Small or medium-scale focused research project (STREP)

Energy Demand-Aware Open Services for Smart Grid Intelligent Automation

SmartHG

EU FP7 Project #317761

Deliverable D7.2.2
SmartHG Project Web-Site

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Consortium

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Panoramic Power	PANPOW	Israel
Solintel	SOLINTEL	Spain
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Objective	**ICT-2011.6.1** *Smart Energy Grids*
Target Outcome	**d**) Home energy controlling hubs that will collect real-time or near real-time data on energy consumption data from smart household appliances and enable intelligent automation.

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Contents

List of Acronyms

DB&A Database and Analytics

DSO Distribution System Operator

EDN Electric Distribution Network

GNU General Public License

TS Technical Section

Executive Summary

For the first two years of SmartHG, the website was designed as a repository to keep project information, newsletters, and related publications. The website look was as clean and simple as shown in Fig. A.

The technical section only contained experimental and economic evaluation information concerning all SmartHG services but showed no information on the hardware deployed in SmartHG testbeds.

Moreover, the SmartHG project was introduced to social media such as Facebook and Twitter but it was not catching the social attention it could earn. Finally, SmartHG test-beds, deployed hardware and technology benefits were not illustrated in a way suitable for the general audience.

Figure A: 1st (left) and 2nd (right) Year Website Home Page

Figure B: New Website Home Page

Our goal with new and completely redesigned SmartHG website (Fig. B) is to provide our visitors (energy distributors, retailers, residential users or simple onlookers) with an easier way to learn about SmartHG aims, services, and benefits. Besides an improvement in the integration with social media (Facebook, Twitter, and Linkedin) the site contains an initial animation showing the idea behind SmartHG services. This introductory movie tells a story to the general audience, showing the differences in energy usage and costs between a quarter without SmartHG technology and one equipped with our technology. This story should attract more visitors and convince them that it is worth investigating on the whole website and on project results.

Amongst the new features and improvements in the website general section both in graphics and structure (Chapt. 1), the site contains also a revised and easy-to-use technical section expressing useful information on data directly gathered from SmartHG test-beds, by means of SmartHG facilities (Chapt. 2). Security and privacy issues have been duly taken into account in selecting the project data that can be made public through the project website.

More than that, the new technical section shows an attractive showcase exposing all information on the hardware (sensors, gateways, ...) deployed in SmartHG test-beds.

Chapter 1

General Section of SmartHG Project Website

The SmartHG website is aimed at a widespread dissemination of the project, consortium, objectives, expected impacts and main achieved results, when publishable.

The current SmartHG website has been realized in WordPress (`https://wordpress.com`) platform. Similar to Joomla (`https://www.joomla.org/`) used in the previous version, WordPress is a free software package that allows easy publishing, managing and organizing of a wide variety of contents on a website. WordPress software is sustained by the following peculiarities as well:

- It provides flexibility, scalability and simplicity for the website construction, content generation, general maintenance and upgrades;
- It offers a user-friendly interface to navigate;
- Documentation, and a community of developers provide technical support;
- It is an open source solution (General Public License (GNU)), therefore it is free.

Furthermore, WordPress is used by more users and web platforms, it offers more plugins, some of which are considered as essential in current version.

Different from the last version, the current website is more user friendly, user oriented and interactive. Menus are reorganized and grouped in a proper way; more graphic icons are inserted making the new website more attractive and easy understanding.

Besides the default home page, the main menu of the website contains the following bookmarks: SmartHG Overview, Project, Consortium, Benefits, Technical Section, News & Events, Downloads, Networking, Newsletter, and Contact (see Figure 1.1). Short description of the functionality of these bookmarks will be given in the following sections.

1.1 Home page

Figure 1.2 shows the latest design of the Home Page of the SmartHG project website.

It is composed of 3 main parts:

1. **Animation of SmartHG Project**.

   It is a responsive animation made with 3D drawings. After loading the website, the animation will be started automatically showing the general ideas of SmartHG

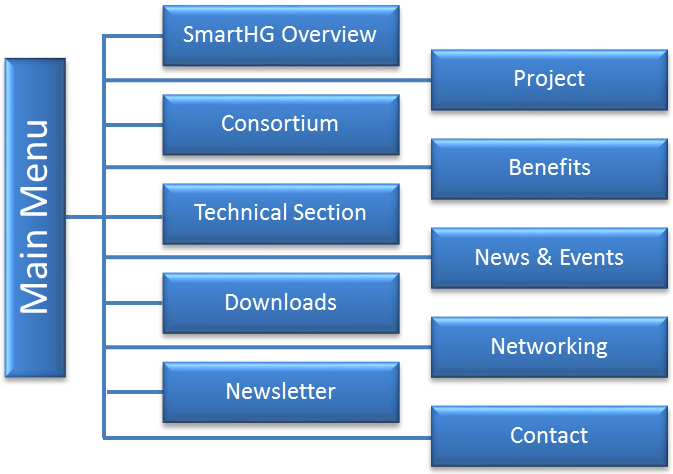


Figure 1.1: Bookmarks of the website

project and benefits for Distribution System Operators (DSOs) in a dynamic way. The main goal of such animation is not to show all the achieved scientific results and benefits to the user, which is too complex for the first visit, but to give a first impression and core ideas of the project.

In current animation, two districts are presented: SmartHG District on the left side, where SmartHG technologies are applied in houses, power grid and the DSO, and Normal District on the right side, where no smart technologies are used. In each side, there is a load curve, which shows the total consumption of the substation of each district.

Figure 1.3 shows a frame of both districts at 3:00 at night, at such hour, both loads are in the valley position as shown in the curves, since there are no user activities in homes and only few consumptions, but looking into the details of each district, the substation of the left side are working with more loads and the electrical load of the houses to the grid are also higher than the right side, thanks to the SmartHG technology, at such hours, batteries of each house and electrical vehicles are making use of the cheap electricity, batteries are being charged and some appliances, such as the washing machines are working. In this way, direct benefits are expected for the left side, such as the consumption are shift to the off-peak hour, energy bill is reduced, substation load is balanced etc. while on the right side, maybe cheap electricity is wasted due to the small amount of consumption and the cost for DSO could be higher.

Figure 1.4 shows a frame of both districts at 21:00 at night, at such hour, both loads are in the peak position as indicated in the curves, more in-house activities are shown and thus causing higher loads to the grid. Looking into the details of each district, the substation of the left side are working with less stress and is still in green status, while the substation of the right side are overloaded and has passed the safety limit, houses on the left side have caused less stress to the grid and the load bars are not full, while on the right side, all the houses are in red status demanding more electricity from the grid. The easy status of the left side is due to the use of SmartHG technology, batteries are discharging and providing electricity to the appliances, bearing a certain stress for the substation, some appliances (i.e. the washing machine) are off, note that the electricity tariff at such peak hour is

Figure 1.2: Home page of SmartHG Website

Figure 1.3: Animation at 3 o'clock at night

high, but the electricity from the battery is obtained from the valley hour, thus the SmartHG houses are spending less money on their power consumption, while the DSO is happy with the balanced load and less cost and maintenance problem. All things are changed for the right side, the electrical vehicle is charging and the peak loads from each house cause higher stress to the substation, and all the cost are higher compared to the left side as well.

Figure 1.4: Animation at 9 o'clock at night

There are more frames showing the different status of the substation, electricity load of each house, status of charge of the batteries and appliances. By visualizing this animation, it is expected to perceive a certain understanding of the project ideas in an easy way.

2. **Main entries of the website**.

   There are three main direct entries (see Figure 1.5) to the following three parts of the website: Technical section, Benefits and Downloads.

Figure 1.5: Main direct entries

The main purpose of having these three main entries is not only for the esthetical design of the web page, but also to give more emphasis on these three sections and to catch more users' attention. For the benefits section, the icon (Figure 1.6) here is designed to show directly the most important benefits that SmartHG can provide, which cover benefits for the DSO, Grid, environment, and residential users. By clicking the "More info" button, users will be directed to the corresponding webpage with detailed descriptions.

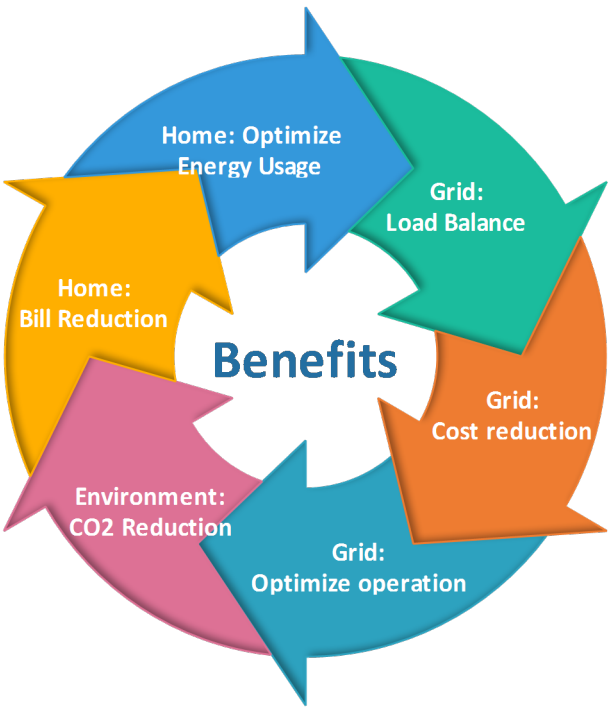


Figure 1.6: SmartHG benefits

3. **SmartHG Project Overview and tweets**.

   The main goals of the project are summarized in a way to be interesting and easy understanding for the wide public, which are clear and simple. The high level

methodology used in the project is also presented in such section with technical description and graphic, more details about the platform can be visualized in the page SmartHG Overview. On the right side, latest tweets are also listed, visitors can easily click in to check more details and follow our tweets. Figure 1.7 shows the detail of the part 3 of the home page.

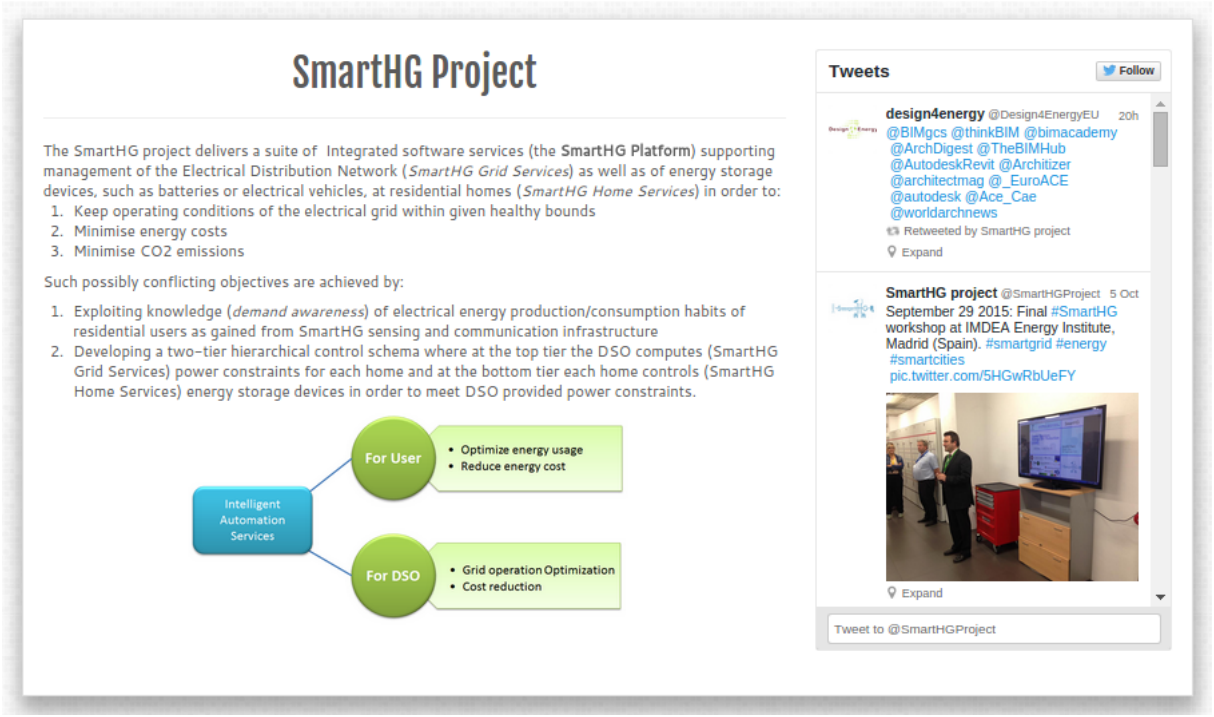


Figure 1.7: SmartHG Project Overview and tweets

1.2 General page structure

In current web design, the layout of the general section of website is further simplified aiming to show directly the key messages and facilitate the operation to the users, all the menus are grouped and positioned in the top area, so that the visitors can easily find all information in which they may be interested.

The general structure of the webpages is made up of the following parts (see Figure 1.8):

1. Top area (header):
   - Project logo;
   - Acronym and full name of the project;
   - Links to SmartHG Twitter account, Facebook and Linkedin page;
   - Pull-Down Main Menus with foldable effect as shown in Figure 1.9.
2. Central area: the main content of the current page of the website. Depending on the webpage that the visitor enters, the content could be different, for instance, for a higher level of webpage (i.e. Downloads page), more buttons or icons are provided for further selection instead of direct downloads.

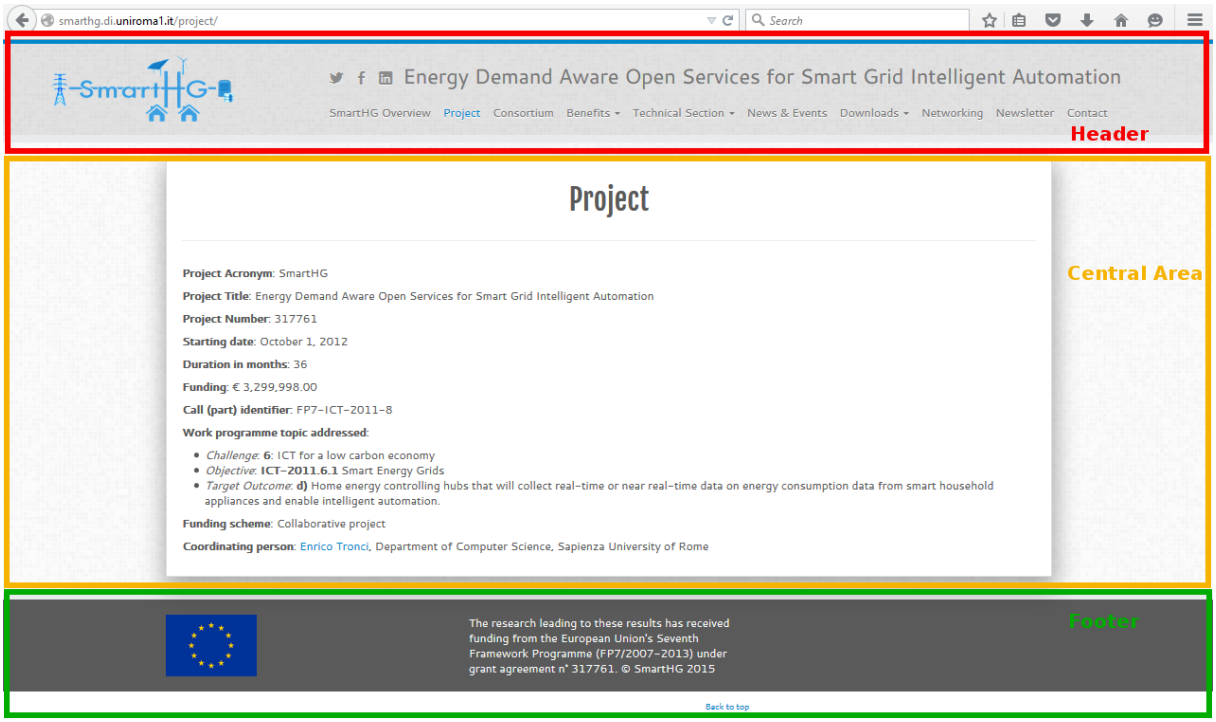


Figure 1.8: General webpage structure

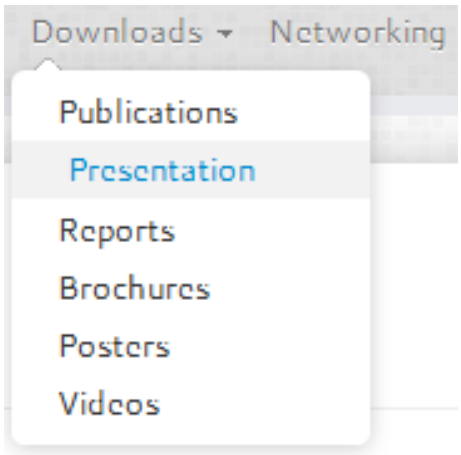


Figure 1.9: Foldable menu

3. Bottom area (footer):
   - European Union flag;
   - Acknowledge to SmartHG funding;
   - Back to Top link.

1.3 Responsive display

In current version, the web page are designed as responsive, depending on the device used or the navigator's size, the organization of the content could be different aiming to facilitate the most comfortable visualization and operation for the visitors.

For instance, for full window navigation in a PC, the top menu could look like Figure 1.10.

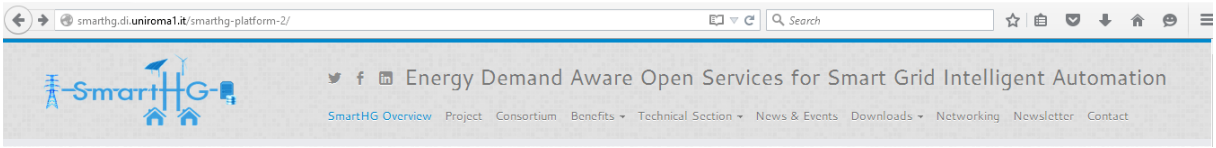


Figure 1.10: Normal menu

When the visitor is scrolling down and checking detail contents, the main menu could be pull-up and the logo's size will be reduced leaving more spaces for the central area, which looks like Figure 1.11.

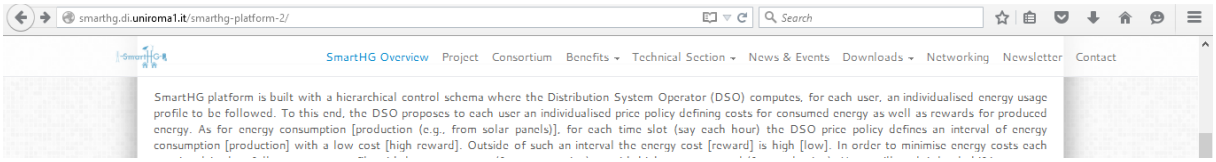


Figure 1.11: Menu with reduced size

When the visitor is visiting through mobile device or with reduce window size, the webpage could looks like Figure 1.12, and by clicking the menu button  , a full menu list will be shown as Figure 1.13.

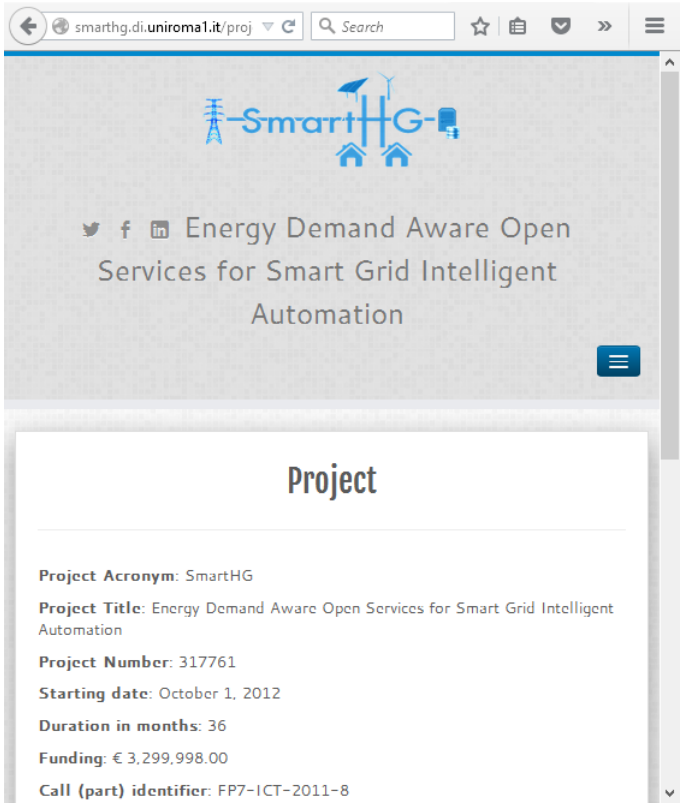


Figure 1.12: Navigating with reduced window size or mobile device

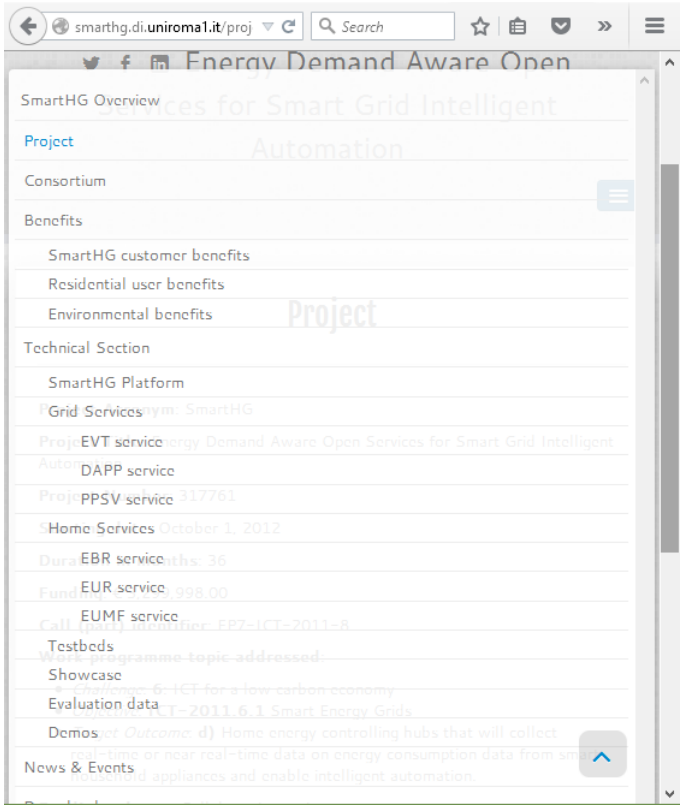


Figure 1.13: Menu shown in a list style

1.4 SmartHG Overview

The "SmartHG Overview" page aim at providing a general description of SmartHG project ideas, key components, control schema and simplified structure. By visualizing this section, it is expected that the visitor could gain basic understanding of the entire project and have the first vision on the Intelligent Automation Services and impression of how different components are connected with the help of pictures inserted.

This webpage is designed as Figure 1.14.

1.5 Project

The "Project" page aims at describing key information of the project, including the project funding, start/end time, call identifier, coordinators etc. A screenshot of the page is reported in Figure 1.15.

1.6 Consortium

Figure 1.16 shows the "Consortium" page, where the SmartHG partners are presented. By clicking the logo of a partner, a brief introduction and contact information of the selected organisation will be shown, which include the project partner description, web link and logo.

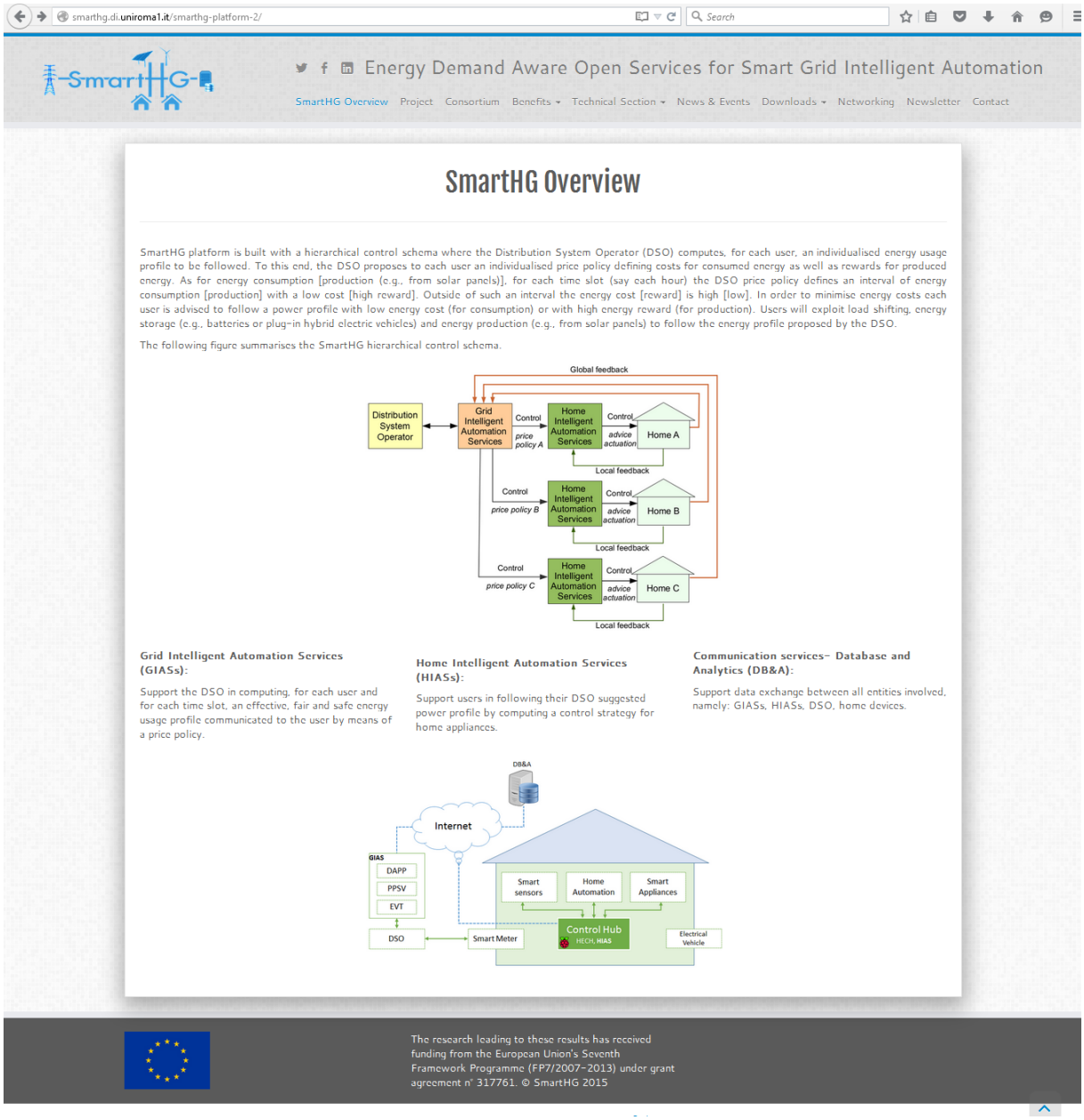


Figure 1.14: SmartHG Overview page

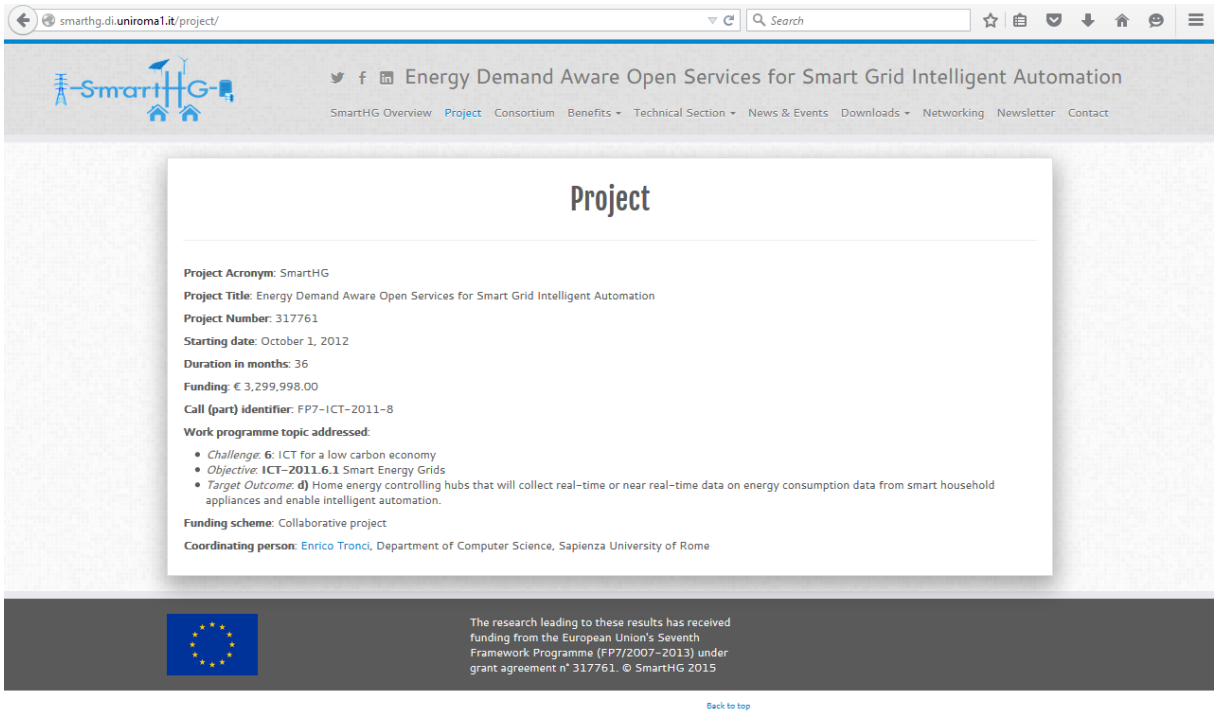


Figure 1.15: Project page

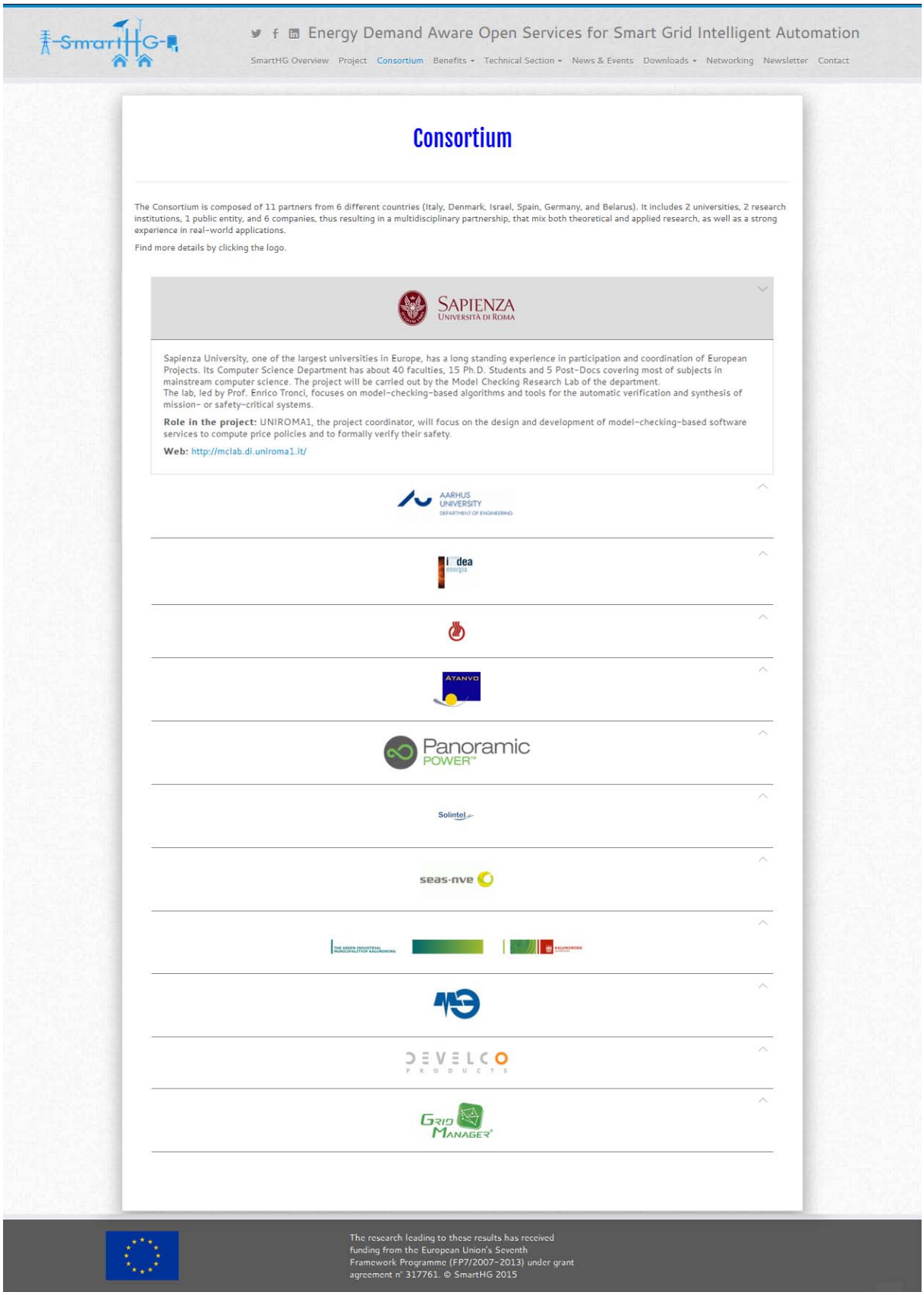


Figure 1.16: Consortium page

1.7 Benefits

Figure 1.17 shows the "Benefits" page, which is accessible from the direct entry on Home Page and categorized in three types: Customer benefits, Residential user benefits, and Environmental benefits. It is important to know that in SmartHG project, the DSOs are defined as end users and targeted customers strategically. Having a glance at the icons for each category, visitors can also get to know the key message of each one, depending on their personal interests, they can choose to get more details, by clicking on the "More info" button, visitors will be redirect to the corresponding page (i.e. Figure 1.18) and more detail descriptions of the benefits will be presented.

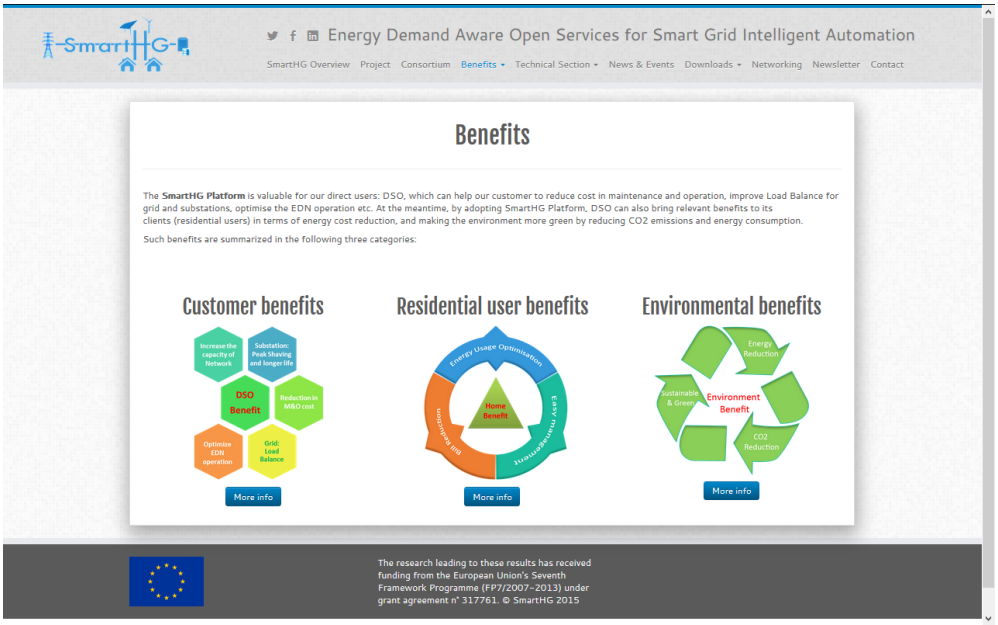


Figure 1.17: Benefits page

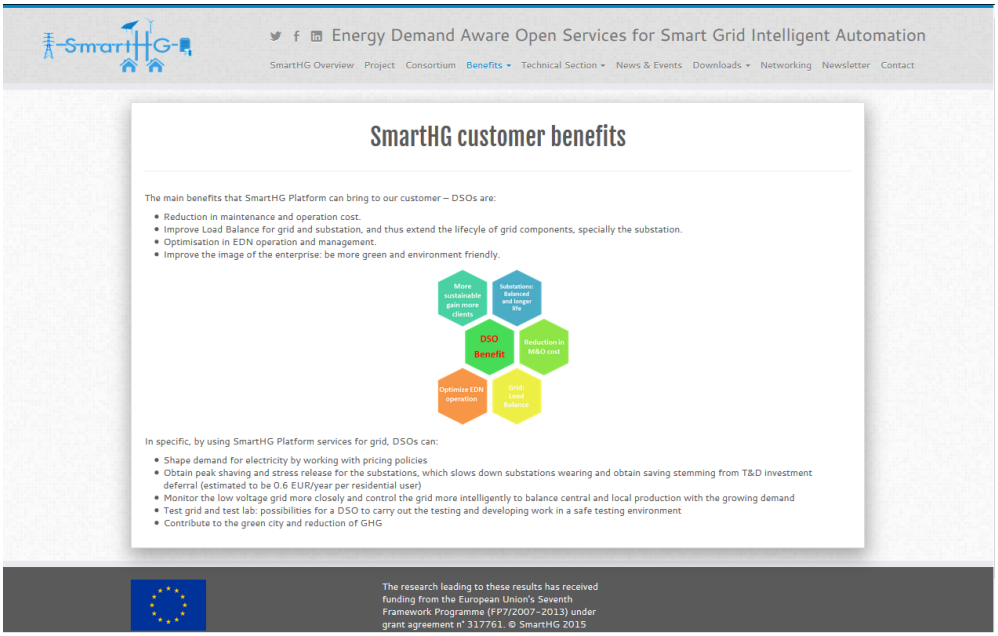


Figure 1.18: Customer benefits

1.8 Technical Section

Figure 1.19 shows the "Technical Section" page, which is accessible from the direct entry on Home Page as well and is categorized in five types:

- SmartHG Platform
- Platform: Grid Services
- Platform: Home Services
- Testbeds Data Analytics
- Showcase: Deployed Hardware & User Monitoring & External Data

Similar to the "Benefits" page, user can go into more detail of each category. More details regarding such page are available in Chapter 2

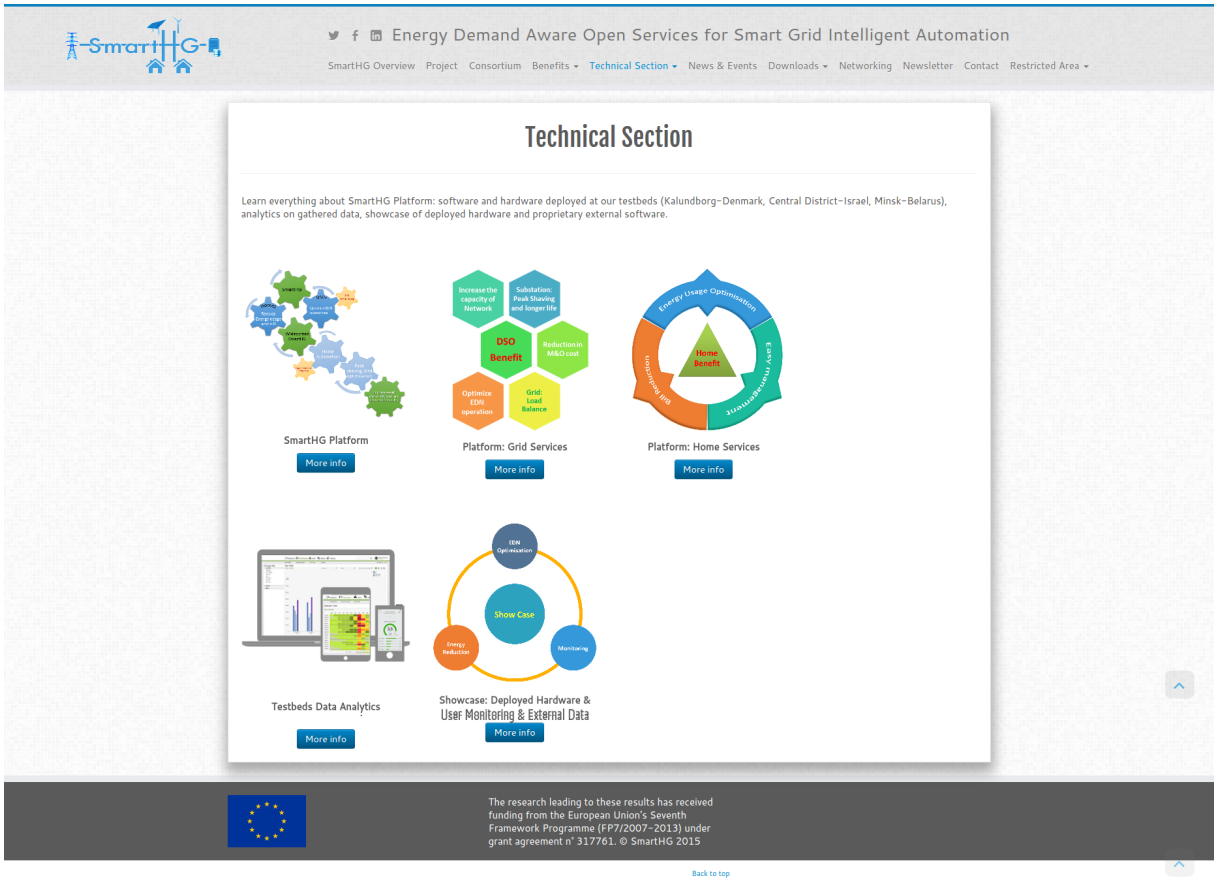


Figure 1.19: Technical Section page

1.9 News & Events

Figure 1.20 shows the "News & Events" page, where information on relevant upcoming or past events of interest for the project (both within the consortium and outside) is reported. This page is continuously updated with the support and inputs of the whole consortium. Latest event is allocated in the first position, passing mouse on the event, detail information will be shown in a pop-up window (Figure 1.21) or by clicking the event title. Visitors can also check the past events in a calendar view by clicking the Agenda button (Figure 1.22).

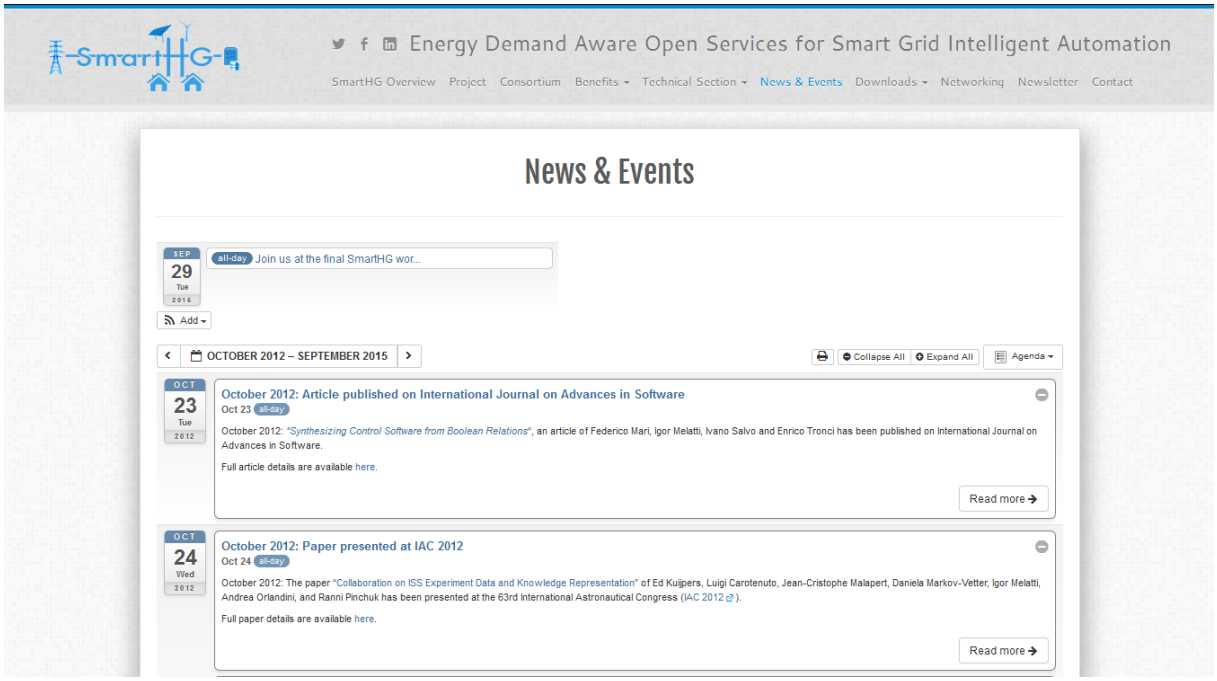


Figure 1.20: News & Events page

Figure 1.21: Latest event

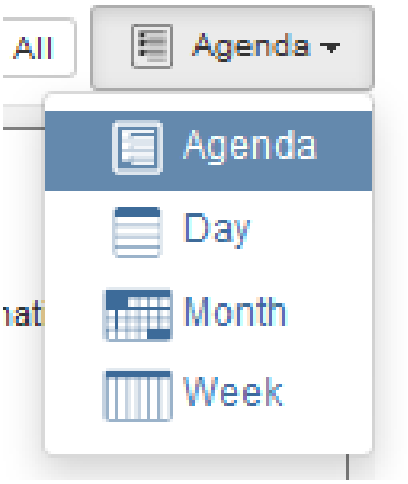


Figure 1.22: View in Agenda mode

1.10 Downloads

"Downloads" section (see Figure 1.23) collects all documents that may be of interest for the public audience, to disseminate the SmartHG project results and objectives. These documents include brochures, posters, presentations, papers, presentations, public deliverables and every other document which may be disseminated outside the consortium. The page includes 6 different categories corresponding to the different document types:

- Publications
- Presentations
- Reports
- Brochures
- Posters
- Video

By clicking on the category, the user will able to visualize and download the selected documents. For the publications (see Figure 1.24), a database is built to provide organized and downloadable publications (see Figure 1.25); visitors can search and download the interested papers in an easy way.

1.11 Networking

In the subpage "Networking" (see Figure 1.26), links and logos of related research projects are provided and categorized into "Networking and cooperation" and "Other project and activities related to SmartHG project".

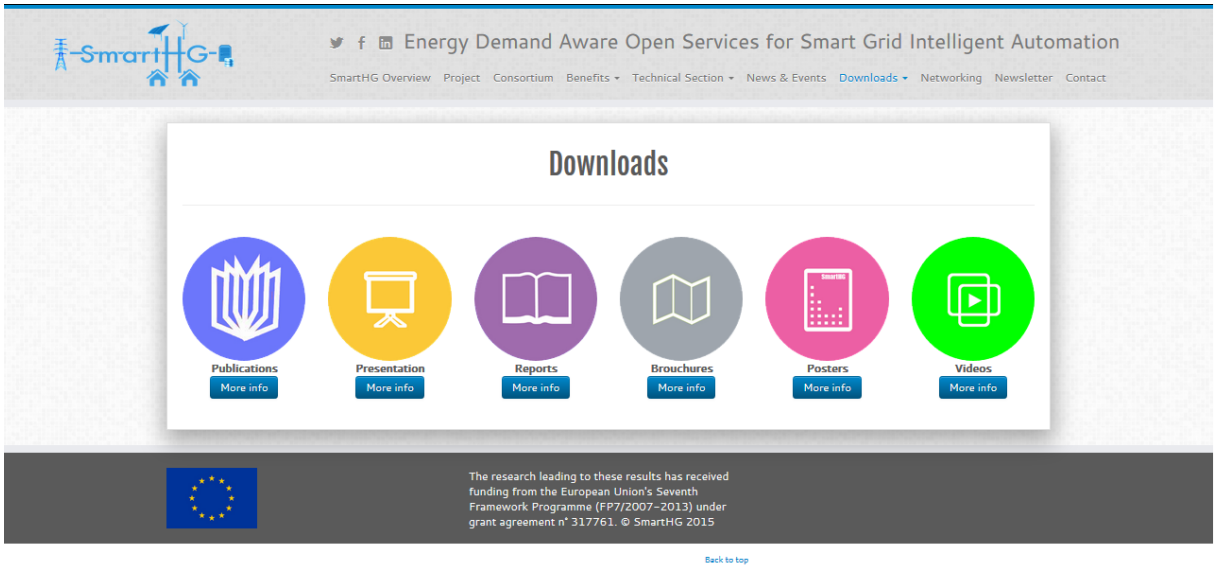


Figure 1.23: Downloads page

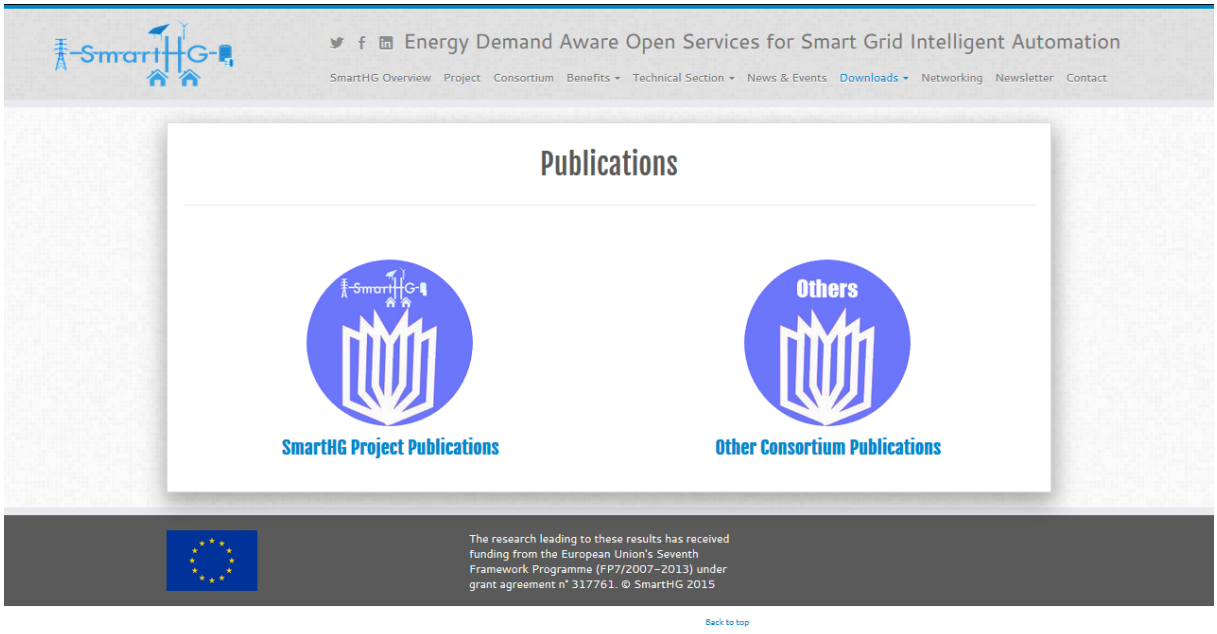


Figure 1.24: Publications page

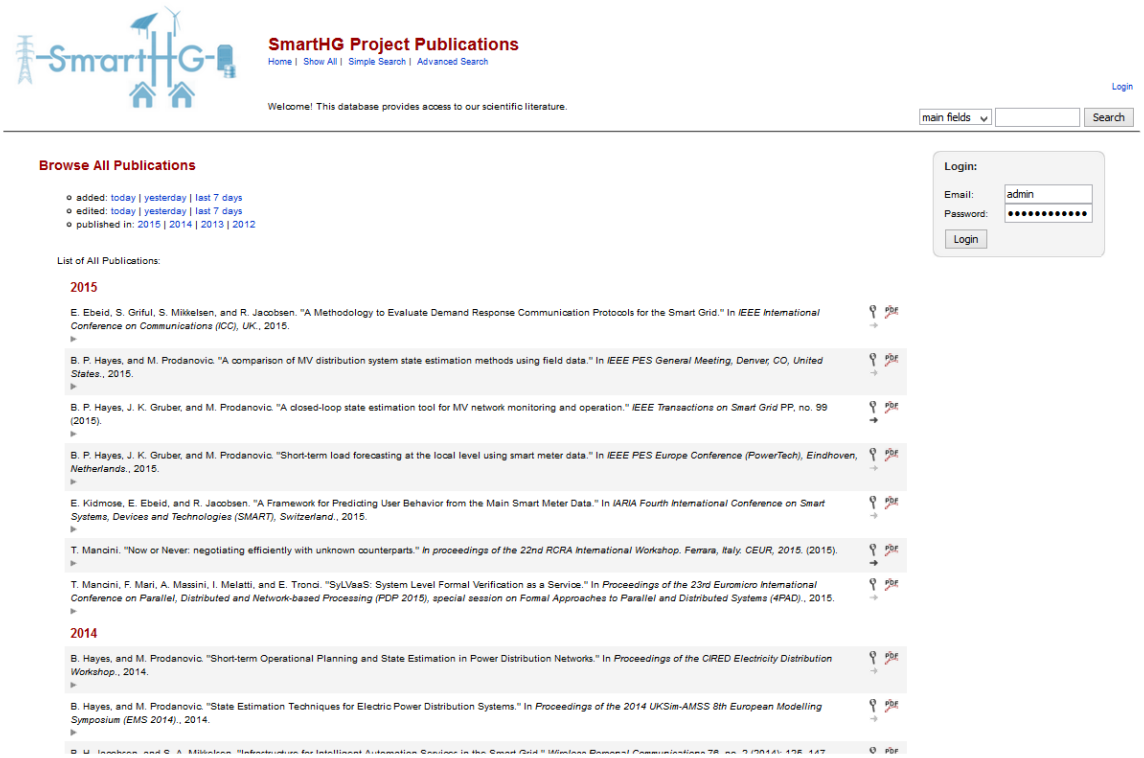


Figure 1.25: Publications database

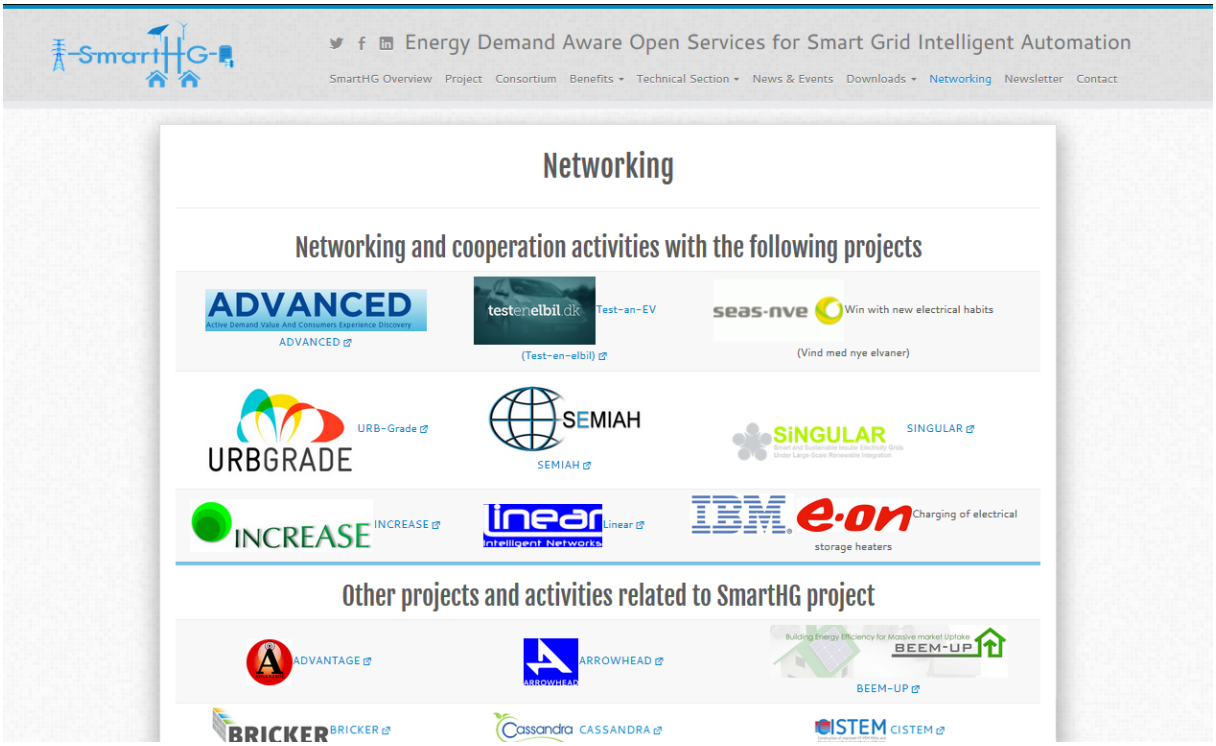


Figure 1.26: Networking page

1.12 Newsletter

Figure 1.27 shows the page with all SmartHG Project Newsletter list. Any web visitor will able to subscribe the Newsletter by registering her own email address. A plugin is used to collect and manage the registered users and newsletters. After creating a new newsletter, the system is able to send the latest newsletter to the registered user in HTML format, and users can easily click to check more detail with the email received and keep informed about the project updates and results.

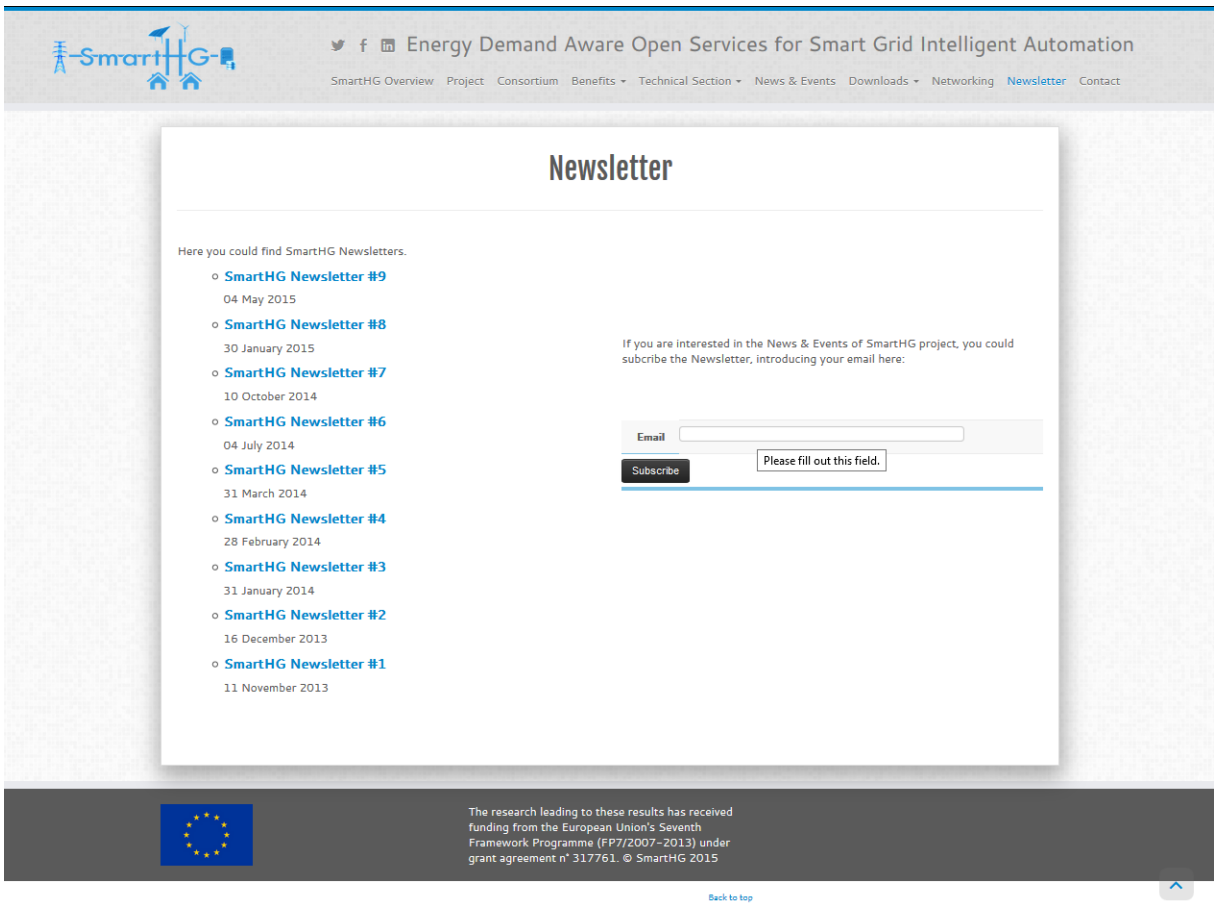


Figure 1.27: Newsletter page

1.13 Contact

The "Contact" page (see Figure 1.28) provides contact details of the project coordinator (phone number and email), through which more information on the project may be retrieved. User also can fill the prepared form in the webpage to send inquiry directly to the web manager; the project web manager will firstly try to solve the inquiry before forwarding the request to the Project Coordinator.

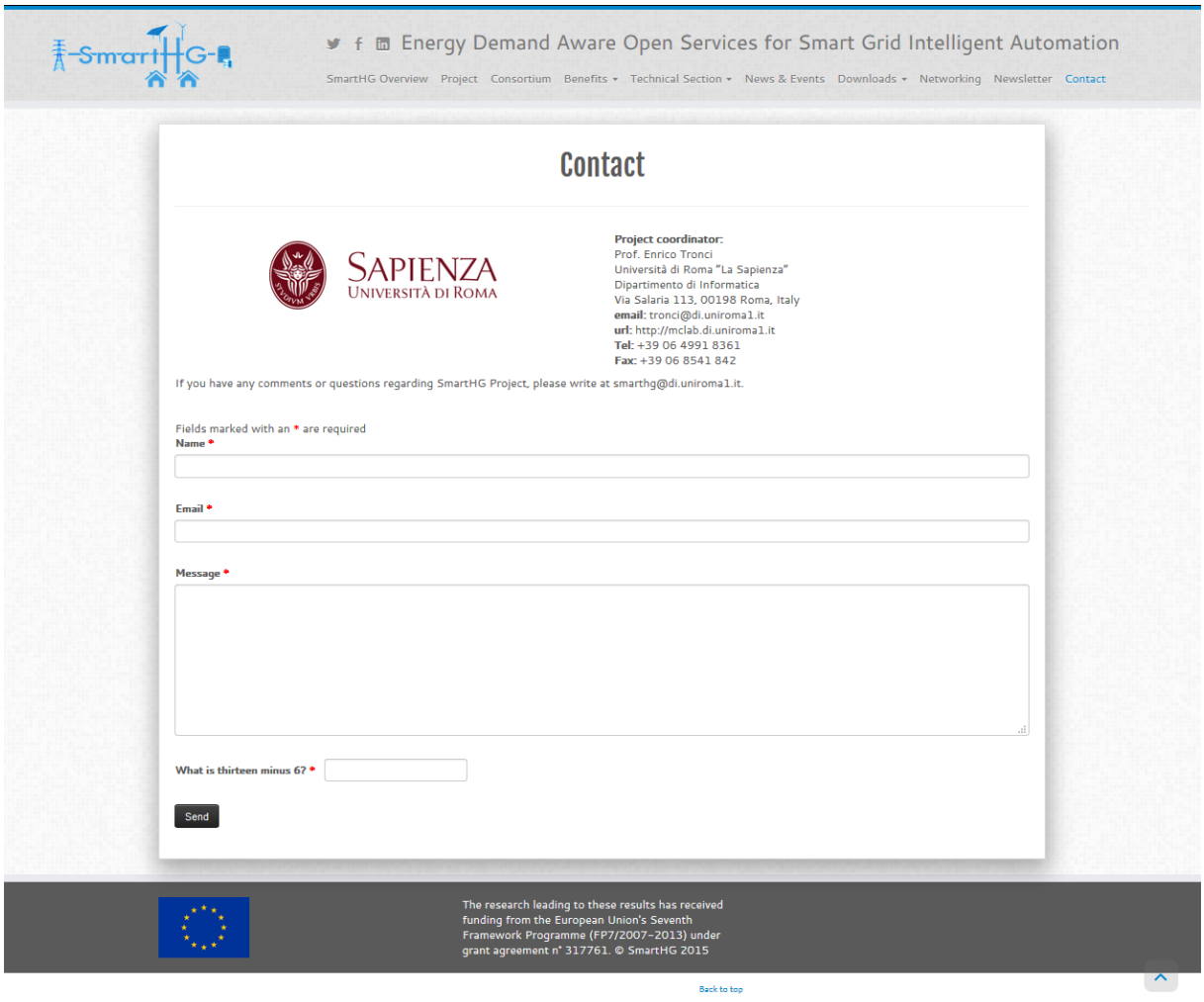


Figure 1.28: Contact page

Chapter 2

Technical Section of SmartHG Project Website

The SmartHG Technical Section (TS) is a web application hosted in the website and showing the data gathered from the project test-beds (Sects. 2.1 and 2.2), in different languages (Sect. 2.5), as well as data showing environmental and economic benefits of the technology developed within the project (Sect. 2.3). Of course, security issues (such as privacy, etc.) are duly taken into account in selecting the project data that can be made public through the website (Sect. 2.4).

2.1 Test-beds

Data from two test-beds are exposed, namely, Kalundborg and Central District. Both historical data (i.e., prior to SmartHG sensors deployment) and data collected by sensors deployed within the project are shown. For the sake of efficiency, instead on continuously querying the SmartHG Database and Analytics (DB&A) service, the TS interacts with an internal database containing historical as well as real-time data gathered from test-beds. Such data are up-to-date and will be synchronized until the end of the project.

Before the end of the project also data from Minsk test-bed will be considered.

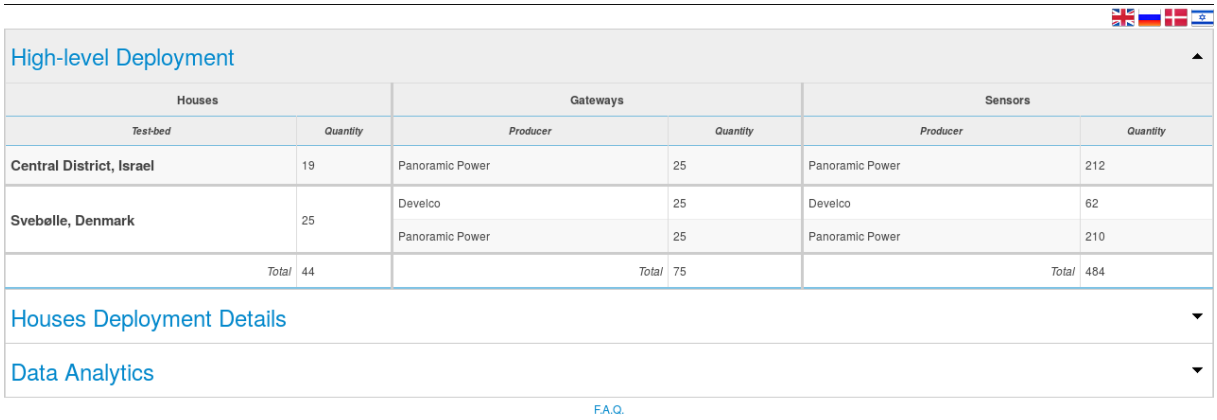
2.2 Aggregations on data

Besides showing raw measurements, the TS shows also several aggregations on them. The system follows a hierarchical approach, starting from the most general aggregations (test-beds level) slowly moving downwards to single residential users profiles.

Before describing TS functionalities, we remind the reader some definitions. The *demand* of a residential user u in a time-slot t, is what is sensed at time t on u's main meter. Given a substation s, the *aggregated demand* is the sum of demands of all single users connected to s, the *average demand* is the average on demands of all single users connected to s.

In what follows we describe all functionalities supplied by the SmartHG TS, in a top-down hierarchical way.

1. **A very high-level view on SmartHG deployment.** Namely, we show a table (Fig. 2.1) where for each testbed there is a row with number of monitored houses and of hardware units deployed (gateways, meters, sensors).



High-level Deployment

Houses		Gateways		Sensors	
Test-bed	*Quantity*	*Producer*	*Quantity*	*Producer*	*Quantity*
Central District, Israel	19	Panoramic Power	25	Panoramic Power	212
Svebølle, Denmark	25	Develco	25	Develco	62
		Panoramic Power	25	Panoramic Power	210
Total	44	*Total*	75	*Total*	484

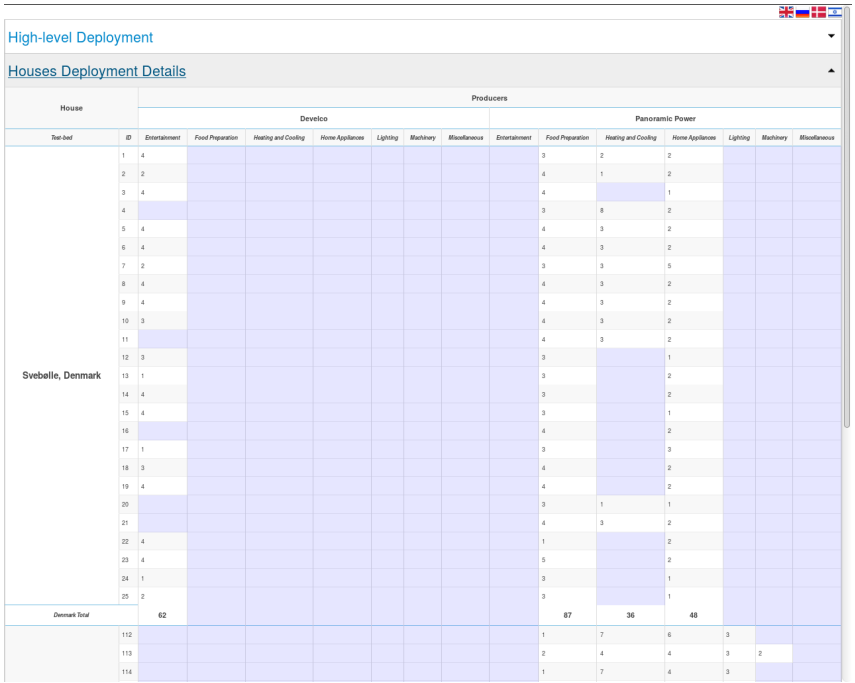
Houses Deployment Details

Data Analytics

F.A.Q.

Figure 2.1: High level view of SmartHG deployment (aggr. 1)

2. **A more in-depth view on SmartHG deployed hardware (Fig. 2.2).** Namely, we show a table where there is a row for each house with: number of gateways/bridges; number of sensors for each appliance type; number of temperature sensors.



High-level Deployment

Houses Deployment Details

House		Producers													
		Develco							Panoramic Power						
Test-bed	*ID*	*Entertainment*	*Food Preparation*	*Heating and Cooling*	*Home Appliances*	*Lighting*	*Machinery*	*Miscellaneous*	*Entertainment*	*Food Preparation*	*Heating and Cooling*	*Home Appliances*	*Lighting*	*Machinery*	*Miscellaneous*
Svebølle, Denmark	1	4								3	2	2			
	2	2								4	1	2			
	3	4								4		1			
	4									3	8	2			
	5	4								4	3	2			
	6	4								4	3	2			
	7	2								3	3	5			
	8	4								4	3	2			
	9	4								4	3	2			
	10	3								4	3	2			
	11									4	3	2			
	12	3								3		1			
	13	1								3		2			
	14	4								3		2			
	15	4								3		1			
	16									4		2			
	17	1								3		3			
	18	3								4		2			
	19	4								4		2			
	20									3	1	1			
	21									4	3	2			
	22	4								1		2			
	23	4								5		2			
	24	1								3		1			
	25	2								3		1			
Denmark Total		62								87	36	48			
	112									1	7	6	3		
	113									2	4	4	3	2	
	114									1	7	4	3		

Figure 2.2: Detailed view of SmartHG deployment (aggr. 2)

3. **Typical daily profile for a residential user and for the whole substation.** In particular, we show a plot with average avg ($\pm$ standard deviation), minimum and maximum profiles (demand) for all time-slots in a day. For example, $avg(0)$ shows the average of in time slot 0 of all days. This aggregation is available both at substation level (Fig. 2.3) in which case we consider aggregated demand, and at residential user level (Fig. 2.4).

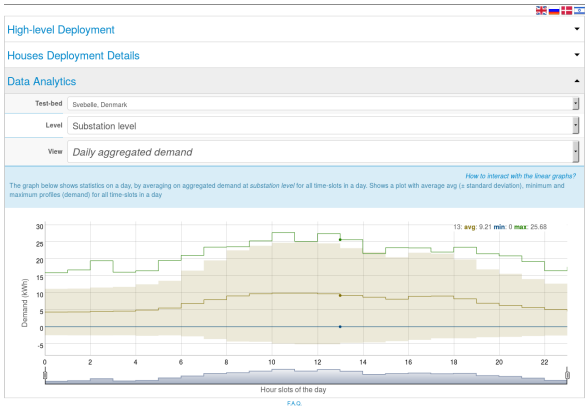


Figure 2.3: Statistics on one day of aggregated demand, at substation level (aggr. 3)

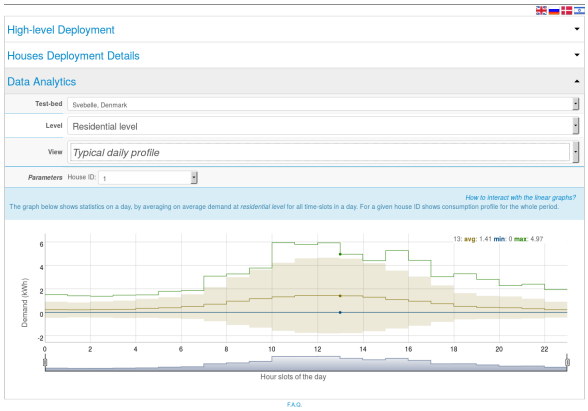


Figure 2.4: Statistics on one day of demand, at residential level (aggr. 3)

4. **Statistics on substation users consumption for the whole period (Fig. 2.5).** In particular we show a plot with average over all residential users connected to the substation (± standard deviation), minimum and maximum profile (demand) on the whole period.

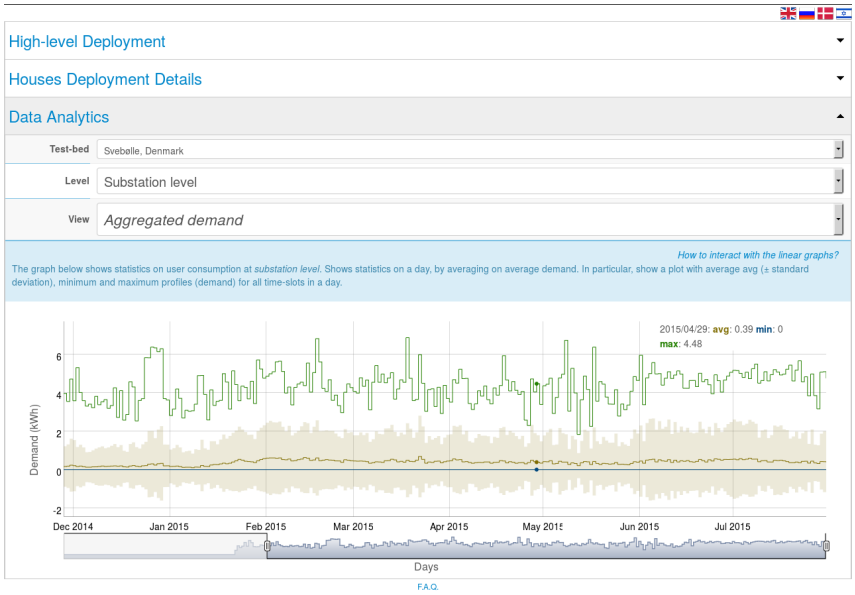


Figure 2.5: Statistics on substation users consumption for the whole period, aggr. 4

5. **Users distribution as for average daily demand** in the whole period (Fig. 2.6) and per month (Fig. 2.7). In particular, we show a plot f with the percentage of residential users for each possible value of average daily energy consumption (E). For the sake of simplicity, we split the range of consumption in classes. Figs. 2.6 and 2.7 show the case where we have 4 classes. In such a case, $f(3)$ is the percentage of residential users having E in the range $[0.28, 0.42)$ kWh.

6. **Distribution of consumptions among different kinds of appliances in the whole period.** This is shown by a pie graph where 100% corresponds to the overall consumption of all users in the whole period. This aggregation is available both at substation level (Fig. 2.8) and at residential user level (Fig. 2.9).

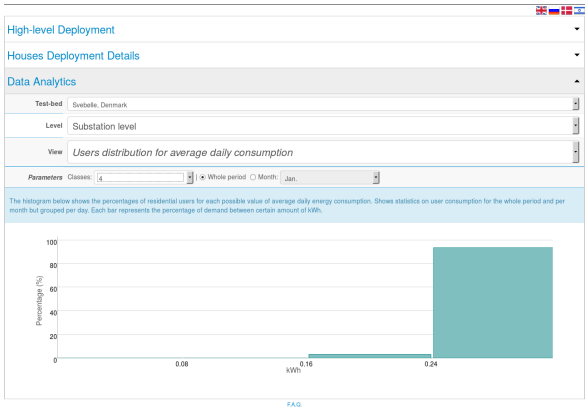


Figure 2.6: Users distribution as for average daily demand in the whole period, aggr. 5

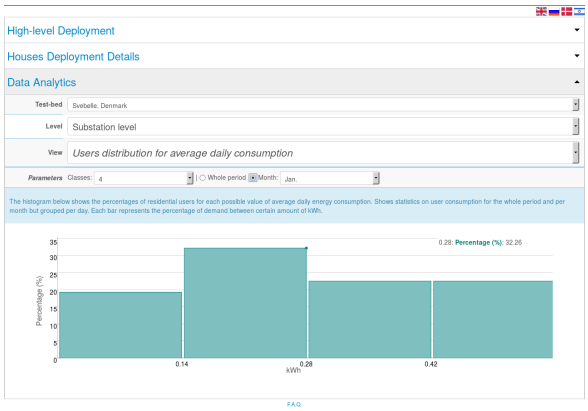


Figure 2.7: Users distribution as for average daily demand for month January, aggr. 5

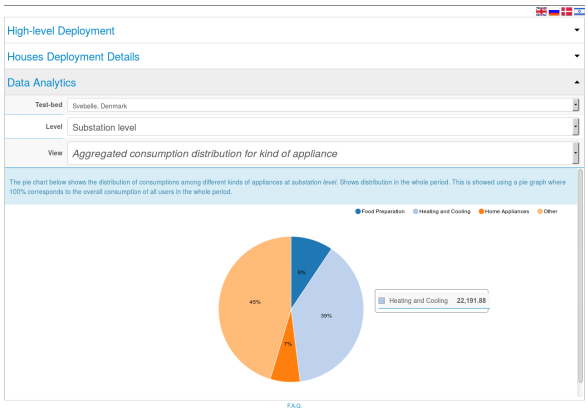


Figure 2.8: Distribution of consumptions among different kinds of appliances in the whole period at substation level, aggr. 6

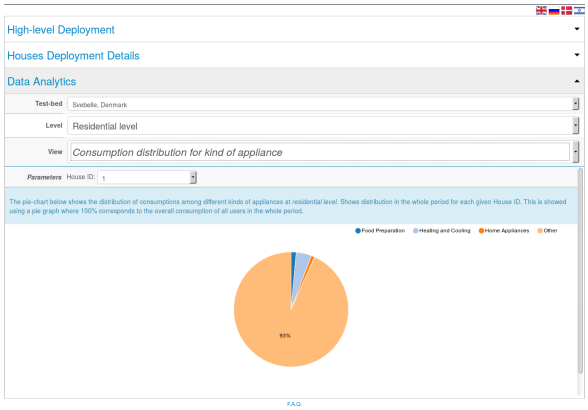


Figure 2.9: Distribution of consumptions among different kinds of appliances in the whole period at residential user level, aggr. 6

7. **Statistics on appliance types consumptions for the whole period (Fig. 2.10).** For each type of appliance (food preparation, heat pump, ...), we show a plot with average over residential users connected to the substation (± standard deviation), minimum and maximum profile (consumption) on the whole period.

8. **Anonymised users consumption profiles**, i.e. raw measurements without personal information (Fig. 2.11), also classified by appliance type (Fig. 2.12).

2.3 SmartHG platform benefits

The system supplies also data showing environmental and economic benefits of the technology developed within the project, namely Electric Distribution Network (EDN) operational cost reduction, energy bill reduction, and CO_2 emissions reduction.

This section of the TS will be further improved before the end of the project, by considering also results coming from the third year services evaluation.

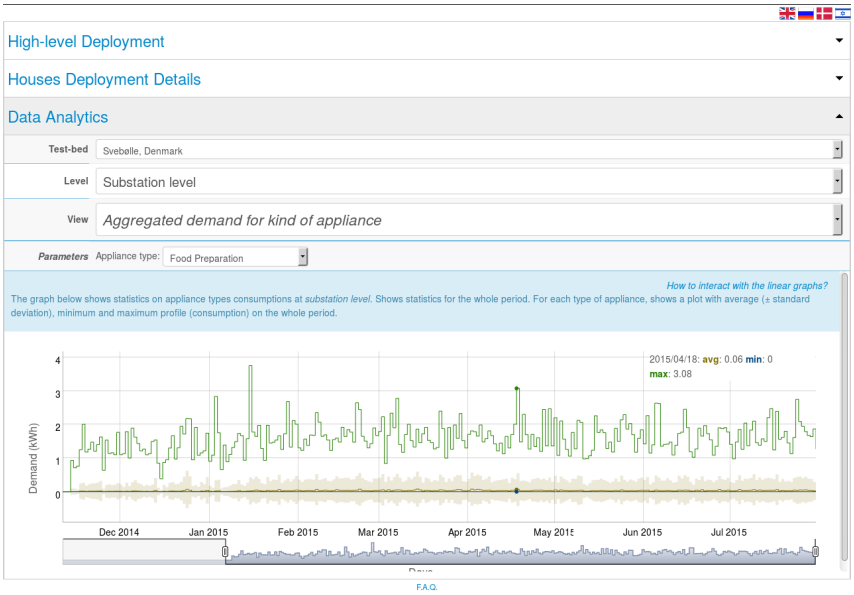


Figure 2.10: Statistics on appliance types consumptions for the whole period, aggr. 7

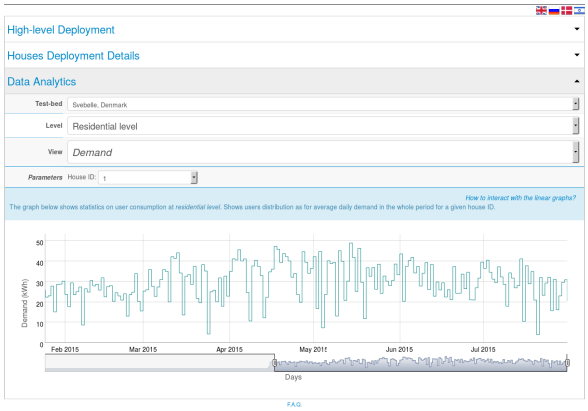


Figure 2.11: Anonymised users consumption profile for user #1 in Svebølle, aggr. 8

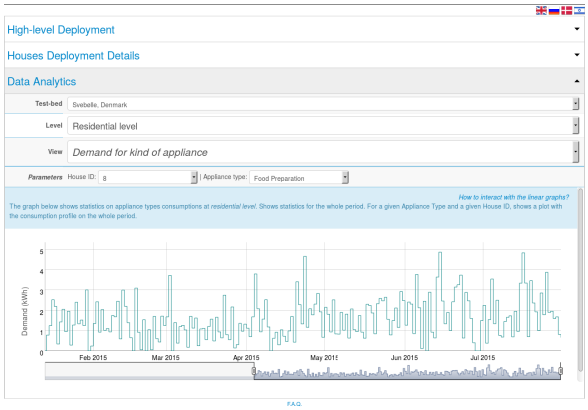


Figure 2.12: Anonymised users consumption profile for food preparation of user #1 in Svebølle, aggr. 8

2.4 Security issues

The TS keeps all residential users information private and anonymised, so data can be safely exposed to the general public.

2.5 Multi-language support

The system is designed to be eventually supplied in several languages, in particular: English, Danish, Russian, Hebrew.

Up to now we have only the English version. Other languages will be delivered before the submission of SmartHG final documentation.