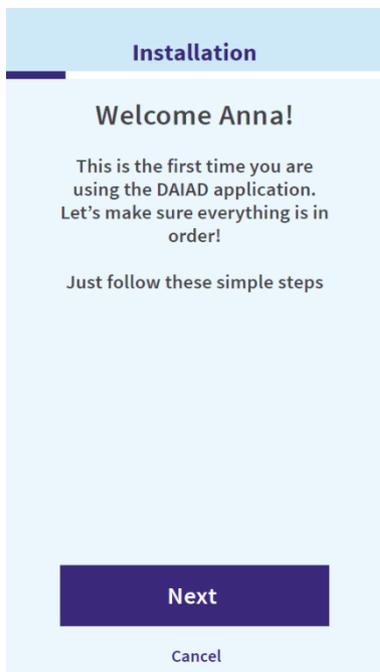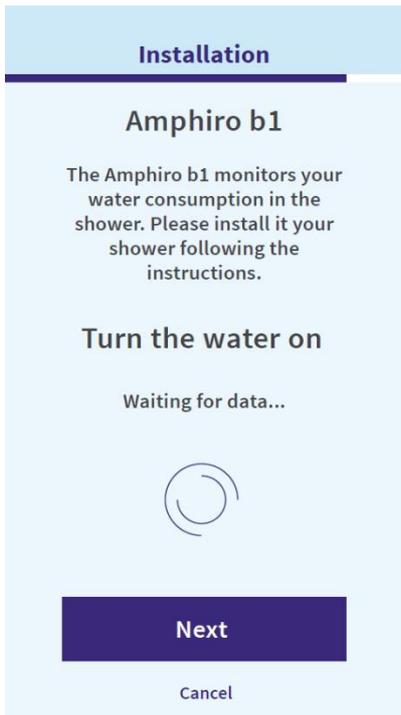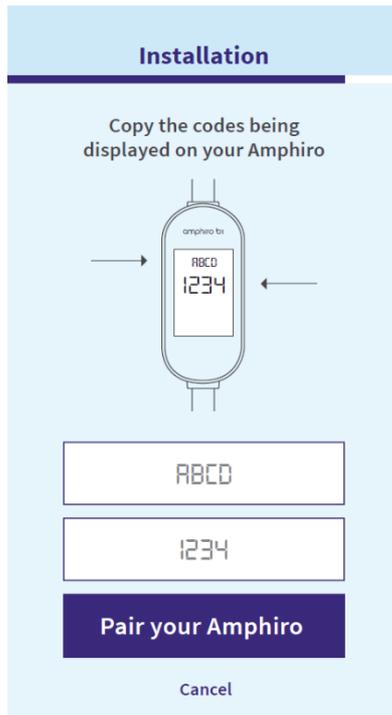

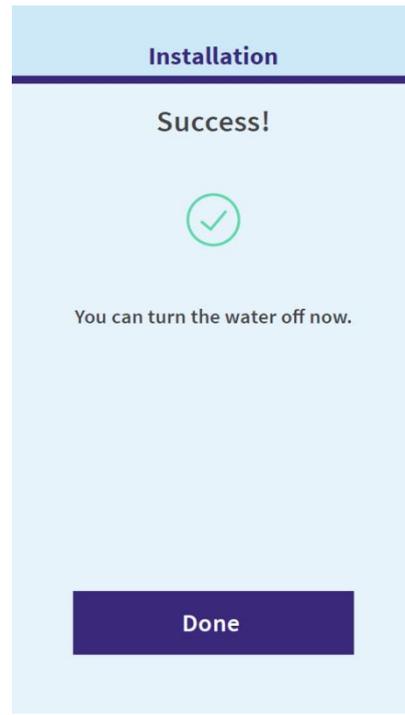*Picture 4: First step*
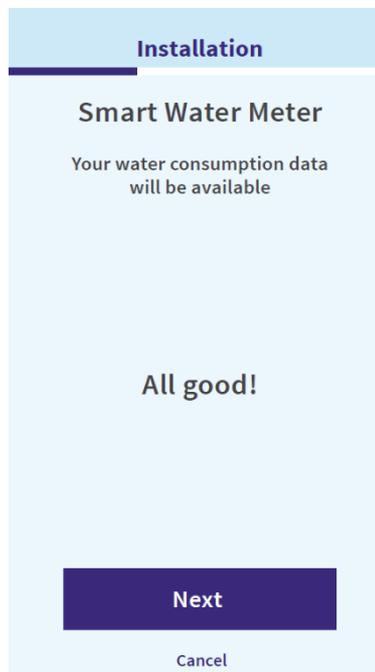
Picture 5: Checking SWM data

*Picture 6: BT connectivity*

Picture 7: Amphiro b1 installation

Picture 8: Enter PIN

Picture 9: Successful initialization

3.3. Learning mode

Specifically for the needs of the Trial, we have implemented a *learning mode*, i.e. a period (*3-4 weeks*) during which we collect water consumption data from our trial participants, but do not provide *any information to them*. This serves the practical need to establish a *baseline* water consumption for our users with no interventions or stimuli that can affect their behavior and introduce bias.
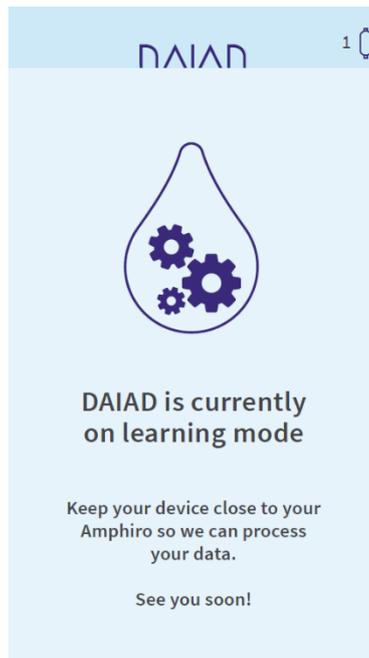

Picture 10: Learning mode message

During this period when the user opens the mobile application she is simply greeted with a message informing her about the learning mode (Picture 10). Similarly, the amphiro b1 display does not provide any information. The management of the learning mode (*start, end*) is remotely managed by the DAIAD system. When we consider that a baseline has been established we can remotely set the application and the b1 out of the learning mode. When this happens, the user is informed by push notification and can start using the DAIAD@home application.
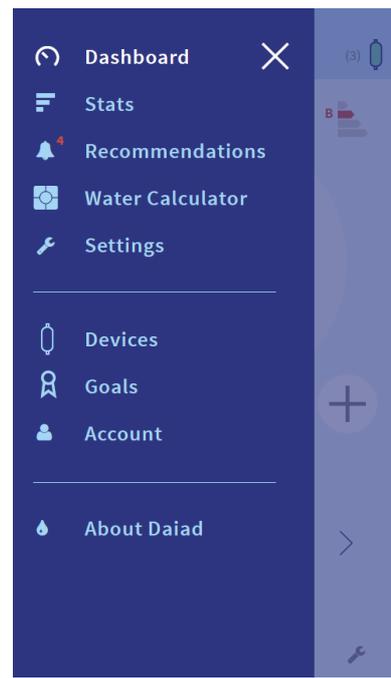
3.4. Dashboard and Menu

The Dashboard is the first screen available to users and provides in one glance information about water consumption, progress, and messages, as well as shortcuts to other application sections (*overview first, zoom and filter, then details on demand*). The top section of the dashboard provides a shortcut to the menu (left side), the DAIAD logo (middle), and a notification/shortcut for the installed b1 devices. The main information placeholder (*gauge*) provides information on the last consumption event or a user-selectable summary of water consumption (Picture 11, Picture 12). The 'complications' surrounding the gauge are user-selectable progress metrics. The lower part of the screen is devoted for presenting any relevant messages (*e.g. tips, recommendations, alerts*) based on their priority and links to the Messages section. The bottom part of the screen includes shortcuts to the other application sections. Finally, the menu (Picture 13) is visible throughout the application (*appears from the left side*) and offers shortcuts to other sections.
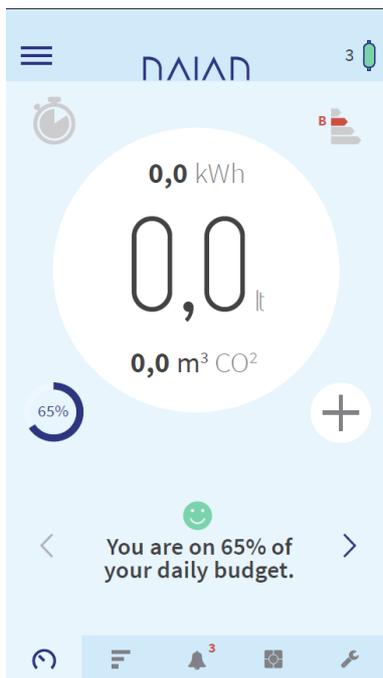
*Picture 11: Dashboard, empty*   *Picture 12: Dashboard: max*   *Picture 13: Menu*

3.5. Analysis

The analysis screen provides information about the historical water consumption of the consumer, along with a detailed analysis of its characteristics and specific consumption events (Picture 14). The user can select the

data source (*SWM, Amphiro b1*) and then explore her consumption over time (*day, week, month, year*) and measuring units (*e.g. flow, energy*). These selections dynamically adjust the entire interface and the information provided. The bottom part of the screen presents individual or major consumption events which the user can then explore in detail (Picture 15, Picture 16). In the detail view, the user has access to detailed information and metrics for the specific event, its impact, as well as a simple what-if facility for exploring how her own behavior is translated in a large scale (*e.g. what if everyone in my city showered the same?*)
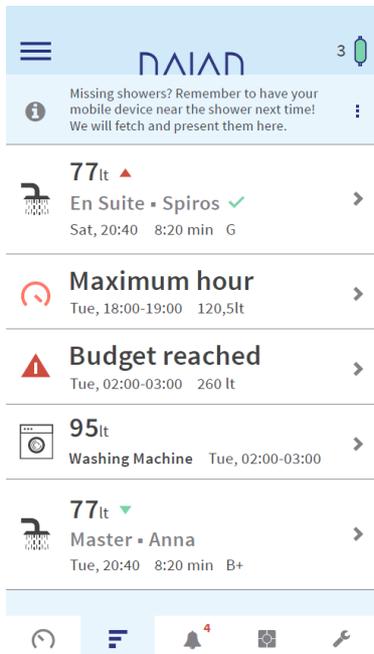

Picture 14: Consumption events

Picture 15: Single event
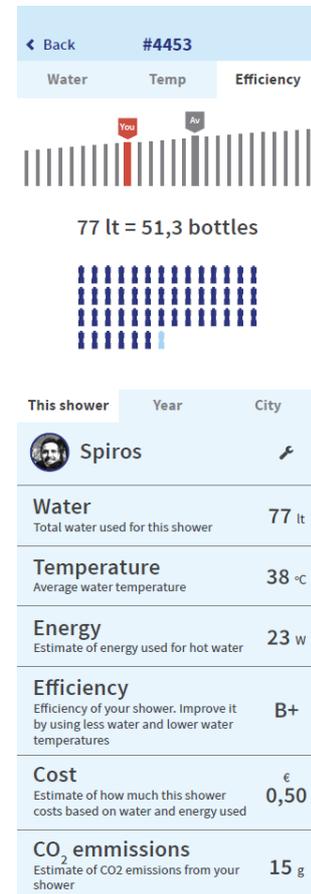
Picture 16: Single event

3.6. Messages

The Messages section includes three categories of content prompted to the user: alerts, tips, and insights. Alerts (Picture 17) inform consumers for events with a genuine sense of urgency, *e.g. in the cases of risk for damage, health & safety, significant exceedance of consumption, etc*. Tips (Picture 18) are messages that do not depend on consumption events/behaviors of the users; they comprise advices on improving water consumption behavior, regarding all types of household consumption. Insights (Picture 19) provide personalized information about the user's consumption, based on the analysis of her own consumption behavior.
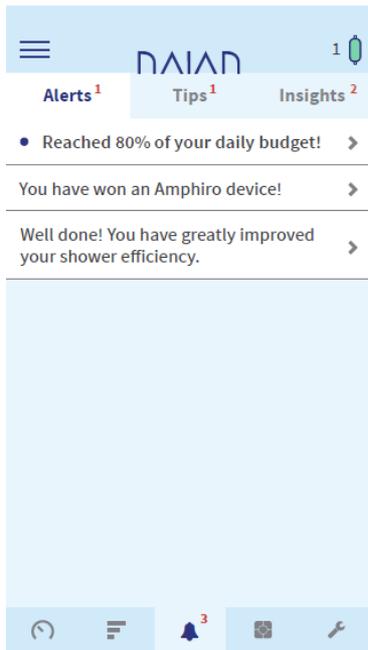
Picture 17: Alerts
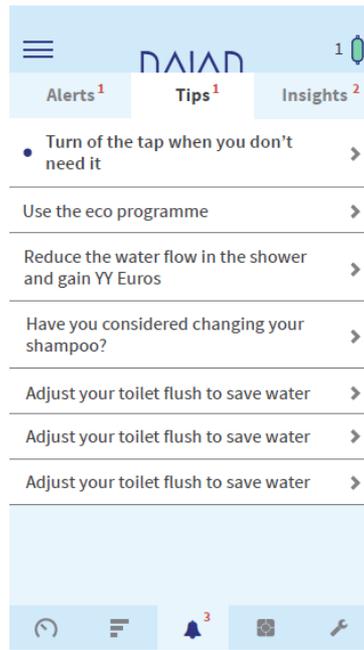
Picture 18: Tips

Picture 19: Insights

3.7. Water Calculator

The application offers an optional Water Calculator (Picture 20), which asks step by step questions about the consumption habits of the user and deduces coarse grained estimations about total household consumption and how it is distributed (Picture 21). The data gathered can be applied in three ways. First, provide a consumption breakdown and profile in the Amphiro b1-only operation mode. Second, provide a seed to handle the "cold start" problem of our personalization algorithms. Third, allow us to establish the perceived water consumption behavior of the consumer and compare it with her actual consumption.
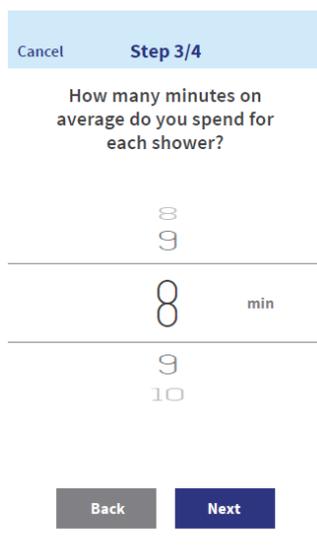

Picture 20: Question
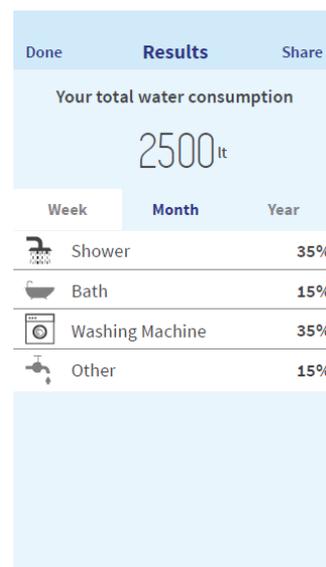
Picture 21: Results
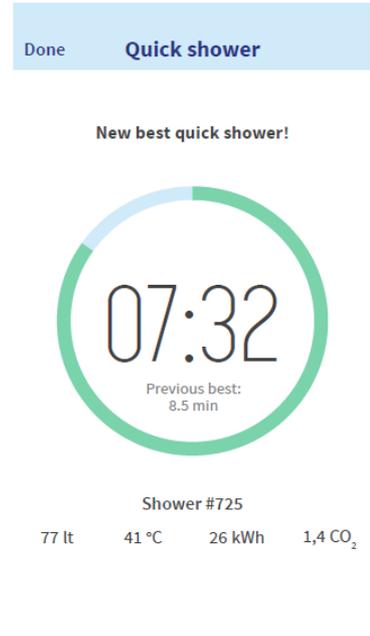
3.8. Shower timer

The application offers an intelligent shower timer (Picture 22, Picture 23, Picture 24), enabling the user to set individual goals and split water with other household members. For example, the user may select the "Single shower" mode, configure the shower options by, e.g. setting the maximum shower duration and start her shower. If she exceeds the set threshold, an alert will pop-up; if she achieves a very quick or very efficient shower, the information will be registered for future reference and comparison.
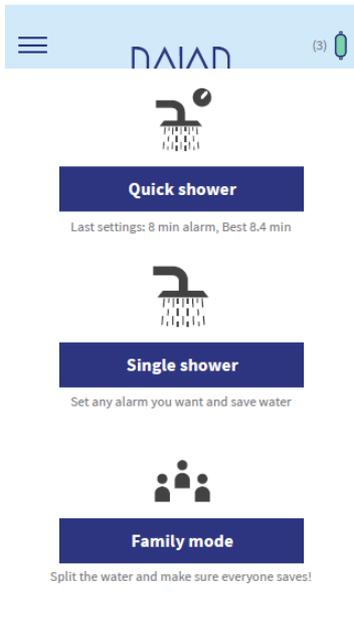
Picture 22: Options
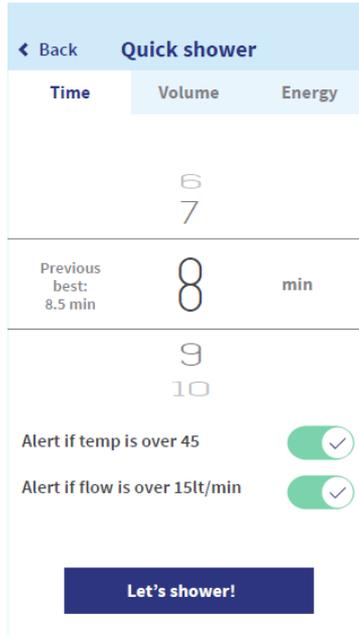
Picture 23: Shower settings

Picture 24Shower results