EEPOS - Energy management and decision support systems for energy positive neighbourhoods

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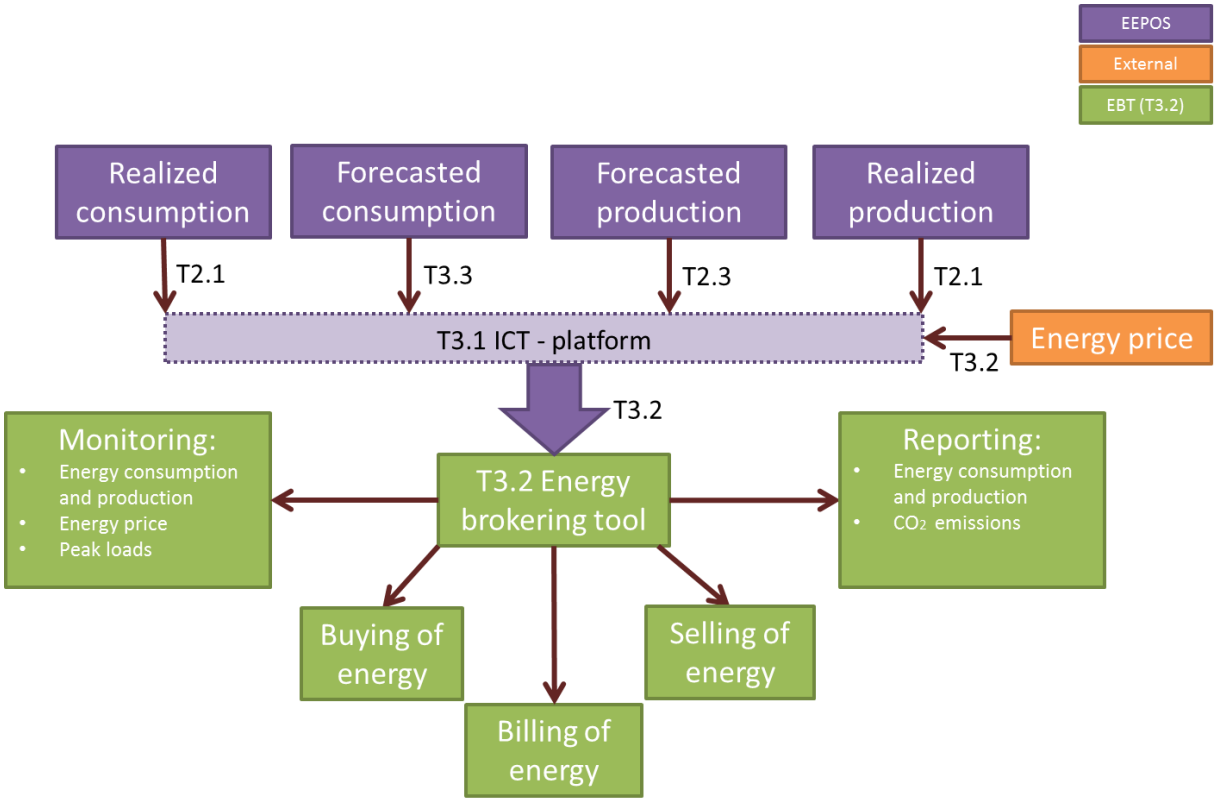
Energy brokering tool (EBT)- Specification



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1. PUBLISHABLE EXECUTIVE SUMMARY

Energy brokering tool (EBT) is an application for facility managers and owners, energy brokers and facility maintenance personnel. EBT's most essential functions are energy brokering related but it will also provide other useful information for its user.

Profitable energy brokering requires information from the building and from the energy market. From the building we will need data from realized and forecasted energy consumption. The same applies with energy production, both realized and forecasted data is needed. After we know the building's demand (past and future) the next thing to do is to inspect whether it is profitable to buy energy from the grid or sell it to the grid.

As there isn't always need for energy on a single building level when there is production capacity available, it will be necessary to be able to handle energy brokering within a larger scale. Larger scale could be neighborhood level but it could be also considered grid level depending if it is possible to sell energy to the grid on the particular location.

EBT will provide user-friendly user interface (UI) for monitoring consumption, production and energy price. It is also possible to monitor and report CO_2-emissions if there is needed coefficients available for the forms of energy.

As there is different kind of functionalities in the EBT, it will be divided in to different modules: Energy consumption, energy production, energy brokering and main module, which is the actual UI of the EBT. Therefor it is possible to combine suitable UI for each stakeholder's use.

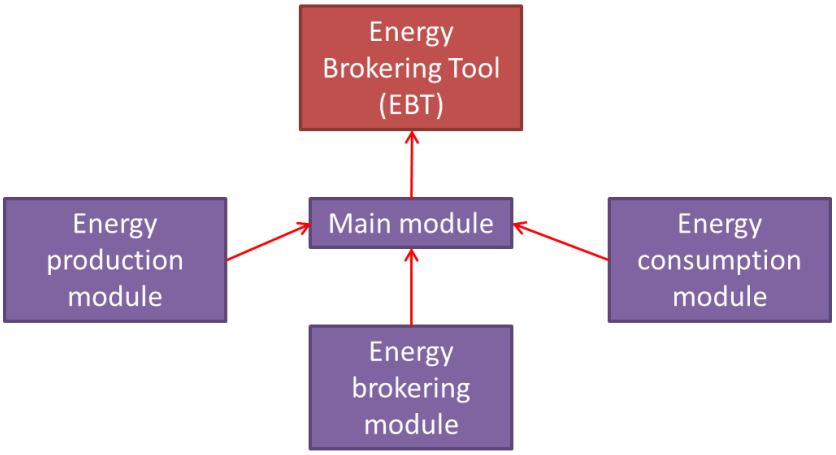

Figure 1. EBT module based approach.

This document is the first step towards implementation of the Energy brokering Tool (EBT). In this document we will present the functions and the schedule for tool development process.

2. INTRODUCTION

2.1 Purpose and target group

This report will define the (EBT) features and scope.

Other tasks needs and requirements will be addressed in this report.

Target group is the people who will be doing the actual programming (FTM) and also partners from different tasks that are connected to this one, for example CAVERION

2.2 Contributions of partners

Fatman (FTM) will be the lead contractor and responsible for this report. Other partners will provide information for the use cases, comments and feedback.

Section / Chapter	Contributor
1, 2, 3, 4, 5, 6, 7, 8	FTM
4.1.1, 4.2, 4.3.2	CAVERION

Table 1. Contributions of partners

2.3 Scope

The scope of this document is to specify the relevant boundary rules and the key features, as well as prepare and plan for the following development work of the EBT

Tool features cover the following requirements:

- monitor the energy consumption, peak loads and energy output
- monitor competitive sales and purchasing prices of the energy
- anticipate sales and purchasing activities according to consumption and forecast
- monitor the activities realizations
- transfer the anticipated supply requirements to sales and purchasing activities
- perform sales and purchasing of energy
- perform actual cost calculation

In order to fulfill the requirements, the tool needs to gather different kinds of external data. This document will specify uniform interfaces to ICT-platform regarding each data type: energy consumption and production, weather forecast, energy price, etc. This means that the data handling and conversions will be done in the ICT-platform as described in task T1.3. The data models will be defined in task T2.2.

In order to compare the actual consumption to the expedient consumption, the tool will need to be able to model energy consumption on the basis of the building's design values. This document will also specify the simulation model for this purpose.

2.4 Relations to other activities

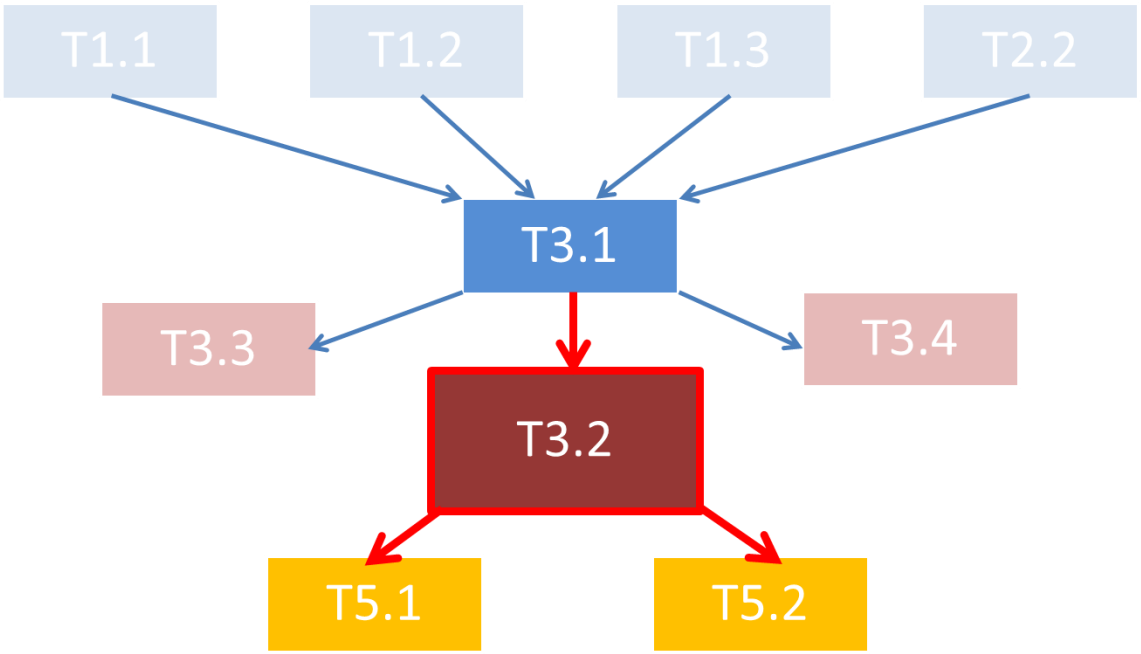

Figure 2. Relations to other activities

T3.2 EBT relation to other tasks is shown in figure 2.

Interface specifications will be based on the information from the WP3 task T3.1 (ICT platform specification and implementation)

Stakeholder's interviews will be considered from the task T1.2 in order to accentuate the resources for the most relevant features.

3. OVERALL DESCRIPTION

EBT user interface (UI) will be web page. Depending on the stakeholder's comments, there might be need for mobilized solutions. In this case the UI might be also device native software, for example Android software.

EBT will be implemented in the existing Fatman Origo architecture. Programming will follow the Fatman Framework guidelines (see appx 1)

Software and product perspectives are described in appendices 1 and 2.

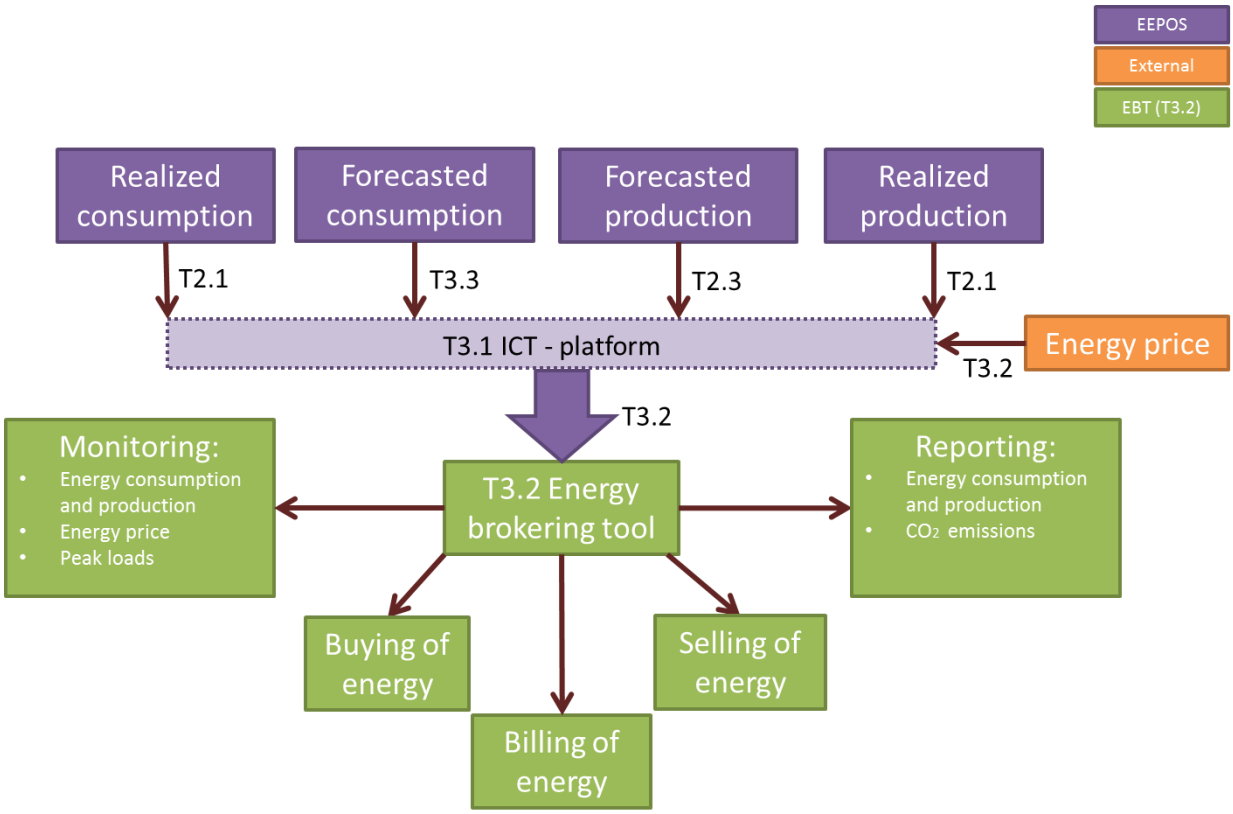

Figure 3. EBT function relations to other activities.

3.1 EBT Installation prequisitions

With a local installation the EBT will be running on a Windows server. It will be designed so that it will run also on a standalone installation without other Origo applications. Programming guidelines will follow the .NET framework 4.5.

It could be also used as SaaS (Service as Software), when there is no prequisitions.

Some of the additional functions described later in this document are linked to the existing Origo architecture. To obtain all the features, it is required to install necessary applications also from the Origo architecture. For example billing features will be available with existing Origo application.

3.2 EBT Functions

As the tool's name itself describes, the main function is the energy brokering ability. Energy brokering requires following main functions:

- Energy price data procurement
- Energy consumption data handling
- Energy storage management
- Buying and selling of energy

EBT consist of multiple modules that handle different kinds of functions that are necessary for the tool. The module-based approach gives the tool apposite solution for each stakeholder. It also makes the implementation to other applications more flexible. Modules are named below:

- Energy brokering module
    - buying and selling and energy
- Energy consumption module
    - Energy and water
    - Waste (in order to get total carbon footprint)
    - Metering for momentary consumption:
        - Energy from grid (heat, electricity, gas, etc.)
        - Energy from local containers (oil, etc.); surface level measurements
    - Metering for energy capacity:
        - Energy from local containers (oil, etc.); surface level measurements
- Energy production module
    - Electricity
    - Heat
    - Energy storage
- Main module
    - Main module is for gathering the information from the other modules above

Some of the features from the Fatman's existing applications and other valuable functions that will be useful to be integrated in the EBT are described below in chapter 3.2.1 – 3.2.3. More specific requirements are handled in chapter 4.

3.2.1 Energy investment observation

Comprehensive energy consumption monitoring requires explanations for deviations in consumption. Therefor we need to implement every piece of data we can find related to the energy consumption module.

In the Netmaster software (see Appx 1) user can specify estimates for energy consumption lowering and timing for each facility maintenance investment related to energy efficiency. This data will be shown in the energy consumption module in aid of user to verify the effectiveness of energy investments but also to point out the causes for the deviations (lowering) in energy consumption.

3.2.2 CO_2-emission calculations

The UI will have a feature where the user can specify CO_2-coefficients for each forms of energy and for each waste category. These coefficients can be specified on different levels (building level, area level, national level, global level).

Actually the CO_2-emission calculations will be a multiplication operation between each CO2-coefficient for energy and waste sort. User can see the CO_2-emission feature as a layer on top of the EBT energy consumption module.

3.2.3 Energy consumption modelling

EBT energy simulation is based on a Finnish building code (D5) [1] guidelines. These guidelines follow regular building energy consumption calculations and therefor are suited also in other regions. Energy consumption is calculated on a monthly basis based on standard climate data. For implementation in other countries it is only required to specify local standard climate.

Simulation counts energy consumption for:

- Ventilation (heat and electricity)
- Heat conduction losses
- Domestic hot water (also distribution losses)

Simulation also takes into account:

- Heating energy from sunlight
- Heating energy from people
- Heating energy from electric devices
- Building type (thermal capacity)

3.3 Energy procurement for whole neighbourhood

This is a feature which would be utilised by energy traders. This feature allows to connect multiple end-consumers together thus making it possible to make bulk energy purchases from the market, thus enabling better energy prices. This feature needs the consumption data of each end-consumer connected with the group, also the consumption predictions based on which the trader can do their trading as well as reporting and billing functionality.

3.4 User Characteristics

The EBT will be able to specify features for each end-user group. At this point it is hard to specify exact features for each user groups. The bottom line is to be able to easily make versatile user interfaces. Some UI scenarios could be for example:

- Facility Manager
    - Dashboard type of UI
    - Comparing facilities (cost rates, consumption, etc.)
- NEMS operator
    - Features focused for energy brokering and management
        - Monitoring UI for energy price, consumption and production
- Service technician
    - Energy consumption monitoring and reporting

3.5 General Constraints

The implementation of the EBT will be done in different phases. The phases are linked to the EBT modules described in chapter 3.2 and they will be scheduled:

1. Main module (m12 - m18)
2. Energy consumption module (m12 - m18)
3. Energy brokering module (m18 – m20)
4. Energy production module (m18 - m24)

In this task we can assume to get processed data for the EBT tool needs from the ICT-platform, as the tool has only one interface to the ICT-platform. Therefor regarding external data, this task only needs to specify the guidelines for the data specifications for the ICT-platform.

4. SPECIFIC REQUIREMENTS

In addition to chapter 3.2, this chapter will discuss more detailed requirements for the EBT. Requirements are divided below for interface, functional and other EEPOS tools related chapters. This chapter also covers Fatman Origo architectural requirements for the tool.

4.1 Interface Requirements

4.1.1 User Interfaces

The leading guideline for the EBT user interface is simplicity.

The user interface will be web based and easily adjustable for portable smart devices (tablets, smartphones) with the help of cross platform languages (HTML5).

The final layout of the UI can be specified for any customer or end-user e.g. what information to show and in what form, and where the data is located. Also cooperation with other tools to present common information in one view is possible.

There will be at least three levels of user categories defined – owner, manager and end-user (possibly also ‘professional’). There is different information for each user category as well as different inputs that they can interact with the system.

4.1.2 Software Interfaces

The only actual interface of the EBT will be EEPOS ICT-platform. Communication technology between EBT and ICT-platform will be Windows Communication Foundation (WCF). Still there must data interface for database (SQL) in order to collect for example energy consumption data. As the EBT will be implemented using Origo architecture there will be an interface to the Origo database.

4.2 Functional Requirements

The EBT should enable, in a simple manner:

- To access relevant energy market data
- To combine the end-consumers (as well as prosumers) into a single entity, which then can be represented by an energy broker.
- With this tool the broker can ensure better price for the prosumers since they are acting as large consumer, thus trading volumes increase and making it possible to lower the end-cost.
- The broker to communicate with end-users
- Provide consumption and production reports

4.3 Requirements from EEPOS tools

4.3.1 T3.1 EEPOS ICT and decision support systems platform

In order to get all the data that is specified in this document, EBT will need to have properties for:

- **Energy consumption and production**
  - type (consumption, production)
  - form (heat, electricity, gas, waste…)
  - timeframe (specified in minutes)
  - data type (consumption, meter reading, container surface level / volume of fuel tanks…)
  - unit (kWh, MWh, m^3, kg…)
  - value (numeric value)
- **Energy consumption forecasting**
  - type (weather)
  - form (temperature)
  - unit (Celsius)
  - value (numeric value)

4.3.2 T3.3 Energy performance monitoring and operations planning tools

Key word for beneficial energy brokering is forecasting. Therefor EBT needs this kind of features. The tool must provide forecasts for energy consumption and energy production. With these pieces of information user can make appropriate energy brokering. The scope for forecasts in this task is to be able to handle forecast data. The actual forecast data will be processed in task T3.3.

4.3.3 Use Case #1: Test case in Finland

The Finnish demonstration of the EEPOS project will be implemented in Merenkulkijanranta neighborhood in Lauttasaari Helsinki consisting of new high-quality blocks of flats. The area consists of 7 apartment buildings with total of 240 apartments. The construction of the area started in 2008 and will be finalized in 2015. Currently 5 apartment buildings are ready; one is being delivered in the beginning of 2014 and the last in 2015.

As a neighborhood management system, EBT should also provide capabilities for incorporating utility billing functionalities and act as a central database for important information regarding the neighborhood and its principals, systems, agreements etc.

In the context of EBT it is not possible to test the full functionality since it is not possible to incorporate all the residents into selecting a single power provider. However, the energy investment observation with RE installation suggestions could be tested in real life demonstrator as well.

4.4 Non-Functional Requirements

Non-functional requirements may exist for the following attributes. Often these requirements must be achieved at a system-wide level rather than at a unit level.

4.4.1 Performance

The EBT will be run as a pilot / demonstration, it should not be considered as production environment. Performance should be in a level that all the aspects of the project can be

demonstrated without problems. Specific details will be updated once the implementation starts and performance can be tested.

4.4.2 Reliability

As we are not building a production environment, there is no need for redundant servers and components. However current planned system infrastructure where the EBT will be installed is built for production servers.

4.4.2.1 Backups

The site is set up on a production web server and the database(s) are on a production database server, and the corporation standard backup routine for the servers is applied. Currently the standard routine consists of backing up all hard drives nightly. Daily state can be restored for up to a month backwards. For states more than a month backwards, a quarterly-year backup is available.

4.4.3 Availability

Service will be run as best effort model. It will be monitored and maintained during working hours but it will not have the priorities and SLA of a production site.

4.4.4 Security

Site will be published to public web using SSL-certificates (https). Accessing user interface will require authentication. Any firewall restrictions won't be used as it would be an unnecessary layer of security in addition to authentication and SSL.

4.4.4.1 Use of personal information

No personal information will be handled in the site.

5. CONCLUSIONS AND FUTURE WORK

The EBT will have the needed features for energy brokering but it will also provide other essential data (e.g. energy consumption and efficiency reporting) for the user. Combining brokering features with also other available data in one tool will make this tool extreme useful.

Module based approach will enable flexible UI management features and also makes it possible to cooperate between other tasks in the EEPOS-project if there comes along opportunities to make use of work from the other tasks.

The tool is designed to be usable in different regions and countries as a part of EEPOS system.

5.1 Future Work

The tentative schedule for the further work of Task T3.2 is shown in Table 2. The plan will be updated during the project. Future work will follow the module based approach:

1. Main module (m12 - m15)
2. Energy consumption module (m12 - m18)
3. Energy brokering module (m16 – m20)
4. Energy production module (m18 - m24)

Action	Time	Misc
Specification	Jun 2013 – Sep 2013 (m9-m12)	D3.2 Deliverable – Specification
Energy consumption module	Sep 2013 – Mar 2014 (m12-m18)	Need input from other tasks related to energy consumption data handling
Main module	Sep 2013 – Mar 2014 (m12-m18)	Need input from partners regarding UI. Especially feedback from Task 5.2 demonstration.
Energy brokering module	Jan 2014 – Aug 2014 (m16-m23)	Need input from partners regarding UI. Especially feedback from Task 5.2 demonstration.
Energy production module	Mar 2014 – Sep 2014 (m20-m24)	
Documentation	Oct 2013 – Sep 2014 (m13 – m24)	D3.2 Deliverable – Technical Documentation
Task completed	Sep 2014 (m24)	D3.2 Specification D3.2 Technical Documentation D3.2 Prototype

Table 2. Task schedule

Some of the modules are also considered in other tasks and we will need to follow other tasks in order to avoid double work.

If there comes along new features or changes to the EBT specifications along the implementation or development process, those will be published in the technical documentation report.

6. ACRONYMS AND TERMS

BIM ..... Building Information Model

ERP..... Enterprise resource planning

ESB..... Enterprise Service Bus

FMI..... Finnish Meteorological Institute

ICT ..... Information and Communication Technology

MVC..... Model View Controller

OOP..... Object Oriented Programming

NEMS..... Neighbourhood Energy Management System

RES..... Renewable Energy Source

SaaS..... Service as a Software

SLA ..... Service Level Agreement

SMS..... Short Message Service

SOA..... Service Oriented Architecture

SOAP..... Simple Object Access Protocol

UI..... User Interface

XML ..... Extensible Markup Language

WCF ..... Windows Communication Foundation

7. REFERENCES

[1] http://www.ym.fi/en-US/Land_use_and_building/Legislation_and_instructions/The_National_Building_Code_of_Finland#D Hepac and energy management
[2] https://huoltokirja.fatman.fi/tuotepaletti.asp?lg=English

8. APPENDICES

Additional information is described in related background documents:

Appendix 1: EBT Software perspective (Confidential)

Appendix 2: EBT Product perspective (Confidential)