STEP-IN

D5.2 – Energy Poverty Assessment and Reduction Tools Version V1

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Abstract: This deliverable contains an overview of version one of the STEP-IN ICT tools (e.g. the architecture, web platform and server).

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Glossary

Abbreviation / acronym	Description
DB	Database
LL	Living Lab
UI	User Interface, what the user sees on the screen.
Client	The web system which is used to enter or see data.
Server	This is what is used to allow users to reach the website. It's where the main code runs.
Users	The types of users and roles. For V1, only consumers, advisors, researchers and super administrator are implemented. Advisors and researchers act as administrators.
HTTP / HTTPS	HyperText Transfer Protocol. This is the protocol used for the communication between client and server. HTTPS is the secured variant.
HTML	HyperText Markup Language. That's a programming language used to develop web pages.
JavaScript (or JS)	A programming language used to create scripts, which allow a website to be dynamic.
CRUD verbs	The most commonly http used methods: POST, GET, PUT/PATCH and DELETE. CRUD stand for Create Read Update and Delete
SQLite	SQLite is the library used as SQL database engine. This is what we use to store and access data.
Angularjs	This is a framework used to develop reliable code in JavaScript.
D3Js	This is a library used to draw graph on the web app.
JSON	JavaScript Object Notation. It is a textual file format used to describe object (data) for a use in JavaScript.
CSV	A file format using commas as a way to create a tabular data structure

Executive Summary

This document outlines what has been implemented within version 1 of the STEP-IN ICT tools. The document is not the output deliverable for this part of the work package, the underlying software forms the actual deliverable. The document is primarily technical in nature and is of interest to those considering deploying or developing similar solutions.

Following on from discussions within STEP-IN it has been identified that the primary users during the first version of the living labs will be the energy advisors. This change is reflected in how the tools are designed and implemented, for example rather than being a freestanding advice tool it will instead act as a way for the energy advisors to collect data and then provide relevant advice to the consumers. Nevertheless, consumers can also log in and access their personal advice, so that the platform is also automatically usable by consumers. Dunring the Living Lab cycle V2 consumers will also start using the platform. The document outlines each part of the system from the underlying software architecture, to the user interfaces and provided tools. The system supports many features from the uploading of consumption data via sensors, through to visualisations of energy consumption and building floor maps along with supporting details. A short description of the overall architecture is also provided. A web-based platform was chosen as this avoids issues with the installation and updating of software and potentially makes the platform more widely available as the underlying IT requirements are quite small.

Introduction

This document is intended to summarise the ICT tools platform within STEP-IN which form the actual deliverable D5.2. It provides an overview of the architecture, features and should be read in conjunction with D5.1 which documents the underlying requirements and platform design. It should be noted that version 1 of the ICT tools focusses primarily on data collection and making that information available to energy advisors. The iterative process in the project means that lessons learned from the living labs and in particular the ICT tools will be used to improve the platform both during version 1, and also subsequently for versions 2 and 3. In particular this will apply to the inclusion of more behaviour change advice and also connections to third party systems such as LCA tools or energy consumption calculation platforms. Version 1 of the platform is a direct result of extensive work between the living labs and LIST, in particular around the requirements and also identifying the current users of the platform. For example, during the early stages of the project it was intended for consumers to be the end users, however it emerged that many consumers will not have continuous access to mobile devices or the internet. Therefore, it was decided to focus on providing a platform for use by energy advisors, as well as for consumers to use the platform and access their individual, personalised report. The system is also web based which means that no installation is required, and the users do not need to worry about updating any software. Instead updates will be available automatically. Where consumers are not able to access the internet platform, advice reports can be printed for these by energy advisors.

STEP-IN is not the only project which is working with ICT tools to assist in understanding energy consumption and behaviour change. A good example of a recently completed project is H2020 EDI-NET[1] which built a platform for energy managers of public buildings. Although with a different focus it illustrated how improved understanding through the use of data analytics coupled with visualisations and other tools can reduce energy consumption. As STEP-IN progresses it will seek to build upon best practice and the existing work of partners (in particular LIST) to provide a range of ICT tools to assist those who are facing challenges in managing their energy bills and consumption.

This summary report presents an overview of the objectives of V1 and the underlying architecture, it then explains the core components including the web interfaces, front and back end along with an overview of aspects such as user management and visualisation. It also includes an overview of deployment and data protection issues and concludes with some next steps.

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[1] https://edi-net.eu/en/home.html (accessed 5-3-2019)

1. Platform Description

1.1 Objectives

As specified in D5.1[2], WP5 focusses on designing and implementing ICT tools used by energy advisors in the following tasks:

- To support data collection in the living labs;
- To provide analysis to help in the understanding of energy poverty;
- To provide advice for the consumers;
- To find solutions for energy poor households.

The overall implementation decisions for the platform are discussed in D5.1. Therefore, the intention here is to focus on providing a summary of the high-level aspects and design goals (see below). These are all provided in the context of the platform architecture (see Figure 1):

- Use of sensors to acquire data about home energy consumption;
- A central platform (described later) used to achieve the tasks raised in D5.1;
- The platform will connect to multiple data analysis engines to enable effective analysis of energy consumption patterns;
- Multiple types of device will be able to reach the platform to interact with it to send, gather and display information from it (e.g. questionnaires, diaries, sensors data, charts).

During the discussions with the living labs leaders it was recognised that there must be a way to import the data from the sensors and to have a way to register the consumers. Furthermore, that the platform must allow the completion of questionnaires and the design of a floor map. A meeting in Budapest in March 2019 identified a range of improvements in particular to the latter point.

Within STEP-IN three versions of the software platform are planned. During version 1, the aim is to receive feedback before and during each version so that improvements can be made. In particular the more focussed behaviour change elements will be developed with assistance from the consumers during V1 and rolled out in V2 and V3.

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[2] D5.1 is confidential, however STEP-IN welcomes contact with third parties who wish to find out more information about the design challenges and issues involved in the project.

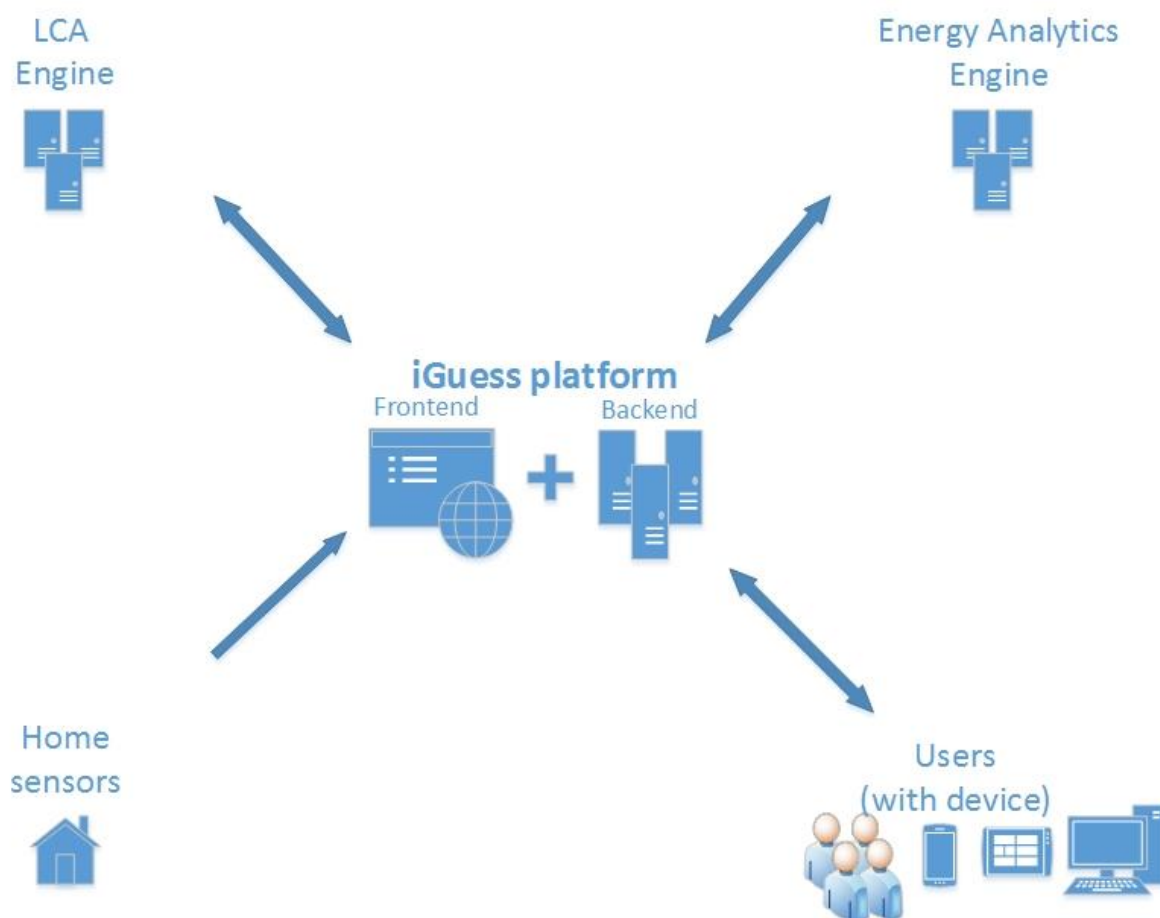# 2. System Overview

2.1 Architecture

Figure 1 : General ICT tool architecture

Figure 1 provides an overview of the architecture. Version 1 primarily focusses on the front and back-end components, along with the ability to collect data from the home sensors (via CSV files) and the ability for users to interact with the system on a device of their choosing.

2.2 Web platform

The following section describes the web platform which is composed by the back-end (the server) and a front-end (the user interface). It is possible to try the platform by visiting: https://step-in.list.lu

At present each living lab location installs and runs a local version of any software they require, this is for data protection reasons. The link above therefore provides access to the generic STEP-IN platform (not linked to any particular location), the intention is to let third parties try out the platform. However, it should not be used for storing of real data. Anyone wishing to register to use the platform should contact LIST. Details are available on the project website.

2.2.1 Back-end

The back-end was developed in JavaScript using nodejs. It's linked to a SQLite database where the data (e.g. questionnaires, sensor data, some consumer's data) are stored. This approach was used so that in the future, external computation engines will be able to be connected to the platform and make use of the information stored in the database. This is planned for future versions of the platform, although it is possible now for data to be exported and used.

The back-end is used to provide the contents displayed on the front-end using CRUD verbs from https methods.

2.2.2 Front-end

The front-end is basically the UI displayed on user devices (which can be a tablet, a phone or a computer). It has been developed in HTML, CSS and JavaScript using the angularjs framework. The content which is displayed comes from the data and algorithms within the back-end components.

The UI is split in multiple parts (see *Figure 2* and *Figure 3*): a navigation bar allows the user to go to the dashboard, about and contact or login / register pages. Once the users have registered it also displays their login and location.
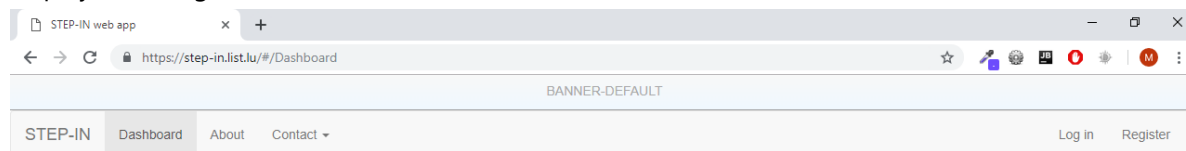
Figure 2 The home page

The main content is displayed in the dashboard page, which is reachable only if the user is registered and logged in. Figure 3 illustrates what the user (in this case an energy advisor) sees when they are logged in with an administrator account.
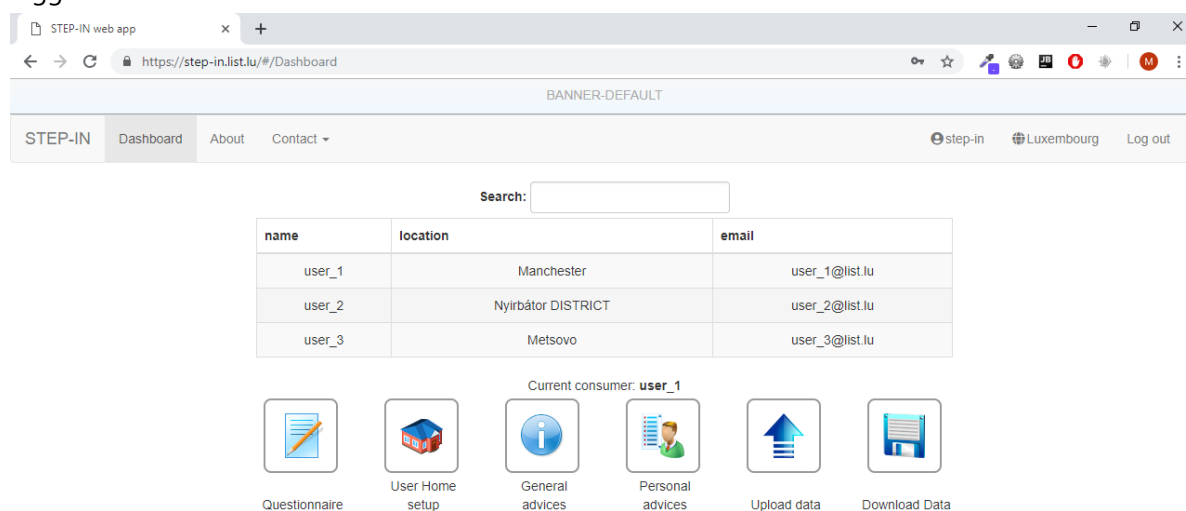

Figure 3 The dashboard and user table

V1 already implements the following list of features reachable from the navigation bar or from the dashboard described in *Figure 3*:

User table

On the dashboard page there is a table used to display and select consumers (see *Figure 3*). This table contains the list of consumers the current logged in user can see. For instance, a default a consumer can only see himself whereas an admin (an advisor or researcher) or a super admin can see all consumers from their location. A search field is provided so that it is easy to find specific consumers data, this is important as there are potentially a large number of consumers.

Credentials

A user can register, log in and log out on the platform. An Access Control List has been implemented. This means that each user has a defined access level to certain features and data. All credentials are encrypted before being stored in the database. A list of user roles can be found in Table 1. It is possible to add new roles if required.

Name	Role	Has access to	Rights
Consumer	Basic user	His own data only	Can access the dashboard related to his own data only (questionnaire, home setup, advice, csv exportation)
Researcher	Administrator	Data from all users from their location	same rights as above for all consumers of their location Also has the possibility to add questionnaire to a specific user
Advisor	Administrator	Same as above	Same as above
Super administrator	Super administrator	Same as above	Same as above Has the possibility to grant administrator rights to other users

Table 1 User Roles

Questionnaires

The platform provides the possibility to import forms so that they can be completed by the users. These forms are displayed directly by the front-end using a questionnaire definition described in a JSON file stored server side. An example is provided in Figure 4. Users can then access a list of questionnaires and fill them in. This is stored server side and can be gathered or modified at any time by simply retrieving the form again.

Figure 4 Example Questionnaire

Consumer home setup

This feature was developed using d3js to let an advisor or a consumer create a map of a consumer's home. It allows users to draw rooms, doors, windows, heaters, sensors. They can add a label (e.g.: living room) and temperature to the rooms. This map is stored in the database, server side and can be created and modified at any time (see *Figure 5*).
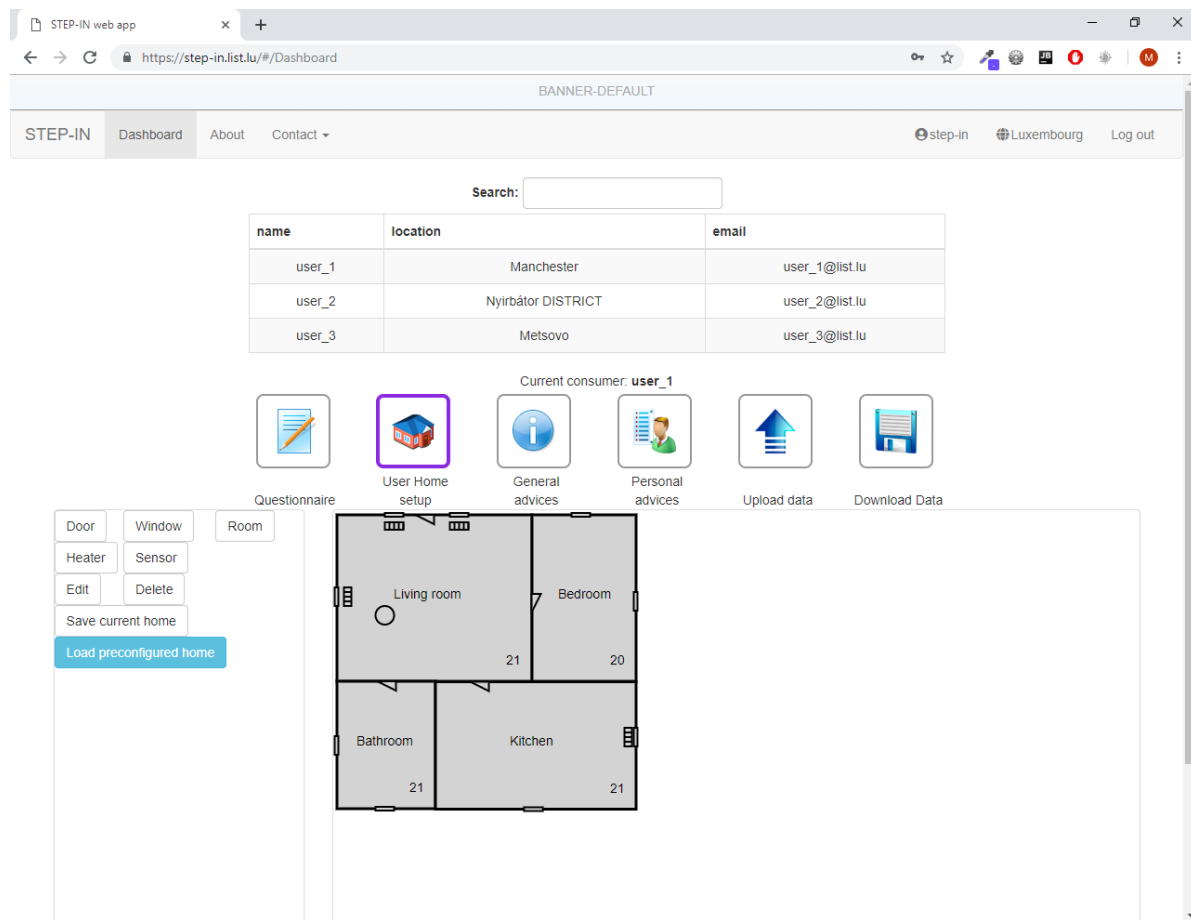
Figure 5 Example floor map

Uploading data

This feature lets users upload data to the server. At present it supports uploading CSV files containing the sensor data. In the future the users will also be able to upload PDF files and pictures. The uploaded CSV file is stored in the server-side database. This has been implemented to allow the user to query the database, for example to display a graph (*Figure 6*).

Downloading data

This is a basic feature which lets users download the data they have previously uploaded. Only data specific to the current selected user can be downloaded. Consumers are only able to download their own data this way. At present it allows the downloading of the previously uploaded CSV file, in future it will support the downloading of more data sources.

Advice

There are currently two defined types of advice:

- General advice: This consists of advice that may be suitable for all consumers, called the public. The content for this can be added as time progresses and to fit the needs of individual living labs. Here an advisor or a consumer or others can find basic advice, general energy consumption graphs and general information displayed on a map. They will also be able to obtain a report containing general advice as a PDF file (see *Figure 6* and *Figure 7*). This general advice part is accessible without login.
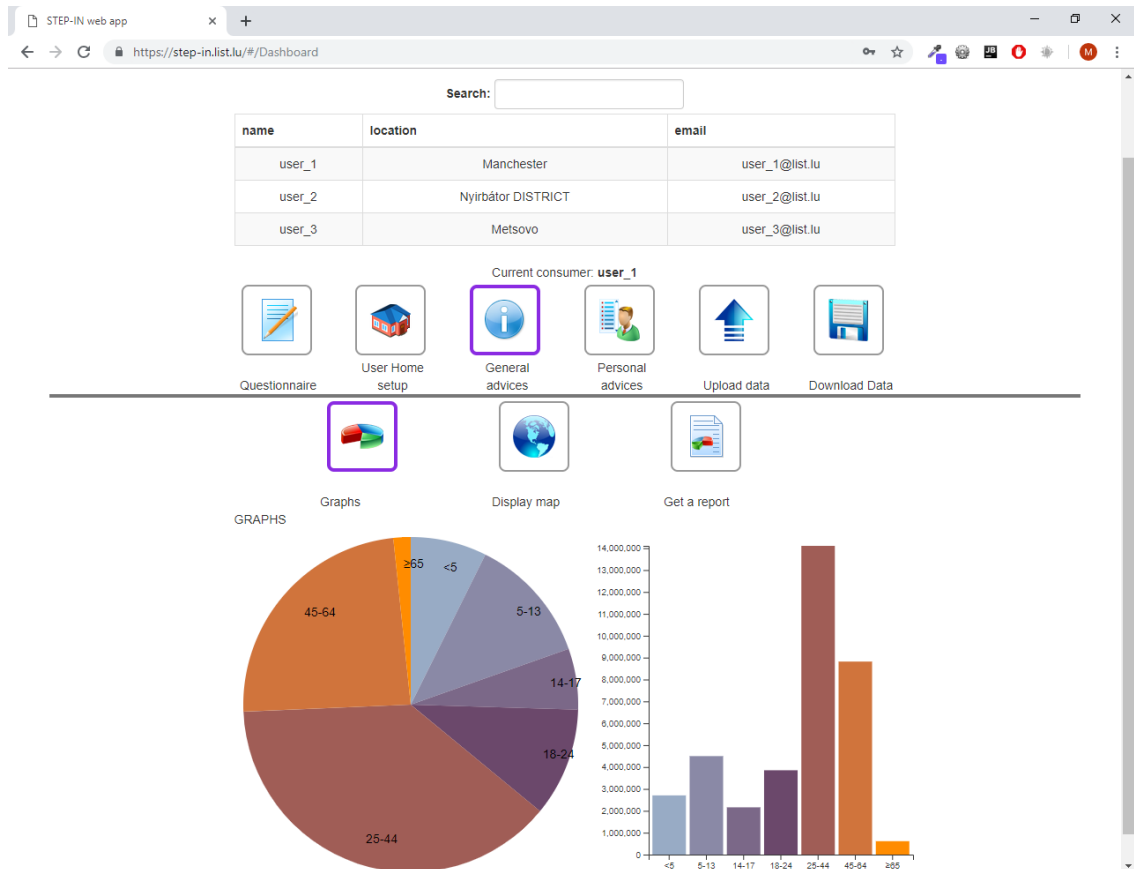
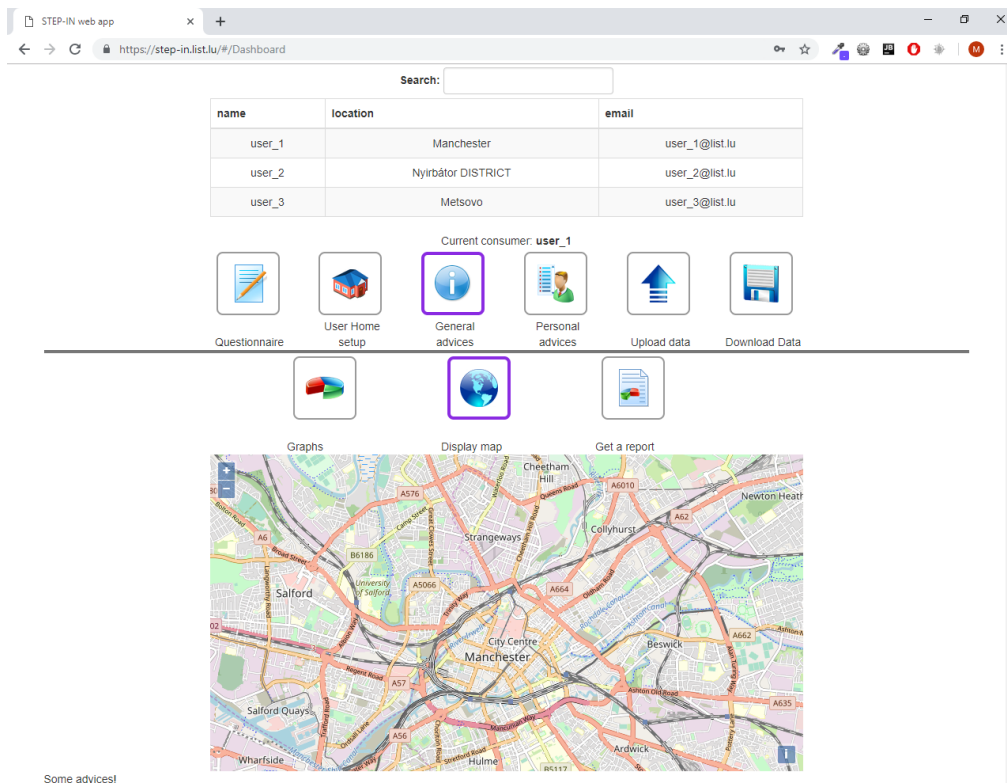*Figure 6 Implemented page for general advice (graph)*

Figure 7 Implemented page for general advice (map)

- Personal advice: This consists of advice for a specific user (customer). Here they can view a line chart based on their data and query it from a specific date to another specific date regarding a selected variable (see *Figure 8*). It is planned to add specific advice, a map, and pdf report here the same way it will be available for the general advice page.
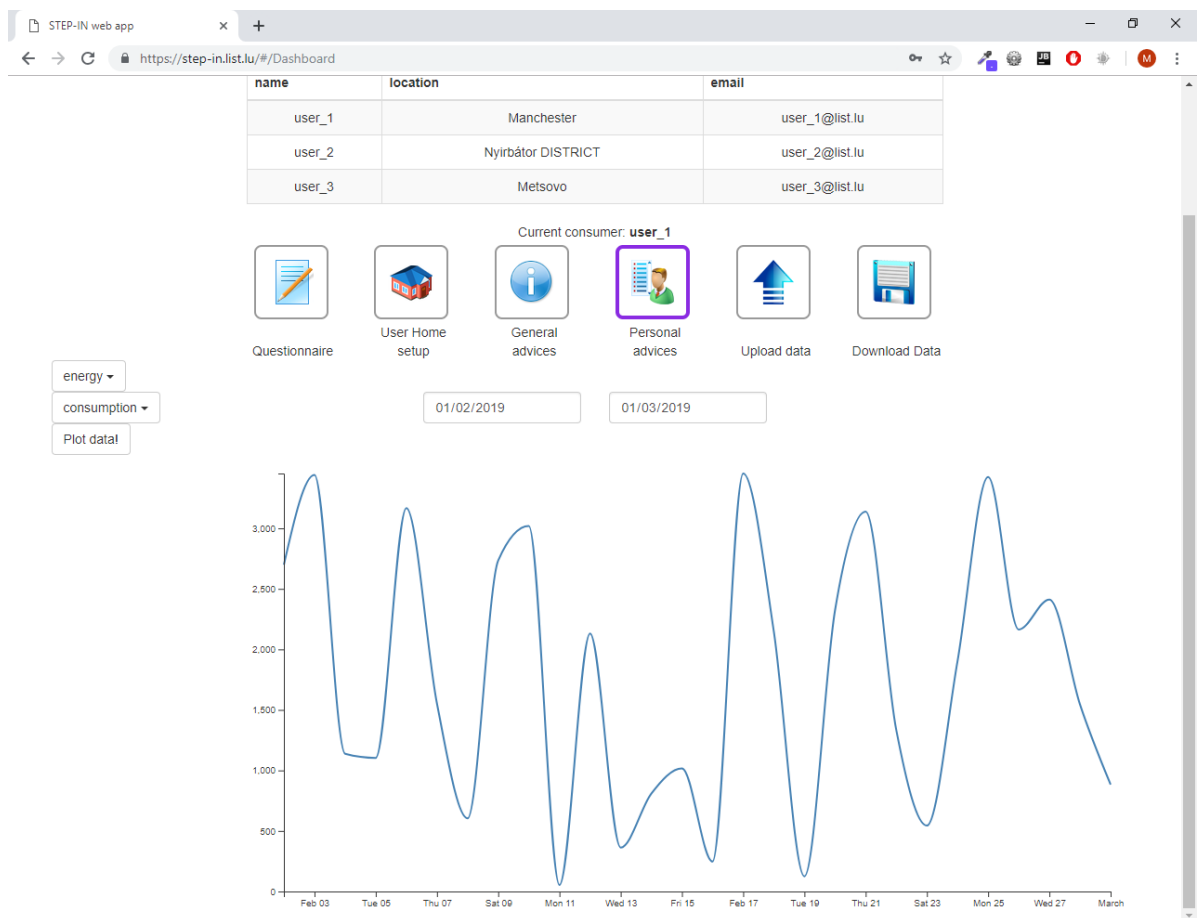

Figure 8 Current line chart displayed for specific consumer

Administration page

This is only accessible to admin and super admin level users. This page is used to set the user role and to assign questionnaires to users (see *Figure 9*)
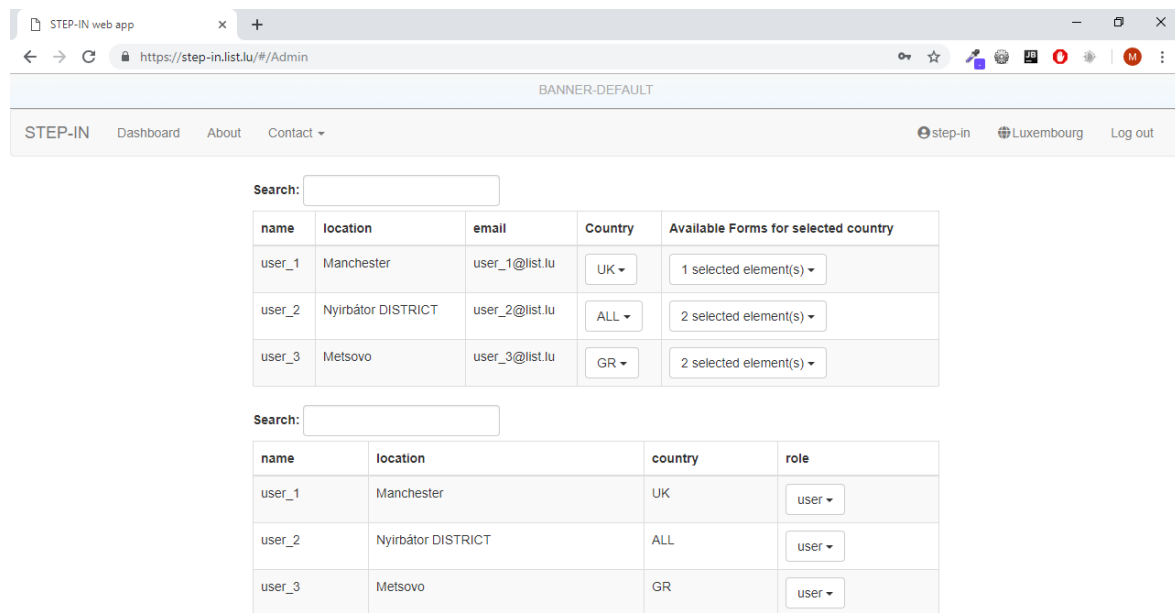
Figure 9 Administration page

2.3 Deployment

As indicated in D5.1, each Living Lab site (Metsovo, Manchester and Nyirbátor district) will install a local version of the platform, see *Figure 10* for a complete schema. Therefore, each Living lab will be responsible for their own data and the administration of their systems. Only anonymised and aggregated data (with no identifiable information) will be shared between living lab sites and LIST.
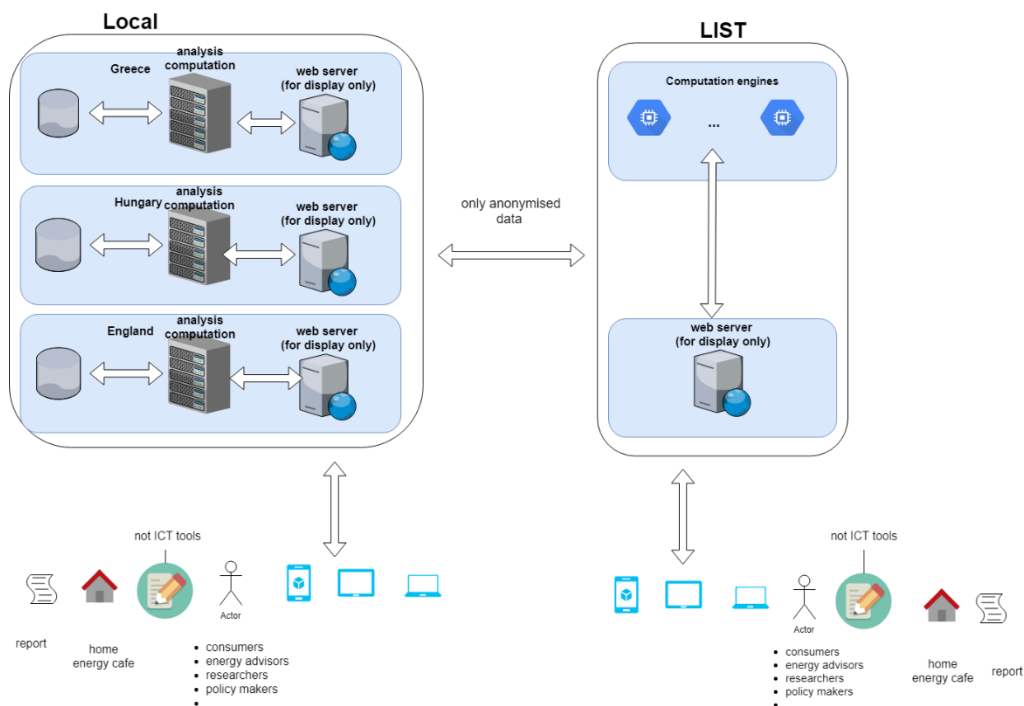

Figure 10 Schema of the deployment of ICT tools

2.4 Data protection

In order to preserve privacy and reduce the risk of any data protection policies being broken, each living lab will be responsible for the storage and use of the data at their location. Furthermore, no identifiable data will be exchanged either between living labs or with LIST. To further protect users, data will only be referred to using an ID, and not a name or similar piece of data. This should ensure that when data is exchanged it is not possible to identify who provided the data, also the table(s) storing any personalised information can be removed when the data is sent between locations.

More detail about ethics and data protection are available in D7.3 and D1.3[3].

2.5 Reuse of existing tools and methods

The platform reuses many existing elements from previous work from LIST. For instance, the credentials system, the general layout of the page, the map system and the libraries used for the prototype are the same that are used in the LIST developed iGuess platform. Compute engines used as a service are also implemented on the same basis as used in iGuess (they can be to compute layers). The only totally new feature that was requested by the living lab leaders was the development of the floor map section.

2.6 Next improvements

As written in this document, some aspects of the platform will be added during the lifetime of project these include:

- It is also planned to add further visualisations (simple graphs or combination of multiple ones) and reports about energy consumption. This will draw on existing tools developed at LIST.
- The map will display aggregated data (gathered during V1 of the Living Labs)
- We are exploring the potential of adding two factor authentication
- Discussions are ongoing about the selection of the underlying computation engine.
- A feedback section will be provided to allow all users to provide information about the platform.
- It is planned to add the general and personal advice part before the start of V2, the specific advice elements will be provided and suggested by each living lab

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[3] Both D1.3 and D7.3 are confidential reports.

3. Conclusions

This document has presented an overview of the ICT tools developed for version 1 of the STEP-IN living labs. For version 1 the ICT tools are designed to be used by the energy advisors and accessible to consumers for their personalised advice reports. As version 1 and future labs operate new features and improvements will be added based on feedback. The document outlined the core features along with issues relating to aspects such as data protection which ultimately influenced the deployment model. The approach leverages some existing tools and techniques and adds some new features. Furthermore, as it is web based it does not require the installation of an application and can run on any Internet enabled device with a suitably sized screen. A web-based approach avoids problems connected to installing or updating software. This potentially increases its uptake and use in STEP-IN and outside.

4. Bibliography

Nodejs documentation: https://nodejs.org/en/

Angularjs documentation: https://angularjs.org/

Related project website: https://edi-net.eu/en/home.html