
Work Package No. T3.5

DELIBERABLE

Development of a dashboard for evaluators and high level users

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1 Introduction

Within the scope of the THE4BEES project, a dashboard to monitor and compare sensor measurements enables the project partners to visualize data they collected. Our project builds on the hypothesis: Energy is consumed by people rather than by buildings. Thus, THE4BEES focuses on the behavioural changes of users in public buildings, and there are numerous challenges we are facing: how to encourage behavioural changes for energy efficiency, how to monitor energy consumption trends and savings, how to make ICT an effective tool for achieving significant energy savings, and how to design innovative ICT tools to engage and motivate energy-conscious behaviour.

2 Dashboard visualization approaches

Different data visualisation (based on queries and analytics) are made available. Data must be represented in a more particularized mode for specific users (building managers, administrators, policy makers) and partners for a complete evaluation.

Dashboards are an appropriate way to visualize changes. In the context of the THE4BEES project, we define dashboards as interfaces designed for users in order to visualize real-time data and compare changes over a period of time. Within the THE4BEES project we are developing a set of ICT tools to support "energy related" behaviour change, energy consumption monitoring, and decision making. Our aim is to monitor energy consumption and air quality in buildings within the nine different pilot sites from six countries (Italy, Switzerland, Germany, Austria, Slovenia and France) and to visualize measurements in a simple way using simple straight forward icons, graphs, and messages.

2.1 Dashboard visualization approaches for the THE4BEES project

The THE4BEES dashboard graphical user interface is user-friendly, it shows error messages and provides as flexible as possible data visualisation solution.

The login screen asking users credentials to login to THE4BEES application is the very first impression users have about the dashboard. We made it intuitive, simple and colourful in order to get it right and to catch the user attention. Once effectuated login the user is redirected to the Home page. This page is referred to the whole pilot site and represents its current situation on energy consumption and CO2 emissions. The tips and hints on efficient behaviour based on the system feedback will be visualized on this page as well.

By clicking on Comparison button the user will be redirected on the page with the set of predefined reports built ad hoc for a certain pilot site. These reports will contain detailed information on actual energy consumption and possible savings providing visual representation of energy consumption trend within a certain timeframe. Comparison page will be designed for non-expert users and can be adapted for in-house screens to be positioned in schools and offices. Furthermore, the Energy Details page will be available for expert users such as energy managers and decision makers. The user will be able to choose a time period, the sensors to be visualised and data granularity.
2.2 Design of the THE4BEES dashboard

Before starting the Dashboard implementation, we performed preliminary studies to define the "look and feel" of the future THE4BEES dashboard. The IREES experts in cooperation with all the THE4BEES partners provided recommendations for ICT developments\(^1\). During the “requirement gathering phase”, the CSI partners were communicating with the CCLabs participants and had a number of interviews with the project partners to discover the actual needs of future users and stakeholders. The opinion and suggestions of the CCLabs participants and partners are summarised in the list of features to be implemented for the dashboard\(^2\). We also have analysed the complete trial plans to comprehend the measurements and other information to be visualized using the Dashboard.

The dashboard will be developed as a flexible tool, adaptable to each Pilot’s needs. Upon the project end the THE4BEES Dashboard will be easily adaptable to other schools, offices, social housing buildings, and mountain huts reality.

As for the design and style of the Dashboard, all the information on the Home page and Comparison page will be adapted to the reference frame of the target group to make the content of the project a thought-provoking and motivating for users. The dashboard is designed using common colours and styles so it is easily recognised as THE4BEES project’s outcomes.

2.2.1 Login page

The application starts with the log-in page (Figure 1). Before starting using the app, users will be given login and password. These data are stored in the THE4BEES back office database table t4bees_t_user (des_user, pwd_user). All operations will be done by user within the one specific pilot. All the pages are associated to the certain user id and functions listed within the THE4BEES database. Based on this definition, the Dashboard allows or doesn’t allow certain functions. In particular, basic and advanced users and associated functions have been created.

\(^1\) See Deliverable 2.2.1 of THE4BEES project: IREES (2017). Knowledge base on efficient behaviours

\(^2\) See the deliverable 3.1.2 of THE4BEES project: CSI (2017). Report on Suggestions and Recommendations for IT System Architectures
2.2.2 Dashboard Home page

The content of the Home page is divided into four main blocks (Figure 2). The figures within the first three objects will represent an easily understandable information about energy consumption and savings. This information will be adapted depends on the pilot context and target group. The fourth object of the Home page is dedicated to hints and tips. The system feedback will be possibly combined with advice on how to change behaviour and achieve energy savings.
2.2.3 Dashboard Comparison page

Comparison page address non-expert user. Based on partners and CCLabs participants requests, the energy trend and other important data will be shown on the predefined reports (Figure 3). These are the four configurations of the main dashboard graph (see the Chapter 2.2.4 Dashboard Energy details page for more detailed explanation). The main graph is customized and made significant for each single pilot.
2.2.4Dashboard Energy Details page

The Energy Details page is designed for a wide range of potential users from energy manager to decision makers. This is the most complex part of the dashboard and all the other pages providing customised reports are based on the Energy Details page core solution. This part of the dashboard gives user a possibility to monitor and analyse historical and near real-time data related to energy and air quality. The data comes from sensors/energy meters installed within the pilots and linked to the Smart
Data Platform\textsuperscript{3}. The customer has a possibility to visualize all the sensors related to the pilot. Once report diagram appears on the screen, there is a possibility to visualize and compare a number of parameters such as energy consumption, energy usage, air quality, open/closed windows (Figure 4). Only the sensors installed within the pilot and registered on the Smart Data Platform are available within the Dashboard.

Initially, the 3 input fields and an empty graph appears on the screen. The key information in real time, such as Date, Time, energy consumption so far, and CO2 emissions will be visualised on the upper part of the Energy Details page.

The main part of the Energy details page consists of the following features (Figure 5):

1. **select time frame.** The input box *select timeframe* for selecting the period to be visualised is mandatory (default for all the pilots). There are no limitations on starting date

\textsuperscript{3} See the deliverable 3.1.2 of THE4BEES project: CSI (2017). Adapted Smart Data Platform
2. **select data granularity** (default for all the pilots). The user is invited to select *data granularity* from the dedicated combo. Possible choice on data granularity is monthly, weekly, hourly. To aggregate the data, we use the Smart Data Platform Statistical aggregation. It allows for aggregate extraction based on a time basis (as an example: `timeGroupBy= month_year`, `timeGroupBy =hour_dayofmonth_month_year`). This choice is not mandatory. If the user doesn’t select any data granularity just a raw data will be visualized.

3. **select sensor from the list.** The user selects sensors to be visualised from the list. Each user can see just the list of sensors he is enabled and within the pilot only. There is a possibility to select one sensor a time. The system creates the sensor names to be visualized on the graph starting from the information coming from Smart Data Platform. The logic applied is as following: Object name as from the THE4BEES database plus Component name from the SDP

   Example

   \[
   des\_object\ (table\ t4b\_t\_object) +\ component\_name\ (table\ t4b\_t\_sensor)
   \]

4. **view data.** The user selects *view data* button. If the user has chosen time frame and a sensor but not data granularity, the system effectuates the call to Smart Data Platform. The requested sensor raw data values appear on the graph (Figure 5). The units of measurement are retrieved from the SDP field UNIT OF MEASUREMENT

![Image of select parameters](image-url)

*Figure 5: Energy Details page design, the user choice example: Temperature sensor*

5. **modify settings.** The user can any time modify *data granularity* and *time frame* for chosen sensor. The system will effectuate a call to SDP sending new parameters. New measurements appear on the screen. There is also a possibility to reset all the preferences and clear the graph.
(by selecting the reset button). User can select and deselect sensors, and delete sensor from the graph using the delete icon.

If the user does not make any choice for the required fields a warning detailed message appears, e.g.: Please select the data granularity, Please select sensor to be visualized (Figure 6).

![compilare i dati richiesti!]

**Figure 6:** THE4BEES Dashboard Details page design, warning message example

6. **Select one more sensor from the list**

The user selects another sensor from the list. If the sensor has the same unit of measurement (the application verifies the field Unit of Measurement within the related SDP component) as the sensor already visualized on the graph, the second sensor on the graph. If the unit of measurement of the second sensor is different than the first one, a warning message appears: “The sensors are not comparable, would you like to cancel your previous search and visualize new sensor type?”. If user clicks “yes”, all the sensors from the first graph will be deleted and the new sensor will be visualized on the graph. If user clicks “no”, no changes will be made (Figure 7).
7. View comparison button

To compare values with different unit of measurements, as an example electrical energy consumption for lighting versus luminosity, the view comparison option is available within the user interface. Once user selects this button, one more graph will be visualised. All the functionalities already described for the first graph will be active. These two graphs can be used for comparison of data with different units of measurements or for comparison within different time ranges (Figure 8).
Figure 8: THE4BEES Dashboard Details use case design, comparison part
2.3 Target user group

There are two target groups regarding dashboard within the THE4BEES project: the high level users responsible for energy efficiency and energy savings, and the target group that are users who will hopefully actively participate in the project activities and use the dashboard to view and monitor their energy consumptions and eventual savings.

The high level users such as **energy managers, decision makers and other public authorities** will be provided with the tool for monitoring in near real-time the energy consumption and other parameters related to energy efficiency/energy savings. The users will be offered a possibility for benchmarking within the pilot, statistics and comparisons to set out different energy management’s strategies.

Another target group will include **pupils from schools, teachers, possibly parents, mountain huts visitors, employees, and tenants**. Members of this target group will be offered an easy and a straightforward tool for energy consumption monitoring. They will be given a clear idea on “what we are measuring”. The dashboard will be available on pc and tablet and on the totems in the schools, offices, and mountain huts. By comparison between various energy related datasets and measurements “before” and “after” interventions, the users from this target group will see the difference their behaviour makes in the energy savings.

2.4 Prototypical implementation

THE4BEES dashboard is an easy-to-use browser-based application. The dashboard technical solution consists of 3 levels: data tier, middleware, and front end (Figure 9). The real back office for data input and management is beyond this project scope. We have created the ad hoc open source database (Figure 10) to simulate a back office and manage logical connection between Smart Data Platform external service and the THE4BEES dashboard.
**Data tier** is implemented based on the database PostgreSQL. All the application configurations are stored within the database. All the measurements coming from sensors are stored within the Smart Data Platform. For more detailed information on Smart Data Platform (SDP), please refer to the Deliverable 3.1. Chapter 2.2 Adapted Smart Data platform.\(^4\)

**Middleware** provides remote web services using the HTTP protocol. These web services allow for gathering information from the database and SDP. This way we get all the necessary data for THE4BEES frontend. The middleware is built using Java 2 Platform Enterprise Edition (j2ee), a platform-independent, Java-centric environment from Sun for developing, building and deploying Web-based enterprise applications online, deployed on Tomcat. The Apache Tomcat software is developed in an open and participatory environment and released under the Apache License version 2.

**Front end** is a web based Graphical User Interface developed in JavaScript with the layout bootstrap and a server component designed using Java technology. We are using the framework React-Redux which controls states in a JavaScript. According to the official site, Redux is a predictable state container for JavaScript apps.\(^5\) Redux Is a tool which allows for creating an application defining basic interface components and integrating these components into more complex ones. The idea is to separate presentational components and a container. This way the components are much easier to reuse.

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\(^4\) See the deliverable 3.1.2 of THE4BEES project: CSI (2017). Report on Suggestions and Recommendations for IT System Architectures

\(^5\) [http://redux.js.org/](http://redux.js.org/)
The technical solution applied for THE4BEES dashboard implementation uses Open Source libraries. The dashboard requires user logins, thus we paid a special attention to creating, maintaining and managing of user profiles so that users can effectively interact with the dashboard. Our solution allows a user to access multiple applications providing the user id and the password just once. If login is successful, the user will be automatically redirected to the THE4BEES dashboard main page. We are taking care of the security issues using HTTPS protocol.

The first release of the Login and Energy Details pages (Figure 11) will be implemented by the end of September 2017. Further developments will be made upon partners’ and CCLabs participants comments.
Figure 11: THE4BEES dashboard Energy details page prototype, work in progress