COMPETITIVENESS AND INNOVATION FRAMEWORK PROGRAMME

Call FP7-ICT-2011-7

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D4.4.2 Cassandra Final Platform

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Reviewed by:	**Christos Diou (CERTH)**

Abstract

This document contains the manual of the Cassandra early platform prototype. The prototype platform and source code are available online at https://github.com/cassandra-project/platform.

Document History

Version[1]	Issue Date	Stage[2]	Content and changes
#1.0	12nd November 2013	Draft	Initial version of the document (CERTH)

List of participants:

Participant no. *	Participant organisation name	Part. short name	Country
1 (Coordinator)	Centre for Research and Technology Hellas/ Informatics and Telematics Institute	CERTH-ITI	Greece
2	Aristotle University of Thessaloniki	AUTH	Greece
3	VaasaETT Global Energy Think Tank	VAASA	Finland
4	Politecnico di Milano	POLIMI	Italy
5	Coventry University Enterprises Ltd	COVUNI	UK
6	Luleå University of Technology	LTU-CDT	Sweden
7	Cleopa GmbH	CLEOPA	Germany
8	Erasmus research Institute of Management	ERASMUS	Netherlands
9	DRAXIS S.A	DRAXIS	Greece

[1] Please use a new number for each new version of the deliverable. Add the date when this version was issued and list the items that have been added or changed. The 'what's new' column will help the reader in identifying the relevant changes. Do not forget to update the version number and date on the front page and the header.

[2] A deliverable can be of these stages: either "draft" or "final". For each stage, several versions of a document can be issued. *Draft:* Work is being done on the contents. *Final*: All chapters have been completed.

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1 Introduction

The aim of the present deliverable is to offer a manual to accompany the final version of the Cassandra platform. The up-to-date electronic version of this document can be found at: https://github.com/cassandra-project/platform/wiki/User-Manual, while the source code of the platform is located at: https://github.com/cassandra-project/platform.

The current document is public and is intended to be read, not only by the members of the Consortium, but also by readers that are interested to use the platform in order to model electrical installations and consumers and run demand side management scenarios.

The report corresponds to the user manual of the platform (Section 2), with each subsection corresponding to each entity modelled through the platform. Section 3 contains the manual of the training module, an external application that can be used to train the simulation agents' activity models form data based on electric measurements from the modelled installations. The document concludes with installation instructions for the Cassandra platform (Section 4).

1.1 The Cassandra Platform

The CASSANDRA platform modules are depicted in Figure 1; these are:

1. The *Agent* module,
2. the *CSN* module,
3. the *Aggregation* module,
4. the *Web service* module and
5. the *End-user* module.

Agent module The agent module plays the role of the simulation engine of the CASSANDRA platform. It contains the necessary structures for modelling the behaviour of agents (persons) and object constructs (i.e. installations, appliances) with respect to energy consumption activities, communication, and response to stimuli in the form of demand side management programmes.

CSN module. The CSN module (CSNM) is a tool for performing general network analyses and capabilities for clustering the population into groups based on (dis)similarities of behaviour or social activities. It provides a benchmark tool for experts to experiment and test different use case scenarios, in order to fine-tune hypotheses on consumer response based on CSNs.

Web-service module. The web service module is the socket of the CASSANDRA platform to the outside world. Through this interface it is possible to define simulation scenarios, policies (pricing, legislative) and KPIs in order to be simulated by the agent module. The same interface can be used to query for results and for post-simulation reporting and analysis.

Aggregation module. The aggregation module serves as the interface between the agent module (simulation engine), the CSN module (graph/clustering studies) and the web-service module (API). Even though it is depicted as a box in Figure 1, it is actually the wrapper code that implements the interactions between the modules. The aggregate module is a form of mapping I/O of one module into I/O of another module.

End-user module. The end-user module is an implementation of a front end-client that adheres to the web-service module communication protocol. It provides a graphical interface for using the platform. We should also mention that due to the incorporation of the web-services it is possible for any developer to implement an end-user module.

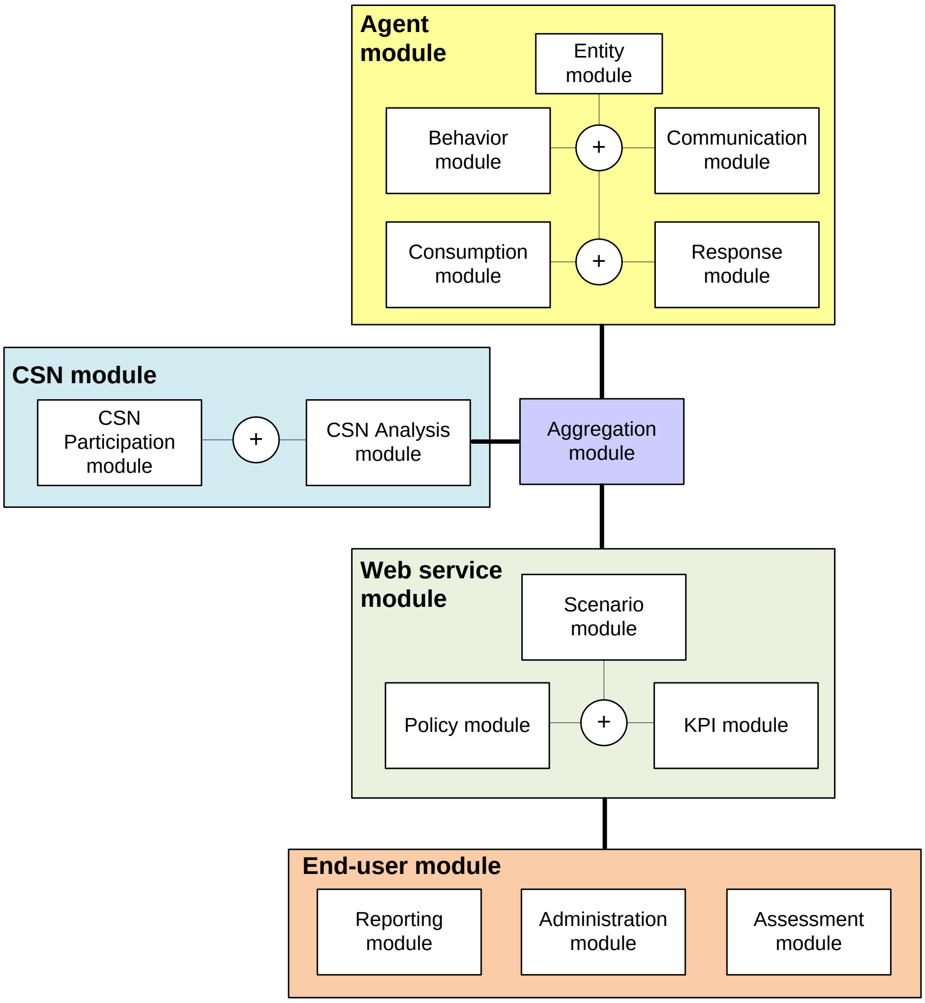


Figure 1 CASSANDRA modules

The overall CASSANDRA platform architecture as projected from the conceptual CASSANDRA platform (Figure 1) is depicted in Figure 2. Besides the aforementioned CASSANDRA modules, several technical layers have been introduced from the conceptual to the implementation design.

As proposed, the CASSANDRA platform was designed to follow the **Software-as-a-Service** paradigm, where the software along with its data will be hosted on the cloud and access to their computational and data resources will be met, on-demand, by users via thin clients. The decoupling of the CASSANDRA platform and the end-user interface introduced a layer of communication between the server and the client implemented through a lightweight RESTful web-service. For the final version of the CASSANDRA platform the CSN module will also be incorporated and supplied with a REST API as well.

Last but not least, a database component was added in order to efficiently store and retrieve data related to the entities of the CASSANDRA platform. There are several types of databases in the platform: (a) the *projects database*, which holds all the modelling information to run the scenarios defined by the user, (b) the *results database*, which holds information regarding runs of a scenario along with their definition and (c) the *CASSANDRA and user libraries databases*, which hold ready-to-use models of CASSANDRA entities so they can be used and re-used in different scenarios.

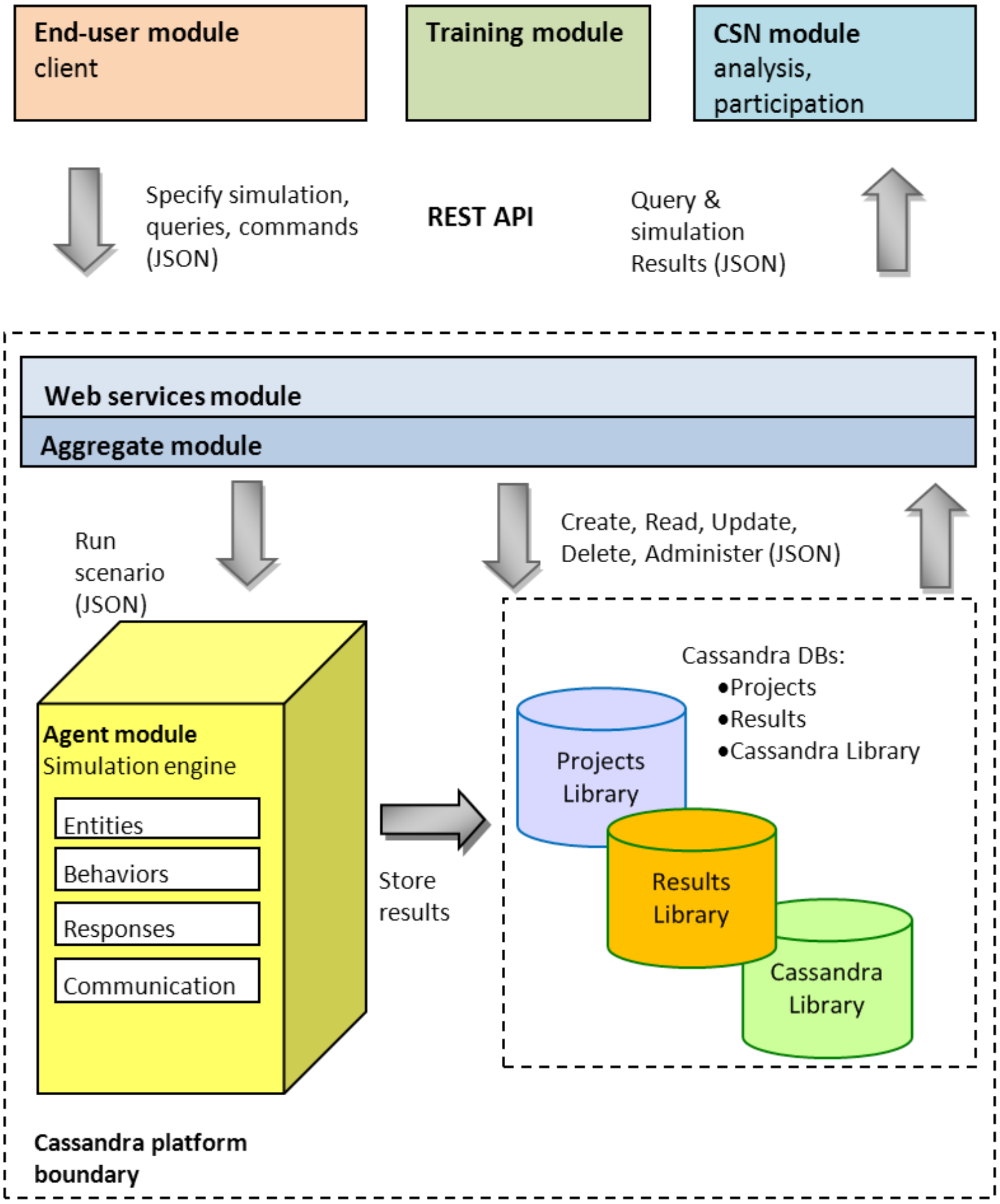


Figure 2. Overall CASSANDRA platform technical architecture

2 *CASSANDRA* Final Platform Manual

This section is the user guide for the current version of the Cassandra platform. The source code of the platform is located at: https://github.com/cassandra-project/platform. A working version of the platform can be found at: https://cassandra.iti.gr:8443/cassandra/app.html.

2.1 Authentication

The platform is user-oriented in the sense that each user has her own workspace consisting of her own projects and a private user library for storing entities for reuse. Before entering the platform the user should be authorized by the system inserting her credentials (username and password). Potential users should contact the system administrator in order to acquire appropriate credentials, since there is no self-registration process.

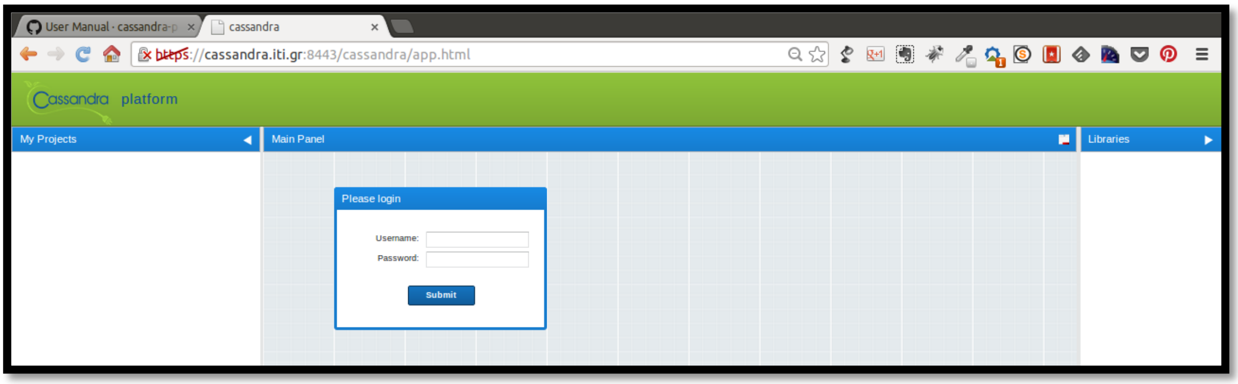


Figure 3: Login screen

2.2 Workspace

The Cassandra platform user interface is separated into three panes:

1. The projects' or workspace pane, at the left of the screen (*My Projects*),
2. the working pane at the middle of the screen (*Main Panel*) and the
3. libraries pane on the right part of the screen (*Libraries*).

The libraries pane includes both the *User library* tree and the *Cassandra library* tree.

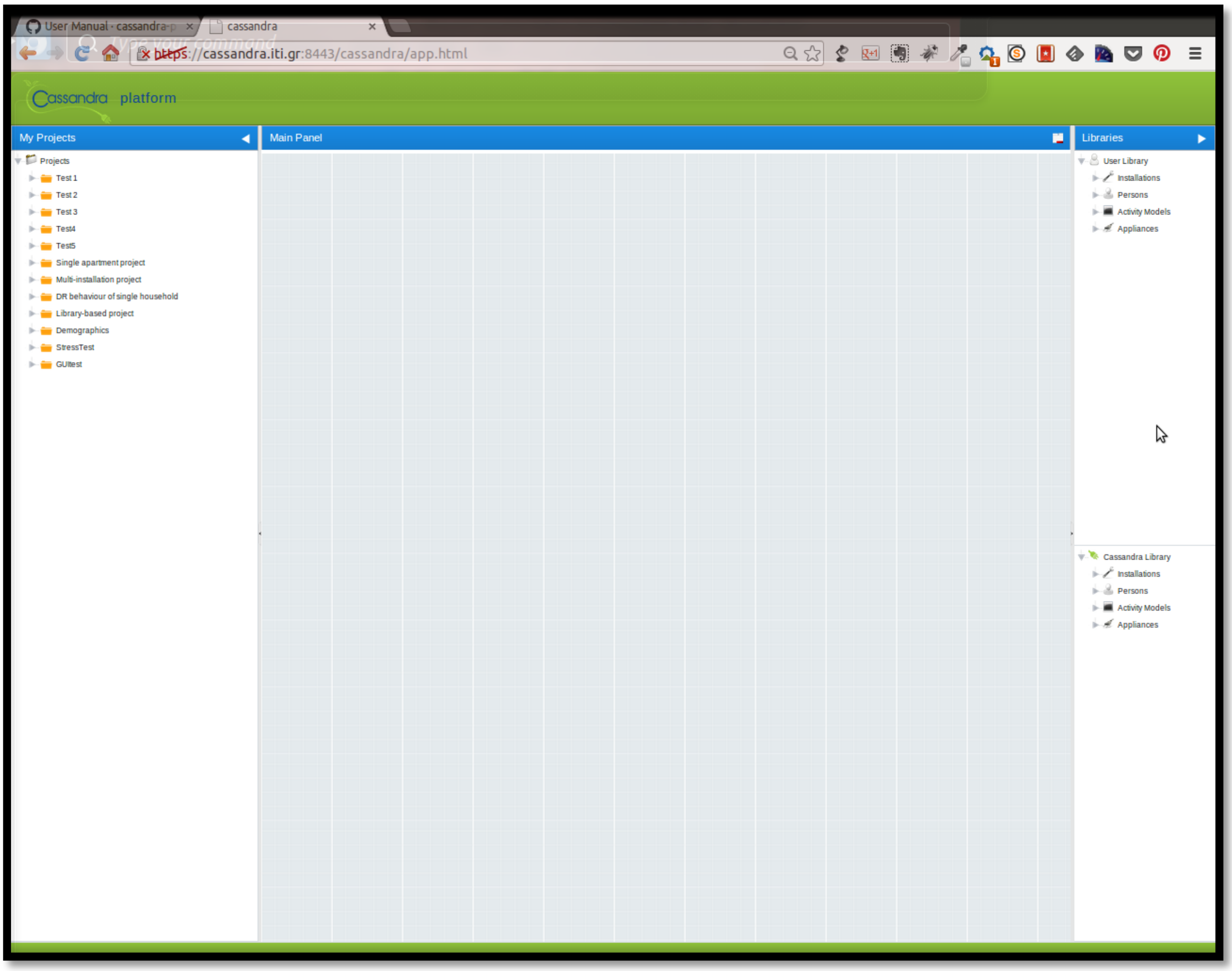


Figure 4: Main screen

The workspace pane holds the projects of the user in a tree structure as follows:

- *Projects* (Level 0)
- *Project* (Level 1)
- *Scenarios* (Level 2)
- *Scenario* (Level 3)
- *Installations* (Level 4)
- *Installation* (Level 5)
- *Persons* (Level 6)
- *Person* (Level 7)
- *Activities* (Level 8)
- *Activity* (Level 9)
- *Activity Models* (Level 10)
- *Activity Model* (Level 11)
- *Appliances* (Level 6)

- *Appliance and Consumption Model* (Level 7)
- *Simulation Parameters* (Grid) (Level 4)
- *Simulation Parameters* (Form) (Level 5)
- *Demographics* (Grid) (Level 4)
- *Demographics* (Form) (Level 5)
- *Pricing Schemes* (Level 2)
- *Pricing Scheme* (Level 3)
- *CSNs* (Level 2)
- *CSN* (Level 3)
- *Runs* (Level 2)
- *Run* (Level 3)

Each tree node represents an entity. The user should click on the links to see instructions about individual entities. Double-clicking a node opens it in a tab on the working pane.

2.3 Libraries

The libraries (User and Cassandra) contain pre-specified entities that can be drag'n'dropped into working scenarios to facilitate scenario building (Figure 5). The supported entities are of type:

- *Installation* (along with its Person and Appliance entities and their children entities),
- *Person* (along with its children entities)
- *Appliance* (along with its Consumption Model)
- *Activity Model* (along with their Distributions)
- *Pricing Schemes*

The *User library* is a read-write library, i.e. a library that the user can store and retrieve entities, while the *Cassandra library* is read-only, meaning that the user can only get entities and not put.

Once a model is placed from a library into a scenario or vice-versa, a copy of the entity is created under the scenario, which can be further customised according to user needs. The user can also store models produced in any scenario from the workspace into the user library for future use. The *Cassandra library* is updated by system administrators only. In general, copies are recursive (deep copies), that is they copy recursively all the entities under the entity being dragged'n'dropped. If the user would like to create a shallow copy, then the Shift key must be kept pressed while dragging and dropping an entity. With respect to deep-copying there is an exception as far as the *Activity Models* are concerned. In general when an entity is dragged’n’dropped that includes Activity Models (i.e. Activity Model, Activity, Person) the appliances listed to participate in the *Activity Model* are not copied and are dropped from the copied Activity Model, since the entity under consideration does not include them. On the other hand if a scenario or an installation is dragged’n’dropped, the Activity Models carries the appliances because they are copied as well.

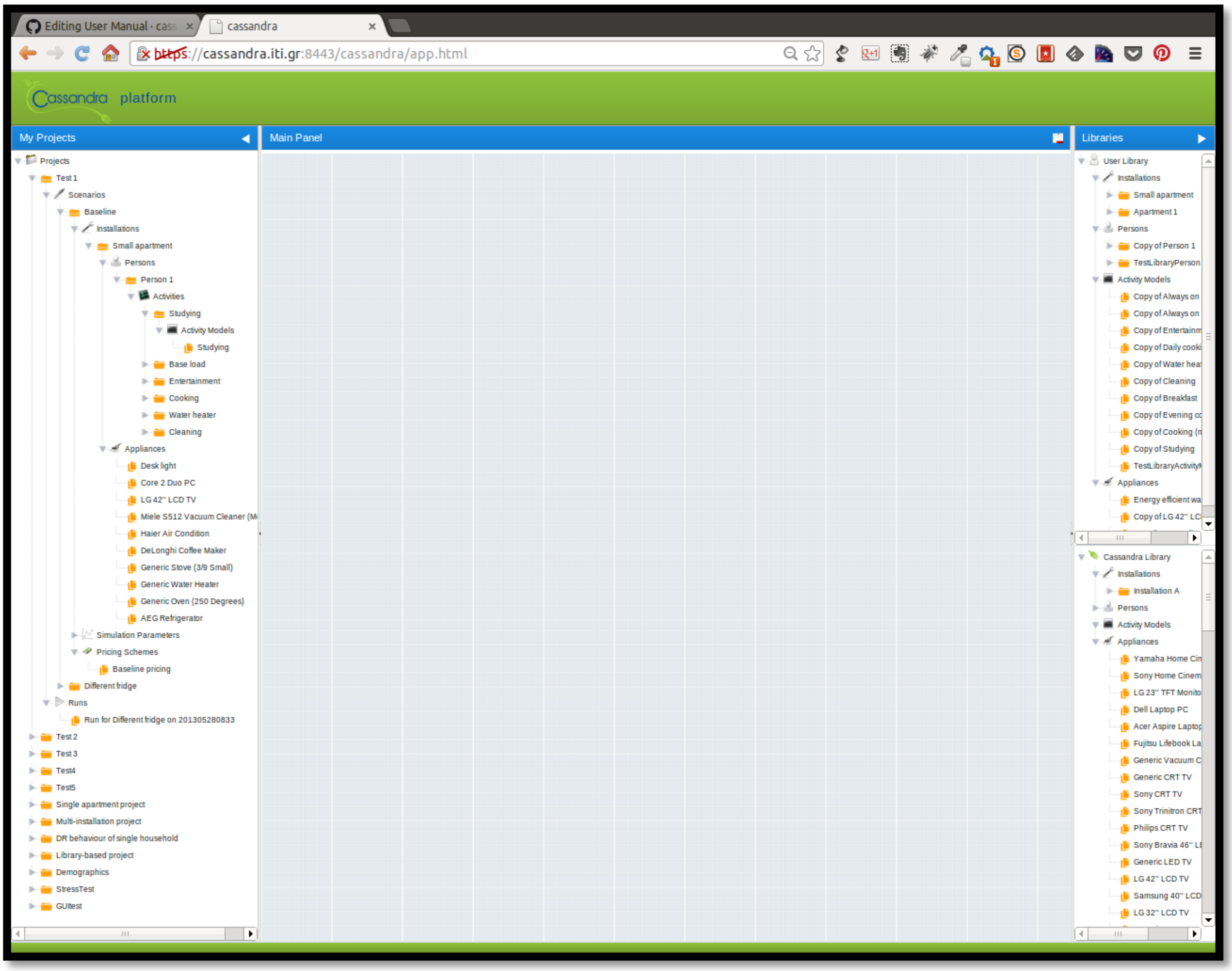


Figure 5: Cassandra and User libraries

2.4 Usage Workflow

The main usage workflow is as follows:

1. The user creates a scenario under a project and setups all the necessary entities and along with their properties: Installations, Persons, Appliances, Activities, Activity Models etc.
2. She specifies the simulation parameters.
3. She runs the scenario.
4. The user double-clicks on the run after it finishes in order to see the results of the simulation. The results open in a new tab on the browser window.
5. The user can run alternative scenarios by changing for example *Appliances*, *Activity Models*, *Pricing Schemes* etc.
6. The user can also compare two runs by selecting two runs (pressing Ctrl while selecting) in the *Runs* grid tab and then by selecting the compare option from the menu.

It is possible to automatically compute model parameters based on measurements obtained from actual consumer installations. This will allow analysis of consumption, as well as the accurate simulation of a range of 'what if' type scenarios. The Training and Response module will be responsible for this process. An activity model of the process can be found in Figure 6.

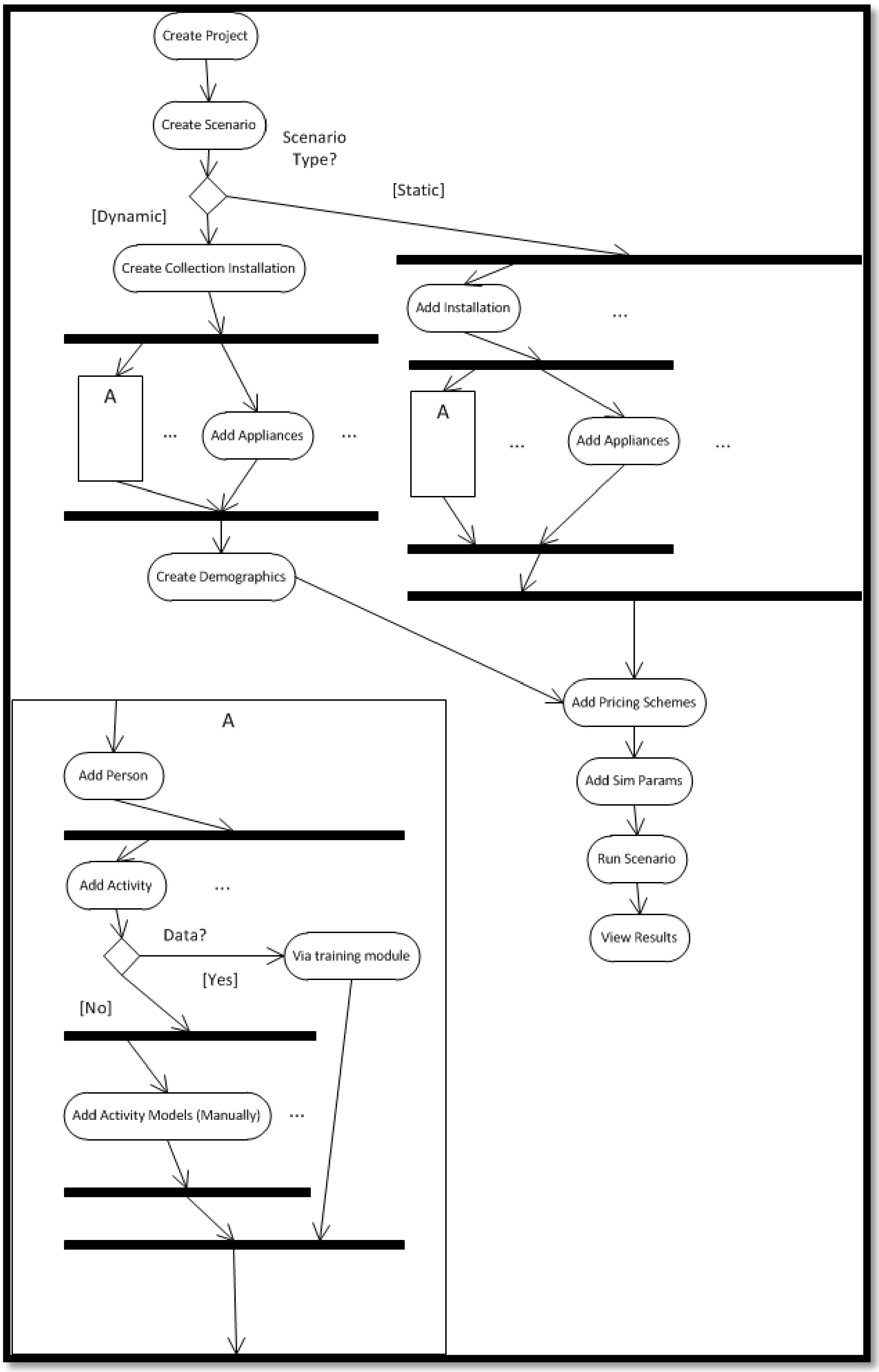
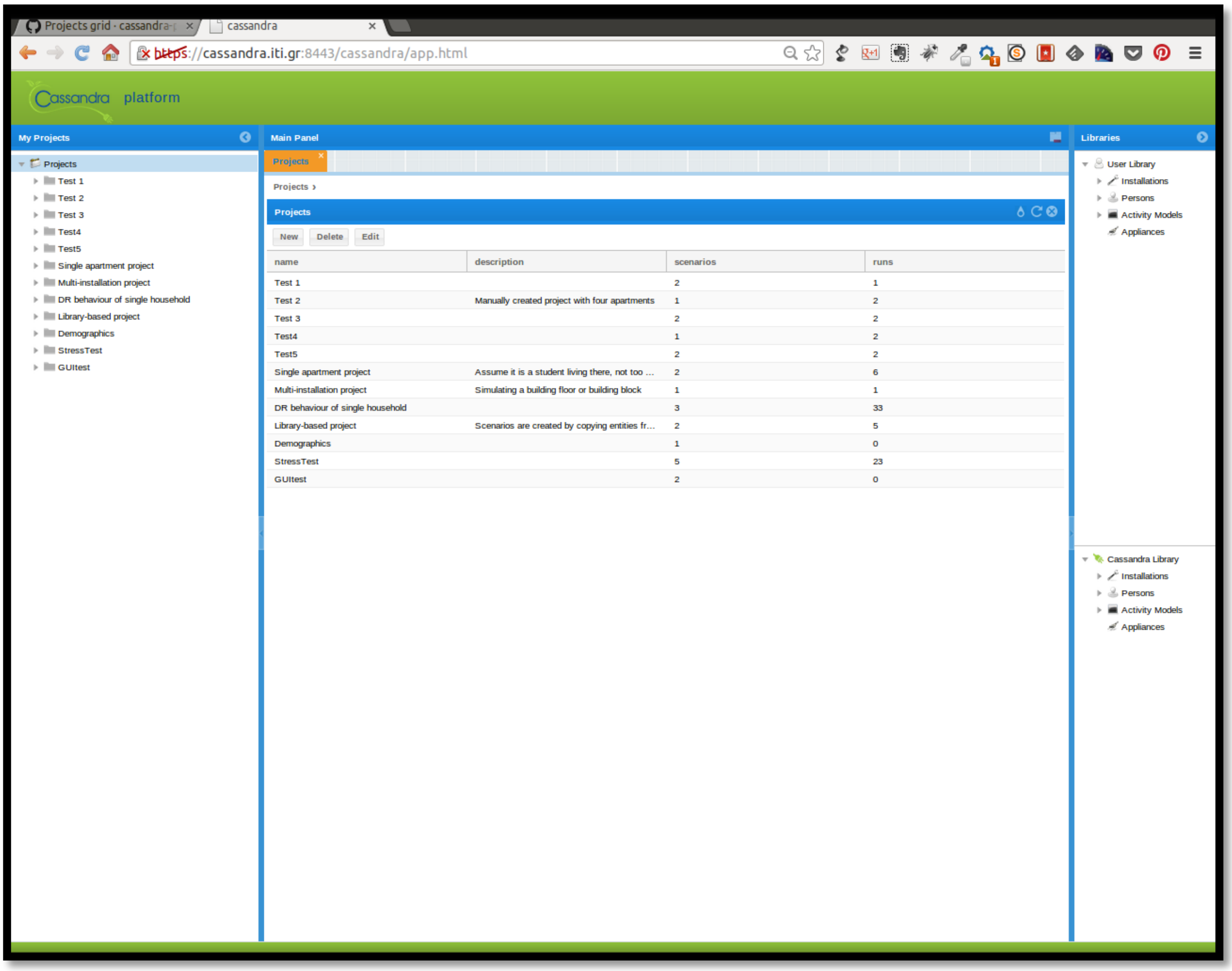


Figure 6 Activity diagram from creating a project to viewing the simulation results

2.5 Projects

The workspace consists of *Projects*. Every project contains scenarios relevant to the project and runs (simulation executions) of those scenarios.

By double-clicking the *Projects* node, the user can see in a grid the projects of the workspace (Figure 7). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either edit or delete. The user can also edit a project by double clicking the corresponding row. A similar grid exists for all other entities in CASSANDRA platform.



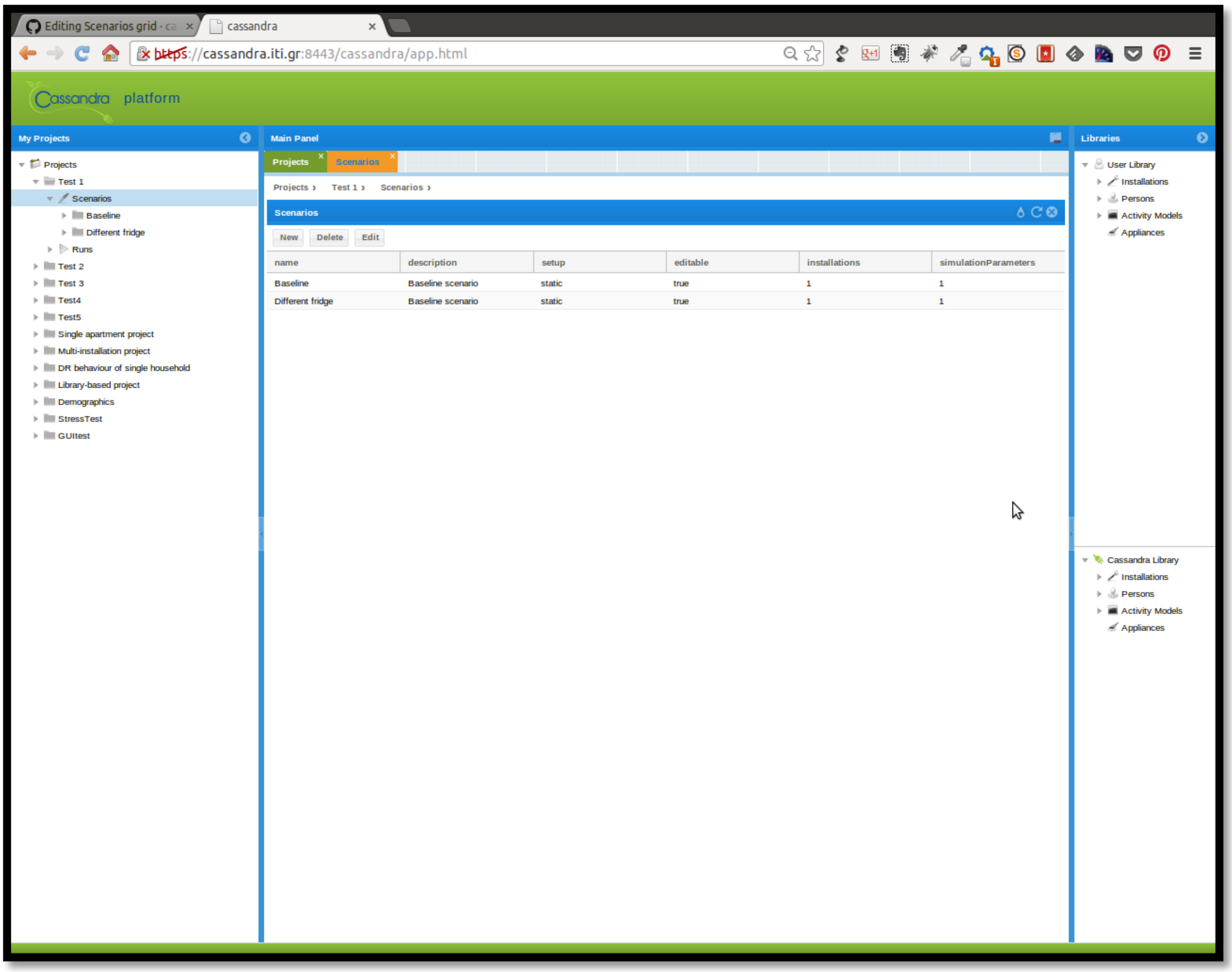
name	description	scenarios	runs
Test 1		2	1
Test 2	Manually created project with four apartments	1	2
Test 3		2	2
Test4		1	2
Test5		2	2
Single apartment project	Assume it is a student living there, not too ...	2	6
Multi-installation project	Simulating a building floor or building block	1	1
DR behaviour of single household		3	33
Library-based project	Scenarios are created by copying entities fr...	2	5
Demographics		1	0
StressTest		5	23
GUItest		2	0

Figure 7: Projects grid

2.6 Scenarios

Scenarios enclose information about electrical loads, consumers and their behavior, as well as simulation parameters. A project can have multiple scenarios, corresponding to different consumer setup, simulation parameters etc.

By double-clicking the *Scenarios* node, the user can see in a grid the scenarios of the project (Figure 8). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.



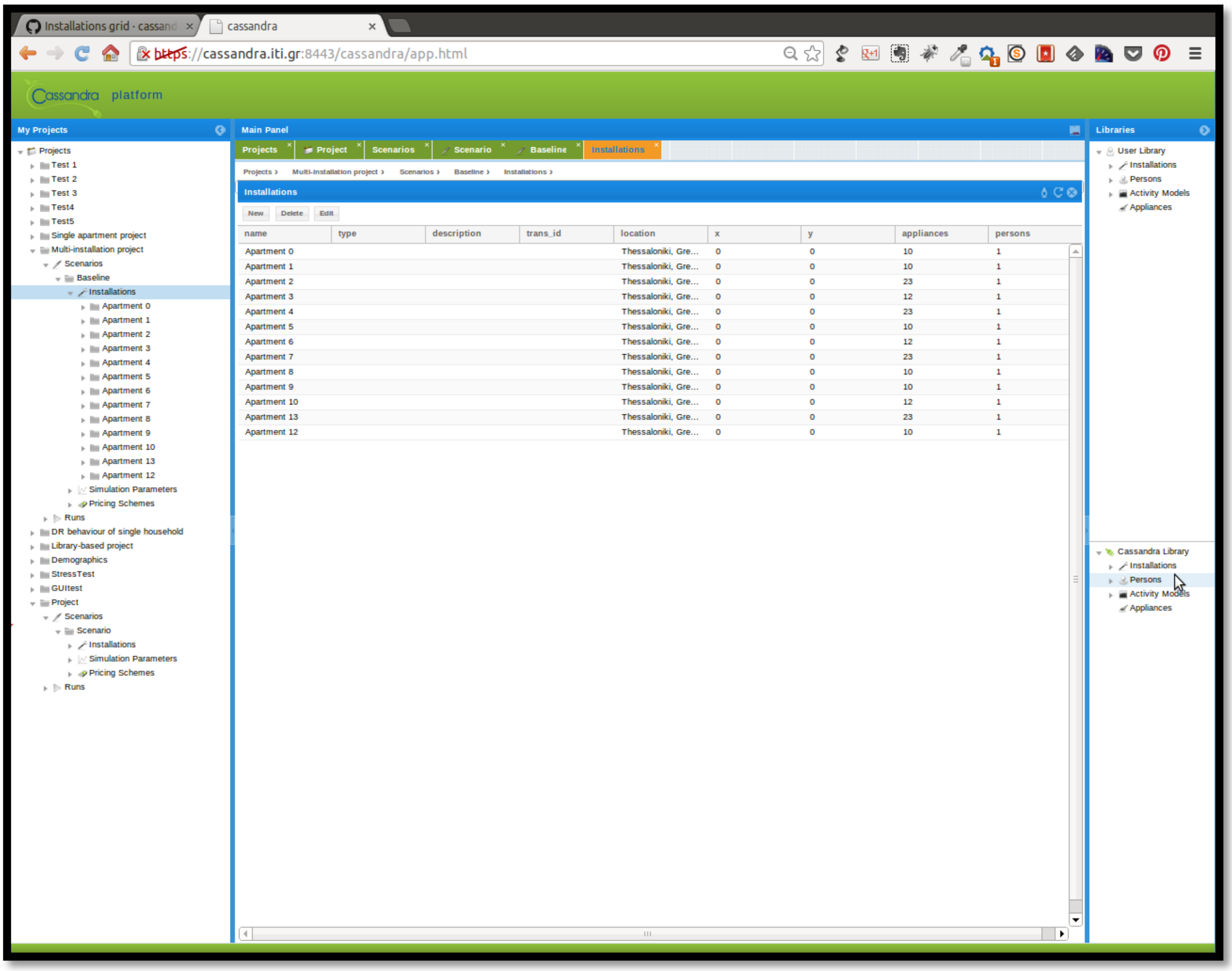
name	description	setup	editable	installations	simulationParameters
Baseline	Baseline scenario	static	true	1	1
Different fridge	Baseline scenario	static	true	1	1

Figure 8: Scenarios grid

2.7 Installations

By double-clicking the *Installations* node, the user can see a grid with the installations of the scenario (Figure 9). Examples of Installations include households, buildings, individual rooms and generally, loads that lie beneath a metering point. *Installations* are containers of *Appliances* that have associated *Consumption Models* and *Persons* that have associated *Activity Models* for *Appliance* usage.

The available commands are to create a new installation and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.

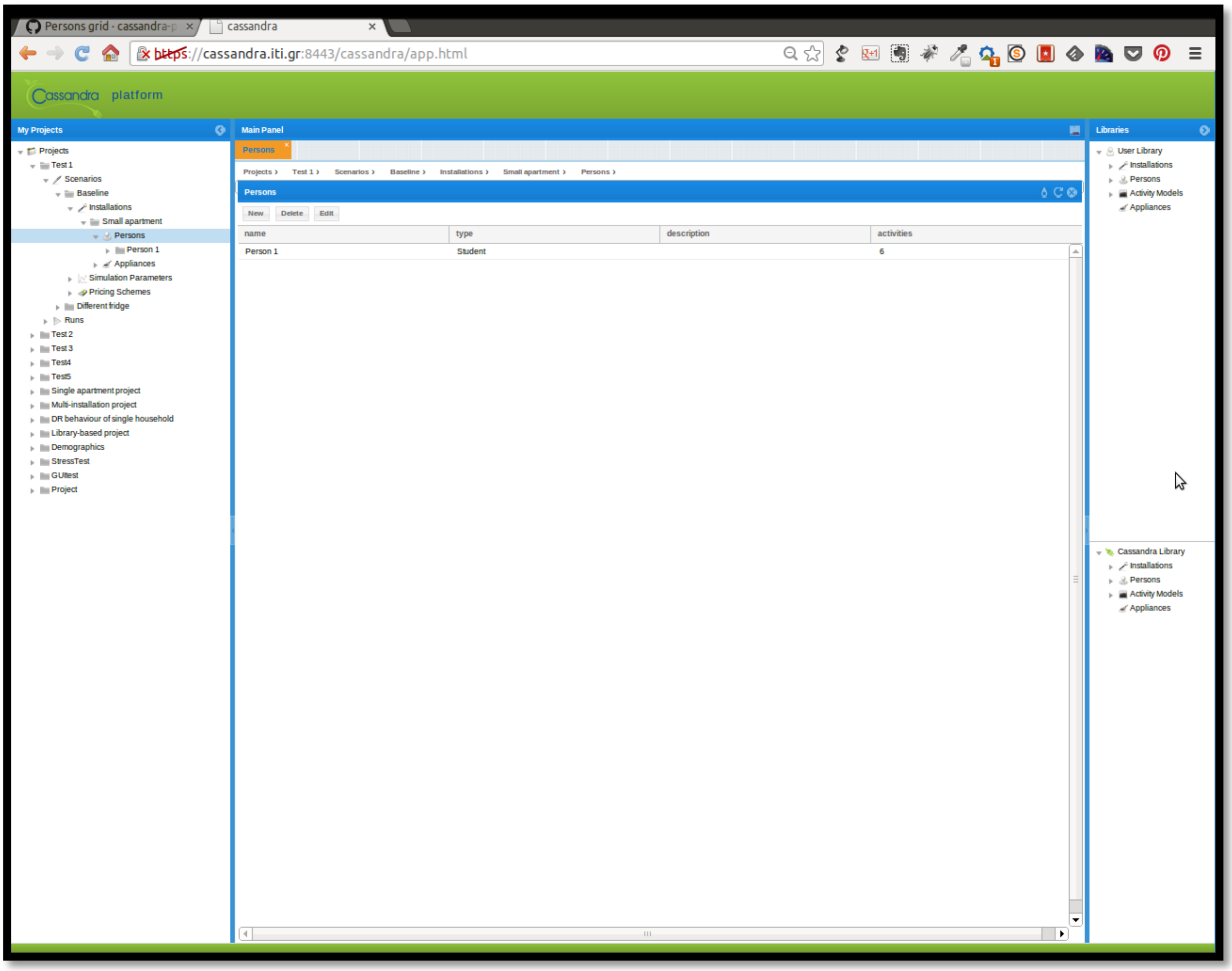


name	type	description	trans_id	location	x	y	appliances	persons
Apartment 0				Thessaloniki, Gre...	0	0	10	1
Apartment 1				Thessaloniki, Gre...	0	0	10	1
Apartment 2				Thessaloniki, Gre...	0	0	23	1
Apartment 3				Thessaloniki, Gre...	0	0	12	1
Apartment 4				Thessaloniki, Gre...	0	0	23	1
Apartment 5				Thessaloniki, Gre...	0	0	10	1
Apartment 6				Thessaloniki, Gre...	0	0	12	1
Apartment 7				Thessaloniki, Gre...	0	0	23	1
Apartment 8				Thessaloniki, Gre...	0	0	10	1
Apartment 9				Thessaloniki, Gre...	0	0	10	1
Apartment 10				Thessaloniki, Gre...	0	0	12	1
Apartment 13				Thessaloniki, Gre...	0	0	23	1
Apartment 12				Thessaloniki, Gre...	0	0	10	1

Figure 9: Installations grid

2.8 Persons

By double-clicking the *Persons* node, the user can see a grid with the persons of an installation (Figure 10). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.

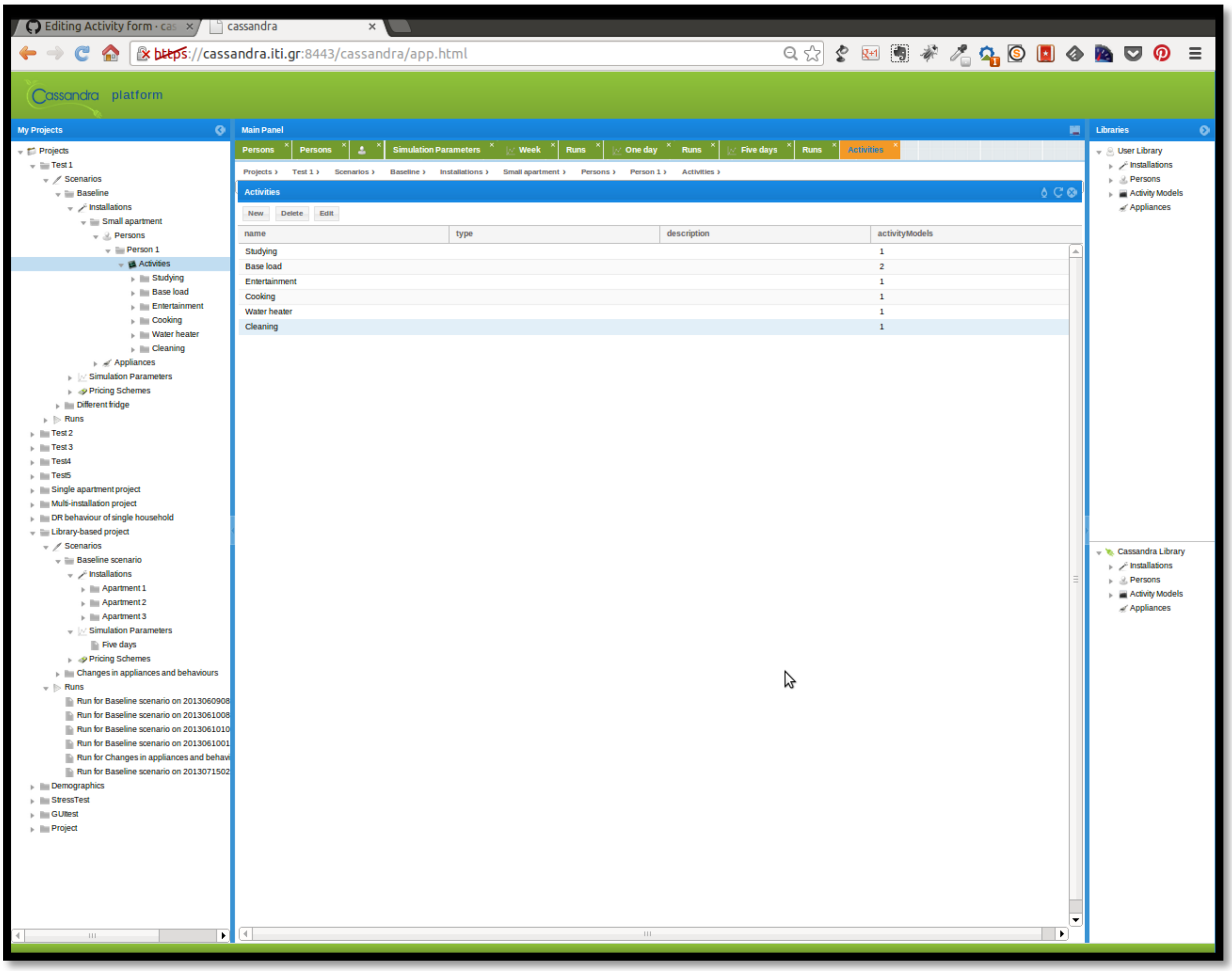


name	type	description	activities
Person 1	Student		6

Figure 10: Persons grid

2.9 Activities

A person can have one or more associated *Activities*. These describe how a person uses the *Appliances* in an *Installation*. By double-clicking the *Activities* node, the user can see a grid with the activities of a person (Figure 11). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.



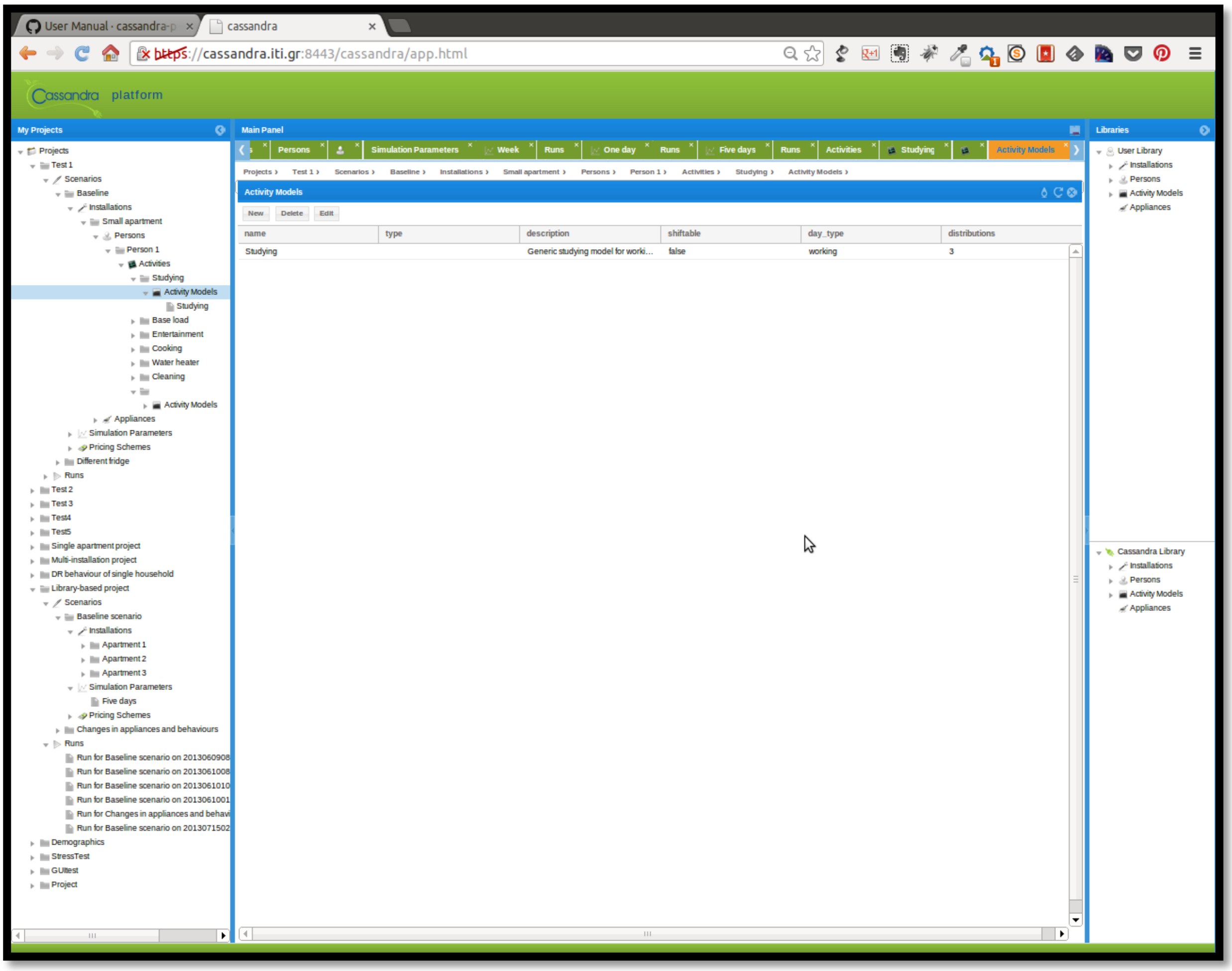
name	type	description	activityModels
Studying			1
Base load			2
Entertainment			1
Cooking			1
Water heater			1
Cleaning			1

Figure 11: Activities grid

2.10 Activity Models

Activities consist of *Activity Models* that include probability distributions for the start time and duration of use of *Appliances*.

By double-clicking the *Activity Models* node, the user can see a grid with the activity models of a given activity (Figure 12). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding line and then pressing either *edit* or *delete*.

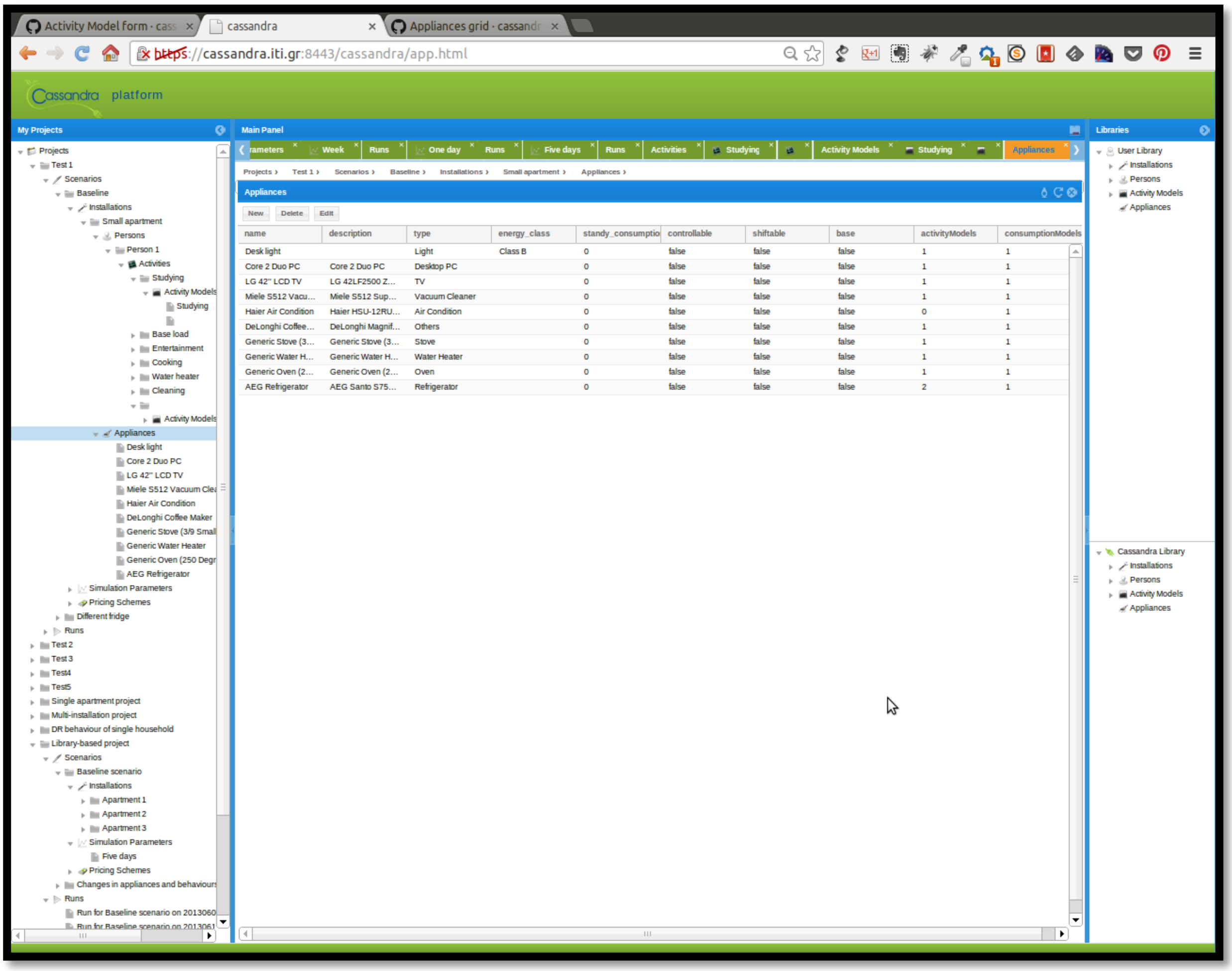


name	type	description	shiftable	day_type	distributions
Studying		Generic studying model for worki...	false	working	3

Figure 12: Activity Models grid

2.11 Appliances

By double-clicking the *Appliances* node, the user can see a grid with the appliances of an installation (Figure 13). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.

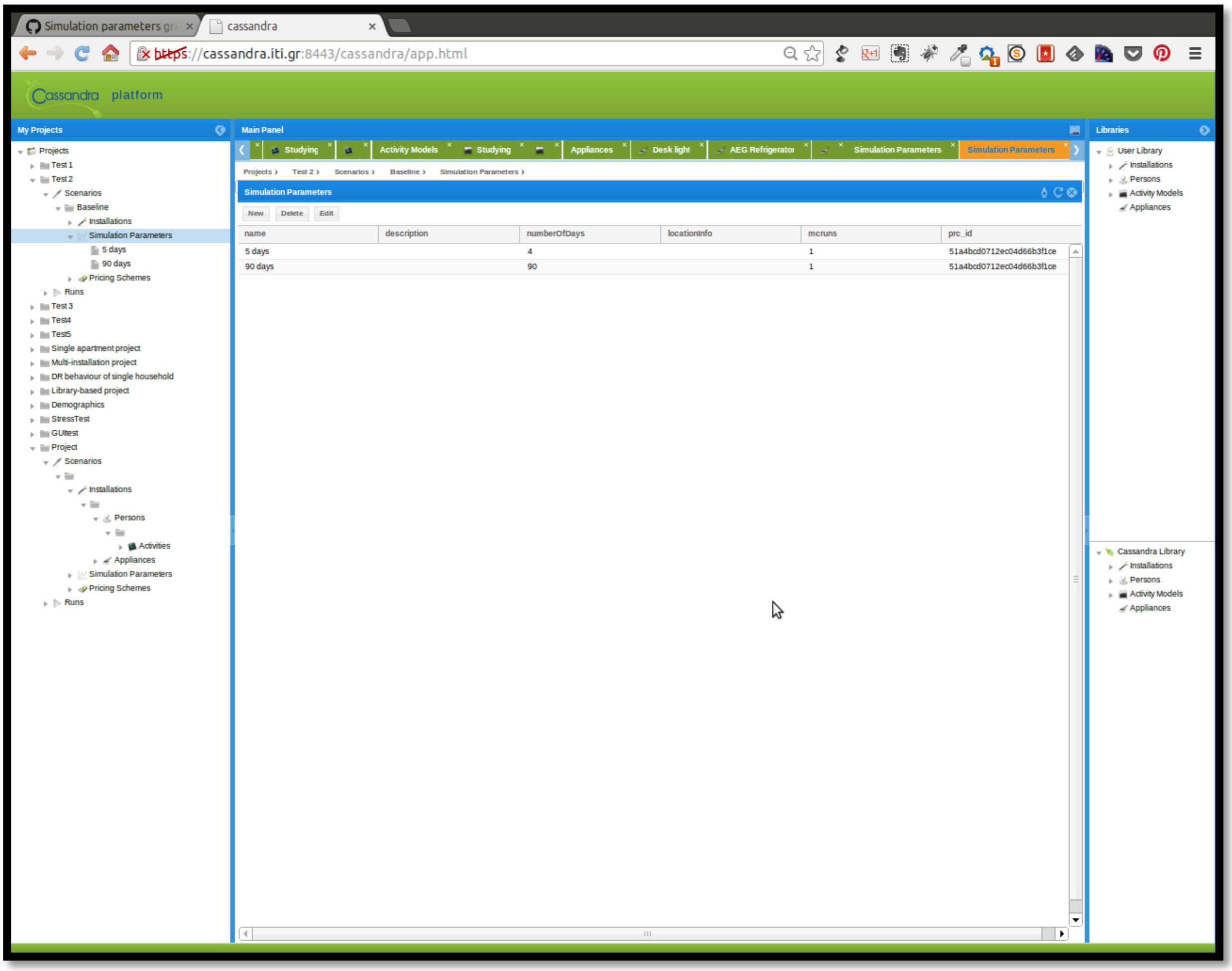


name	description	type	energy_class	standy_consumptio	controllable	shiftable	base	activityModels	consumptionModels
Desk light		Light	Class B	0	false	false	false	1	1
Core 2 Duo PC	Core 2 Duo PC	Desktop PC		0	false	false	false	1	1
LG 42" LCD TV	LG 42LF2500 Z…	TV		0	false	false	false	1	1
Miele S512 Vacu…	Miele S512 Sup…	Vacuum Cleaner		0	false	false	false	1	1
Haier Air Condition	Haier HSU-12RU…	Air Condition		0	false	false	false	0	1
DeLonghi Coffee…	DeLonghi Magnif…	Others		0	false	false	false	1	1
Generic Stove (3…	Generic Stove (3…	Stove		0	false	false	false	1	1
Generic Water H…	Generic Water H…	Water Heater		0	false	false	false	1	1
Generic Oven (2…	Generic Oven (2…	Oven		0	false	false	false	1	1
AEG Refrigerator	AEG Santo S75…	Refrigerator		0	false	false	false	2	1

Figure 13: Appliances grid

2.12 Simulation Parameters (Grid)

By double-clicking the *Simulation Parameters* node, the user can see a grid with the simulation parameters corresponding to a scenario (Figure 14). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.

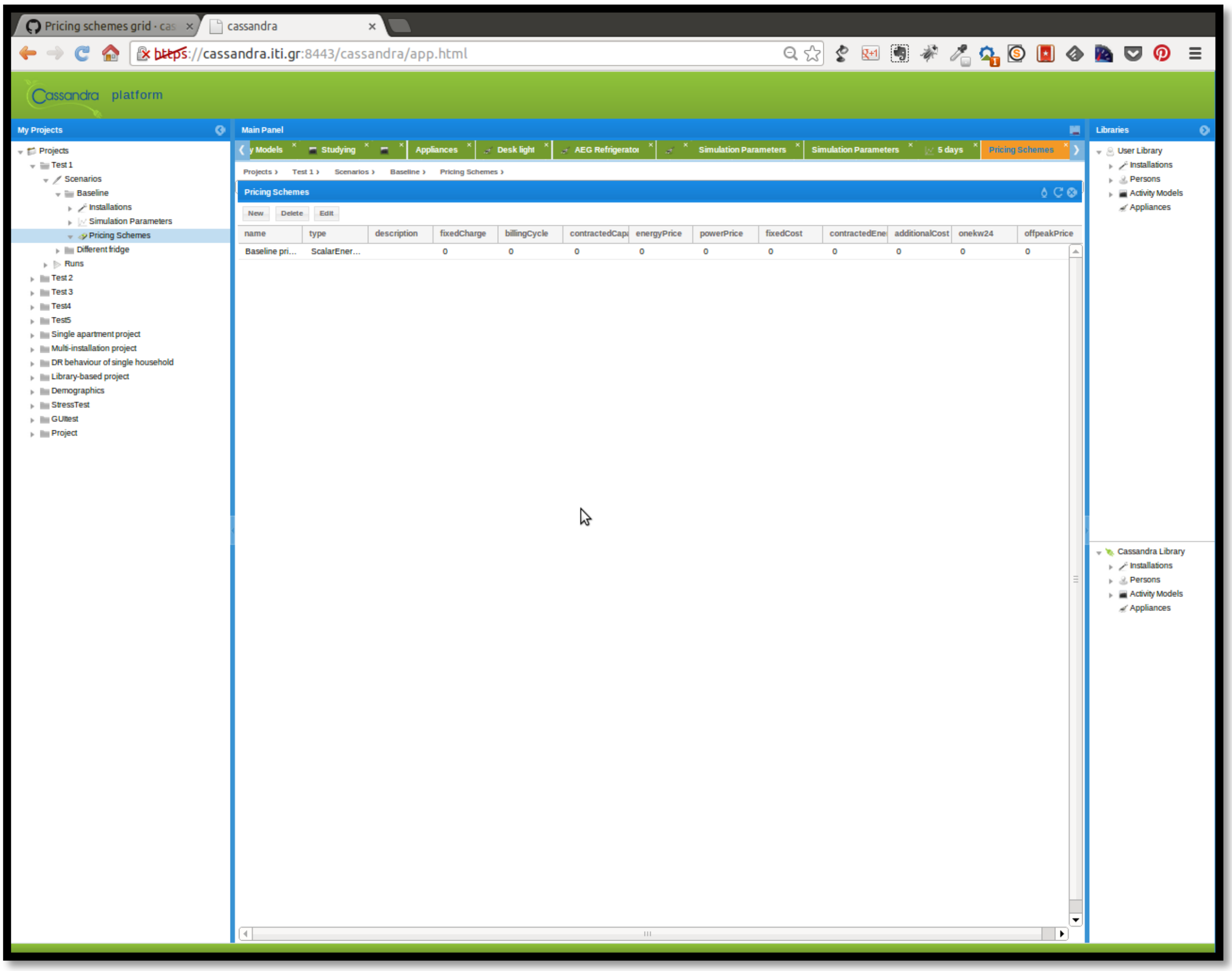


name	description	numberOfDays	locationInfo	mcruns	prc_id
5 days		4		1	51a4bcd0712ec04d66b3f1ce
90 days		90		1	51a4bcd0712ec04d66b3f1ce

Figure 14: Simulation parameters grid

2.13 Pricing Schemes

By double-clicking the Pricing Schemes node, the user can see a grid with the pricing schemes of a scenario (Figure 15). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.



name	type	description	fixedCharge	billingCycle	contractedCapa	energyPrice	powerPrice	fixedCost	contractedEne	additionalCost	onekw24	offpeakPrice
Baseline pri…	ScalarEner…		0	0	0	0	0	0	0	0	0	0

Figure 15: Pricing schemes grid

2.14 Demographics (Grid)

The *Demographics* (node) is included when the scenario is chosen to be a dynamic one. In this case the user does not build the installations one by one, but rather builds a *Collection* installation with a lot of appliances and person types, adding statistics on the distribution of appliances and person types among the generated installations. This way it is easy to construct a variety of installations in the order to 1K, 10K or more installations in an automated manner.

The process is as follows (Figure 16):

1. Declare the scenario as *dynamic*. A *Demographics* node will appear.
2. Create one installation with the name *Collection*.
3. Add in the *Collection* as many persons (with activities and activity models) and appliances (with consumption models) you wish.
4. Create a demographics parameter set.
5. Set the number of entities (Installations for now) you wish to create.

6. Drag and drop persons and appliances from the *Collection* installation to the grid Entities, also setting their probability of participating. The probabilities for person types should sum up to 1, while probabilities for each appliance should be between 0 and 1.

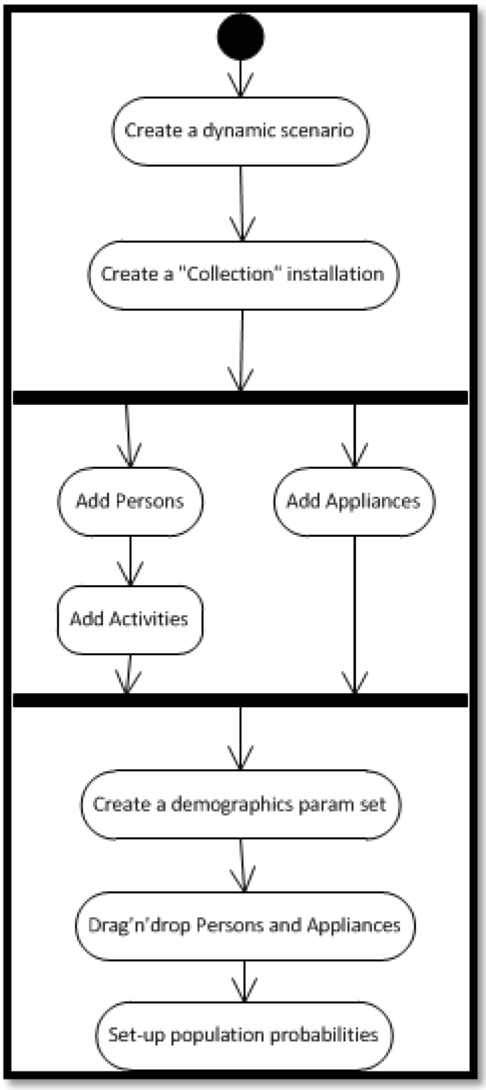
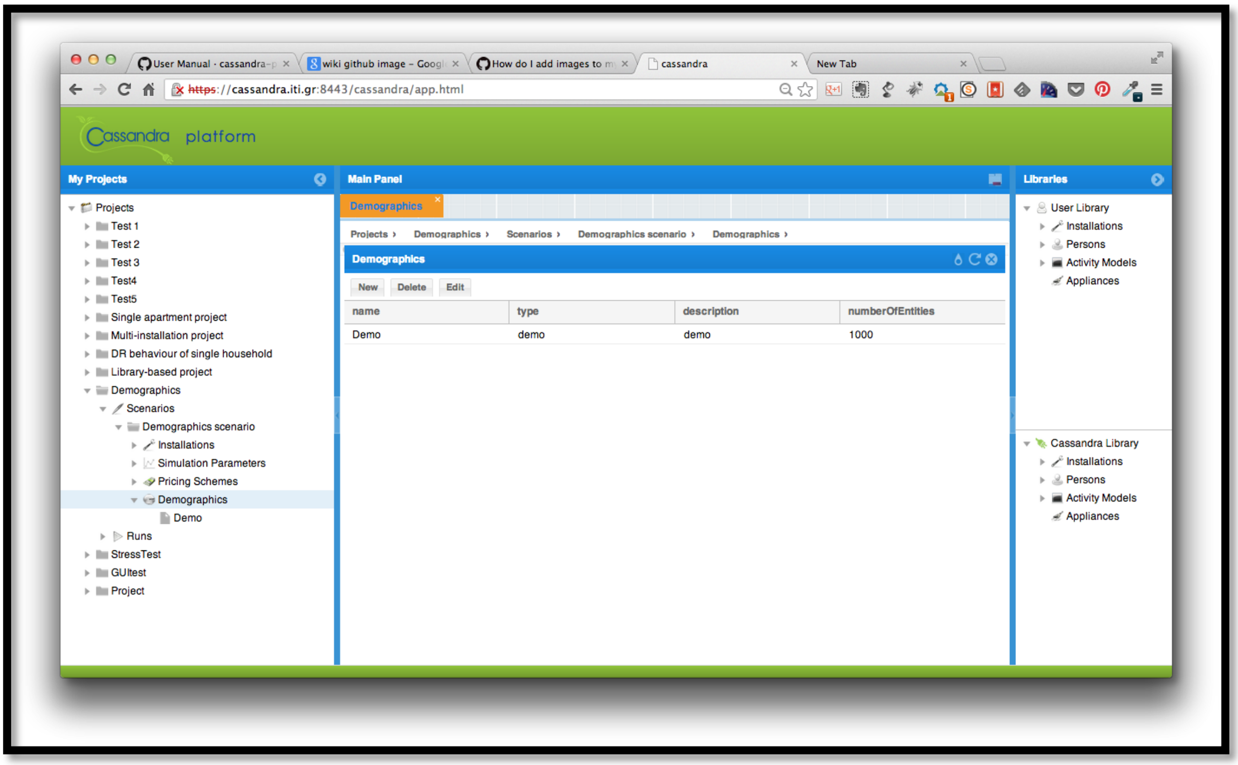

Create a dynamic scenario
Create a "Collection" installation
Add Persons
Add Appliances
Add Activities
Create a demographics param set
Drag'n'drop Persons and Appliances
Set-up population probabilities

Figure 16 Activity diagram for creating a dynamic scenario

By double-clicking on the *Demographics* node, the user can see a grid with the demographics parameter sets of a dynamic scenario (Figure 17). The available commands are to create a new one and edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.



name	type	description	numberOfEntities
Demo	demo	demo	1000

Figure 17: Demographics grid

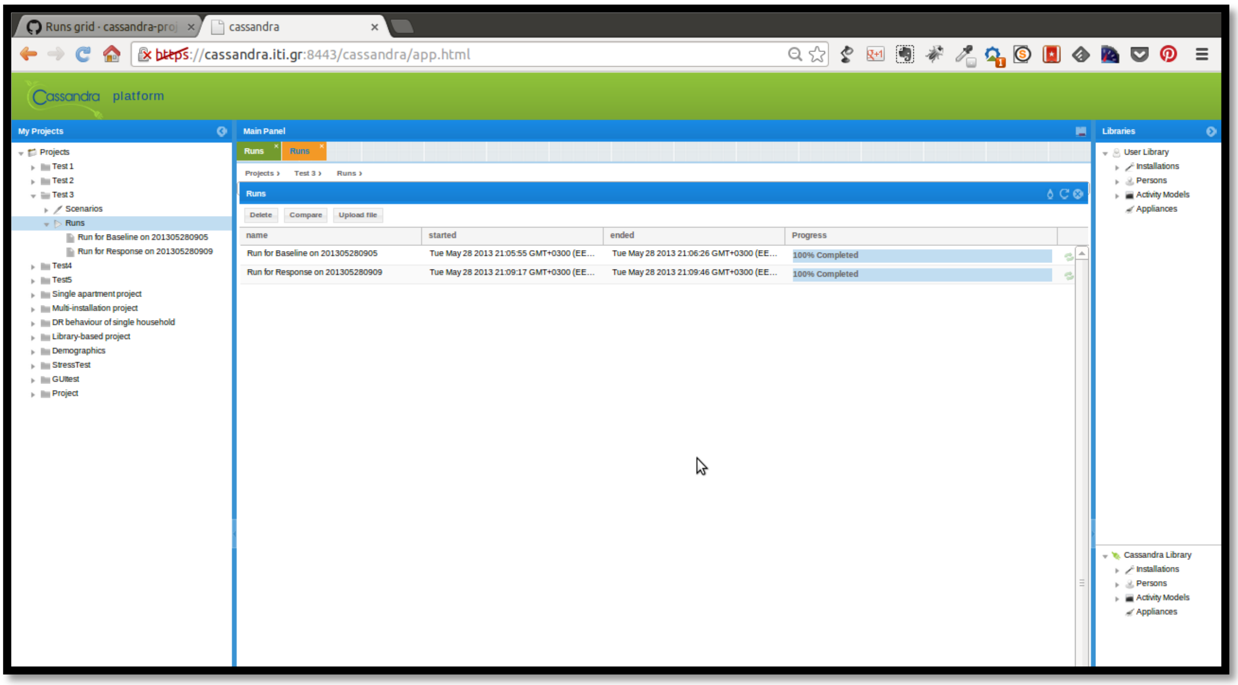
2.15 Runs

By double-clicking on the *Runs* node, the user gets a grid with the runs of scenarios of the corresponding project (Figure 18). The user can delete a *Run*, watch the progress by pressing the *Refresh* button of incomplete *Runs*, or compare runs by selecting multiple *Runs* (Ctrl+click) and then pressing the *Compare* button (Figure 19). Through this tab the user can also upload a file with electrical measurements in order to compare it with the simulation results. The format of the uploaded file should be CSV and it structure should be like the following example:

```
minute, inst1, inst2
  0, 123.00, 100.50
  1, 123.50, 100.50
  2, 120.32, 100.50
```

where the header row includes the names of the installations.

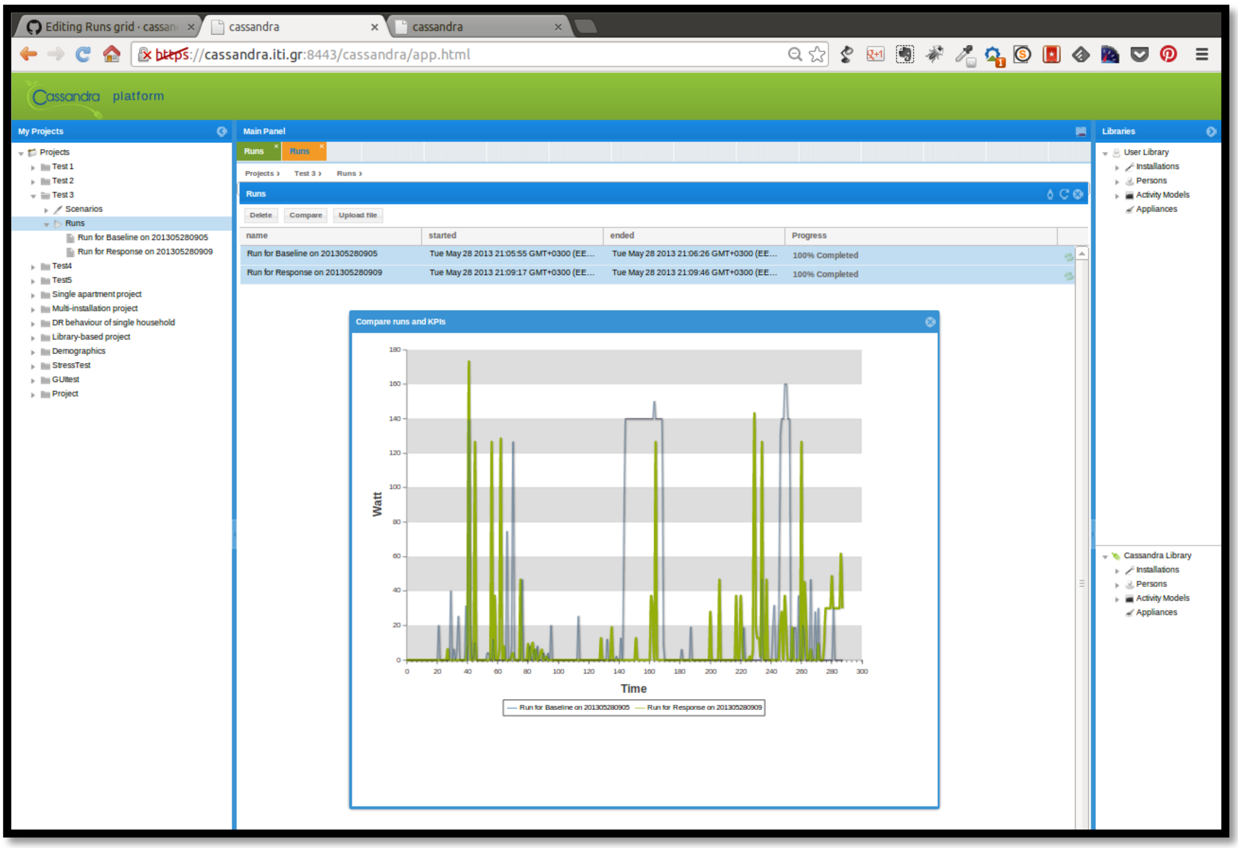
Last but not least, after selecting a run, the user can choose to create a CSN using the simulated results of the run.



- Projects
  - Test 1
  - Test 2
  - Test 3
    - Scenarios
    - Runs
      - Run for Baseline on 201305280905
      - Run for Response on 201305280909
  - Test4
  - Test5
  - Single apartment project
  - Multi-installation project
  - DR behaviour of single household
  - Library-based project
  - Demographics
  - StressTest
  - GUItest
  - Project

name	started	ended	Progress
Run for Baseline on 201305280905	Tue May 28 2013 21:05:55 GMT+0300 (EE...	Tue May 28 2013 21:06:26 GMT+0300 (EE...	100% Completed
Run for Response on 201305280909	Tue May 28 2013 21:09:17 GMT+0300 (EE...	Tue May 28 2013 21:09:46 GMT+0300 (EE...	100% Completed

Figure 18: Runs grid



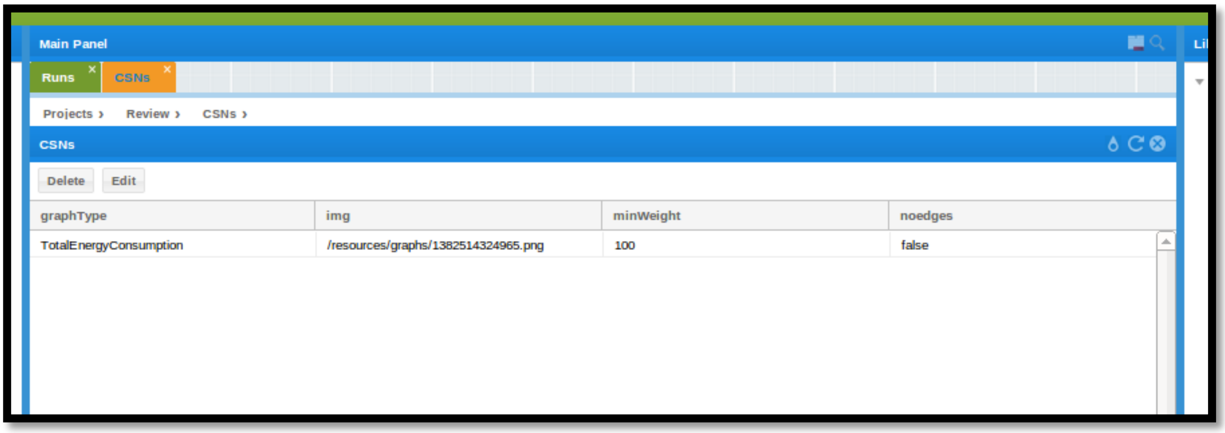
- Projects
  - Test 1
  - Test 2
  - Test 3
    - Scenarios
    - Runs
      - Run for Baseline on 201305280905
      - Run for Response on 201305280909
  - Test4
  - Test5
  - Single apartment project
  - Multi-installation project
  - DR behaviour of single household
  - Library-based project
  - Demographics
  - StressTest
  - GUItest
  - Project

name	started	ended	Progress
Run for Baseline on 201305280905	Tue May 28 2013 21:05:55 GMT+0300 (EE...	Tue May 28 2013 21:06:26 GMT+0300 (EE...	100% Completed
Run for Response on 201305280909	Tue May 28 2013 21:09:17 GMT+0300 (EE...	Tue May 28 2013 21:09:46 GMT+0300 (EE...	100% Completed

Figure 19: Comparison functionality

2.16 CSNs

By double-clicking the *CSNs* node, the user can see a grid with the CSNs of a project (Figure 20). The available commands are to edit or delete an existing one, by first selecting the corresponding row and then pressing either *edit* or *delete*.



graphType	img	minWeight	noedges
TotalEnergyConsumption	/resources/graphs/1382514324965.png	100	false

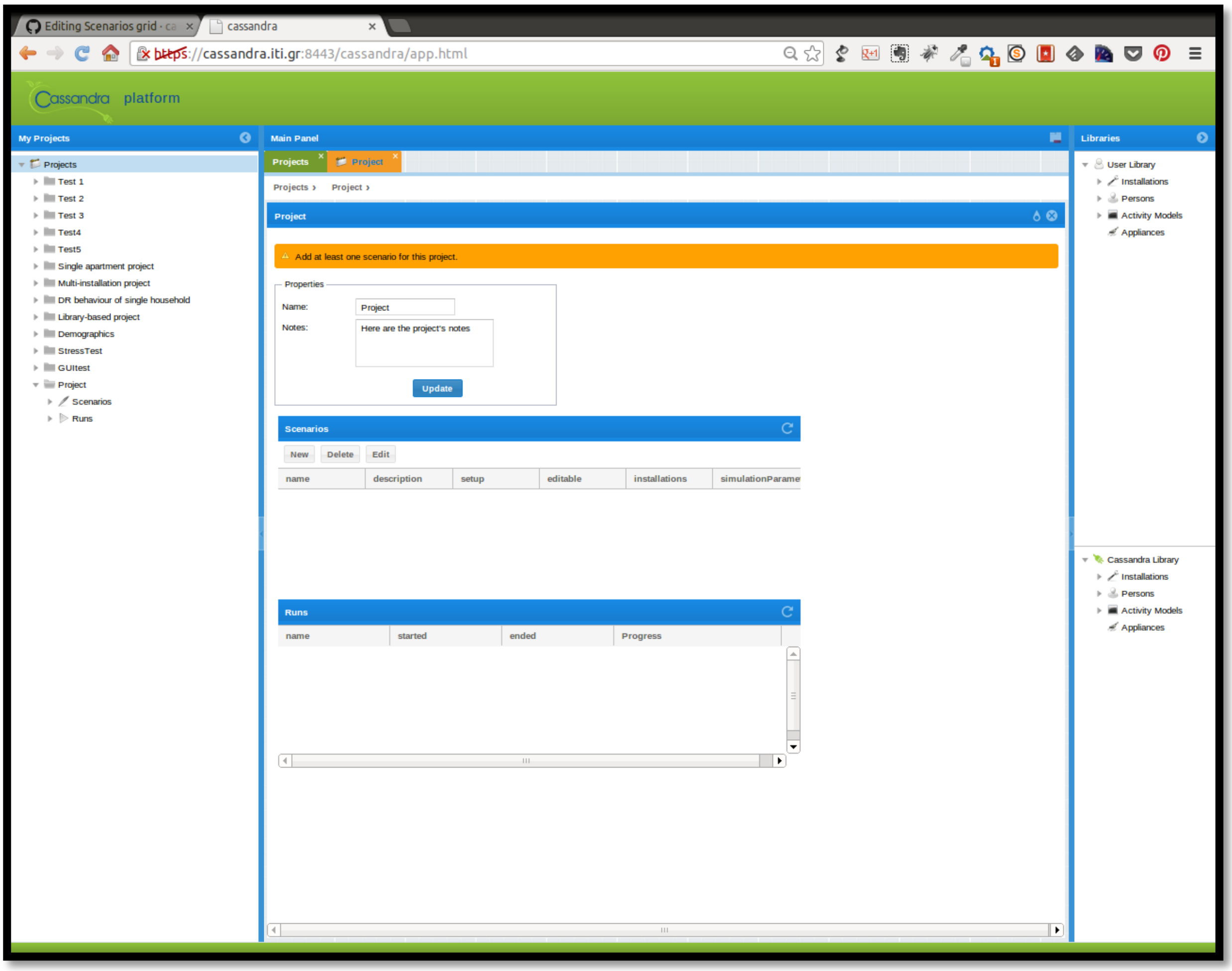
Figure 20: CSNs

2.17 Project

When creating/editing a project (Figure 21), the user enters the following data:

- Name: the name of the project
- Notes: a short description of the project

Upon creating/editing a project the user is informed that at least one scenario should be created under that specific project. The information/warning messages guide the user into creating a complete simulation scenario.



Add at least one scenario for this project.

Name: Project

Notes: Here are the project's notes

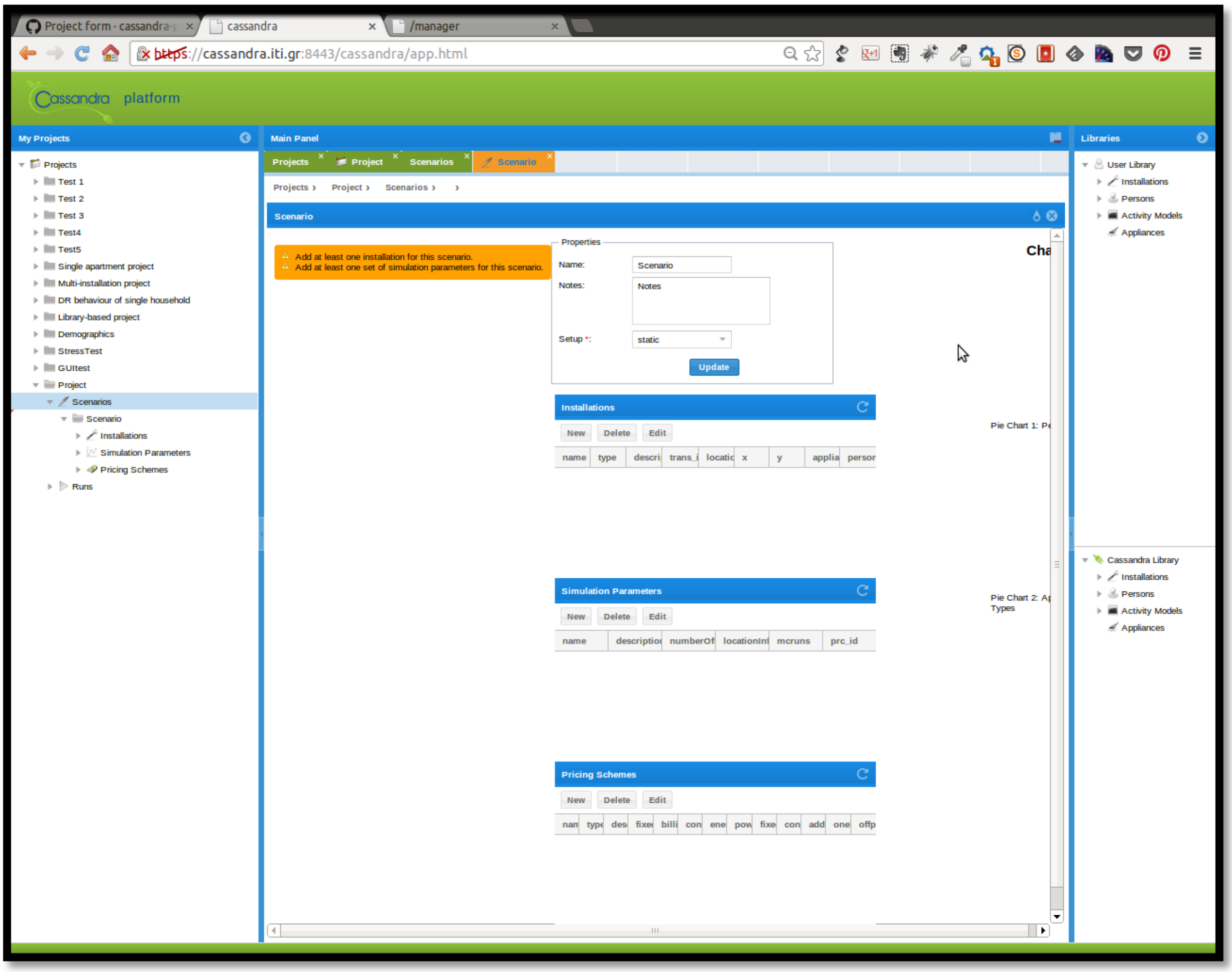
Figure 21: Project form

2.18 Scenario

When creating/editing a scenario (Figure 22), the user enters the following data:

- Name: the name of the scenario
- Notes: a short description of the scenario
- Setup: a selection between *Static* and *Dynamic* scenario setups. In the *Static* case the user builds the scenario step-by-step (probably the best choice for small scenarios, or for larger scenarios with available measurements), while in the *Dynamic* case the user enters demographic data and the platform populates installations based on those demographics.

Each scenario should have at least one complete installation and the necessary simulation parameters set so that it can be simulated.



⚠ Add at least one installation for this scenario.
⚠ Add at least one set of simulation parameters for this scenario.

Properties

Name: Scenario

Notes: Notes

Setup *: static

Update

Installations

New Delete Edit

name	type	descri	trans_i	locatic	x	y	applia	persor

Simulation Parameters

New Delete Edit

name	descriptio	numberOf	locationInf	mcruns	prc_id

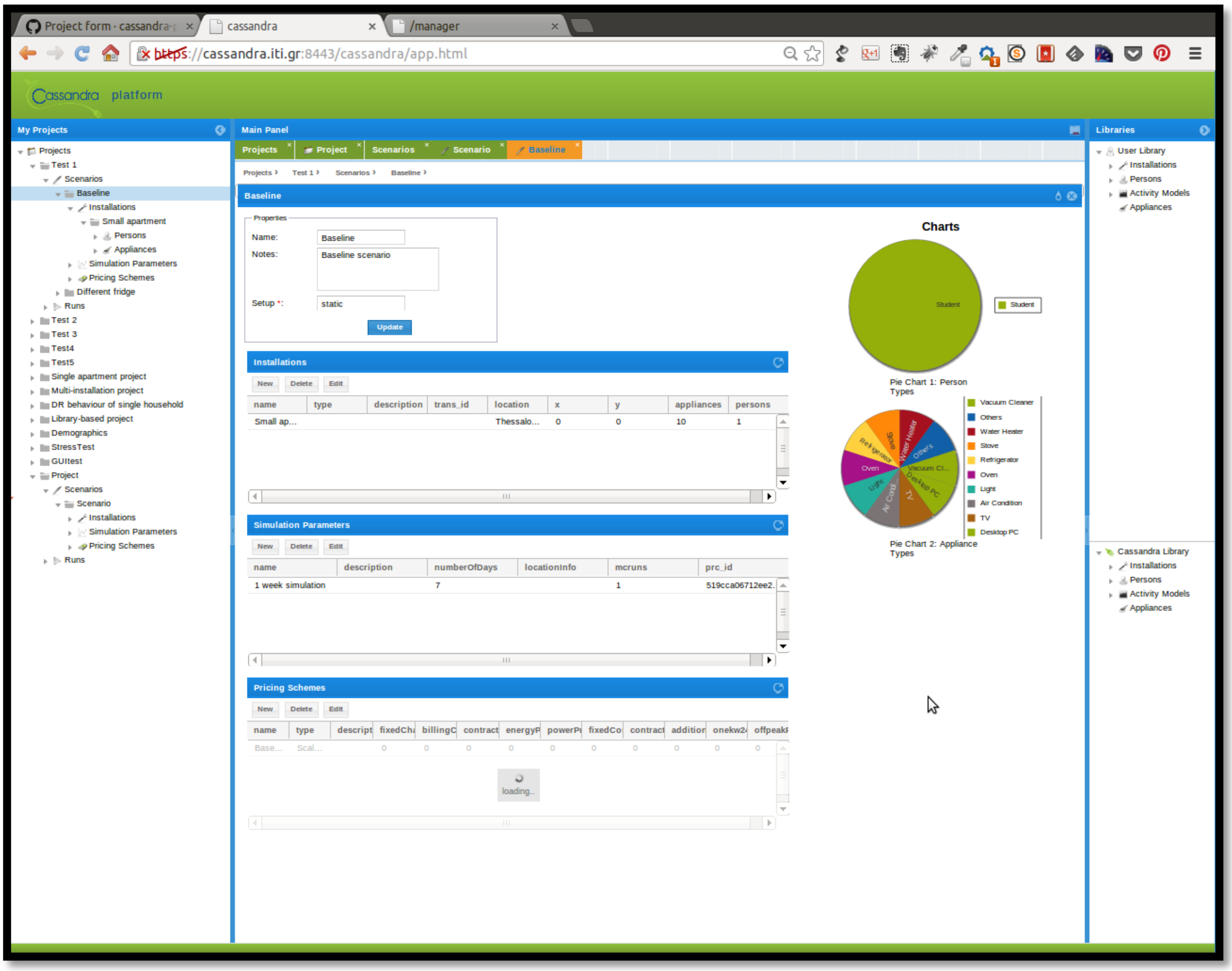
Pricing Schemes

New Delete Edit

nan	type	des	fixe	billi	con	ene	pow	fixe	con	add	one	offp

Figure 22: Scenario form

In a complete scenario, the user may observe statistics on person types and appliances comprising the scenario (pie chart diagrams - Figure 23).



Baseline

Properties

Name: Baseline

Notes: Baseline scenario

Setup *: static

Installations

name	type	description	trans_id	location	x	y	appliances	persons
Small ap...				Thessalo...	0	0	10	1

Simulation Parameters

name	description	numberOfDays	locationInfo	mcruns	prc_id
1 week simulation		7		1	519cca06712ee2.

Pricing Schemes

name	type	descript	fixedCha	billingC	contract	energyP	powerPr	fixedCo	contract	addition	onekw24	offpeakF
Base...	Scal...		0	0	0	0	0	0	0	0	0	0

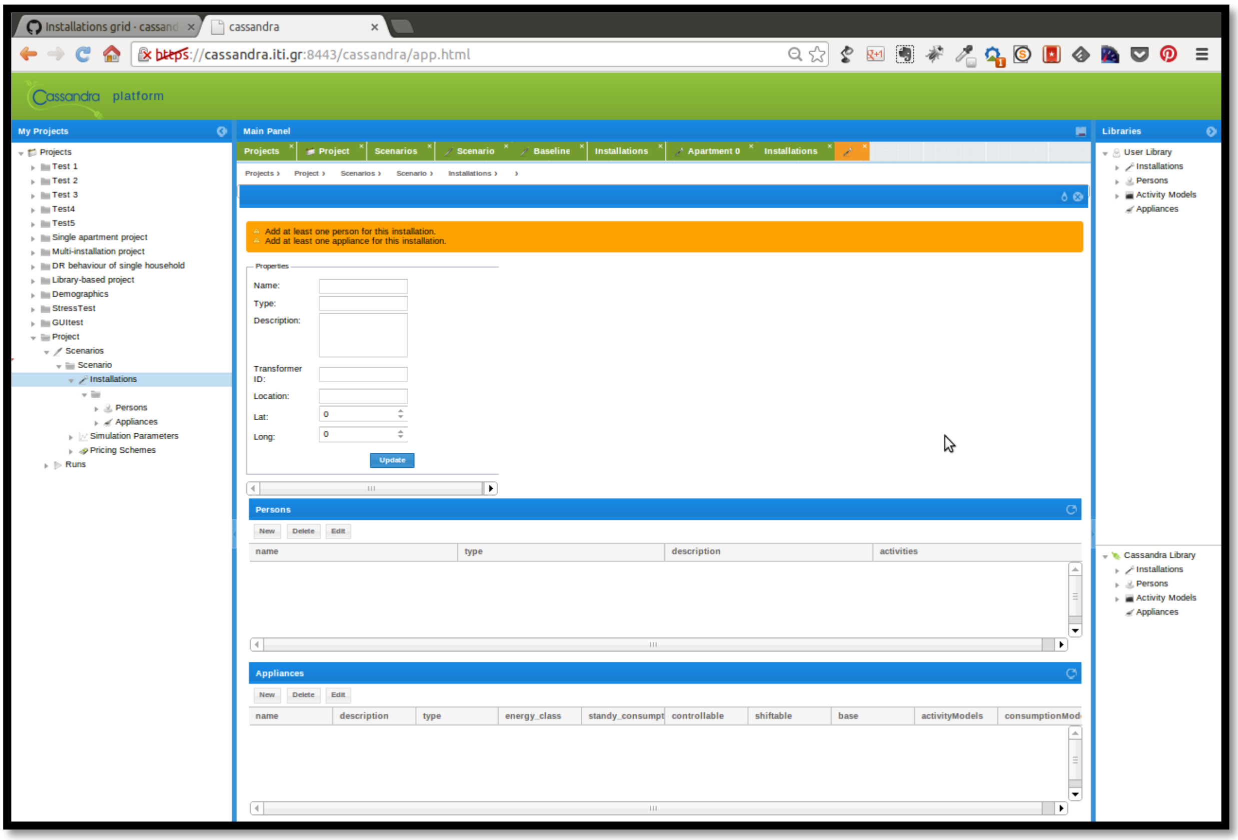
Figure 23: Complete scenario

2.19 Installation

When creating/editing an installation (**Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**, Figure 25), the user enters the following data:

- Name: the name of the installation
- Type: the type of the installation
- Description: a description of the installation
- Transformer ID: a label indicating the ID of the transformer under which the installation is located.
- Location: the location of the installation
- Lat: the latitude of the installation's geolocation
- Long: the longitude of the installation's geolocation

Each installation should be consisted of at least one complete person and appliance.


https://cassandra.iti.gr:8443/cassandra/app.html
Cassandra platform
My Projects
Main Panel
Libraries
Projects › Project › Scenarios › Scenario › Installations ›

⚠ Add at least one person for this installation.
⚠ Add at least one appliance for this installation.

Properties

Name:

Type:

Description:

Transformer ID:

Location:

Lat: 0

Long: 0

Update

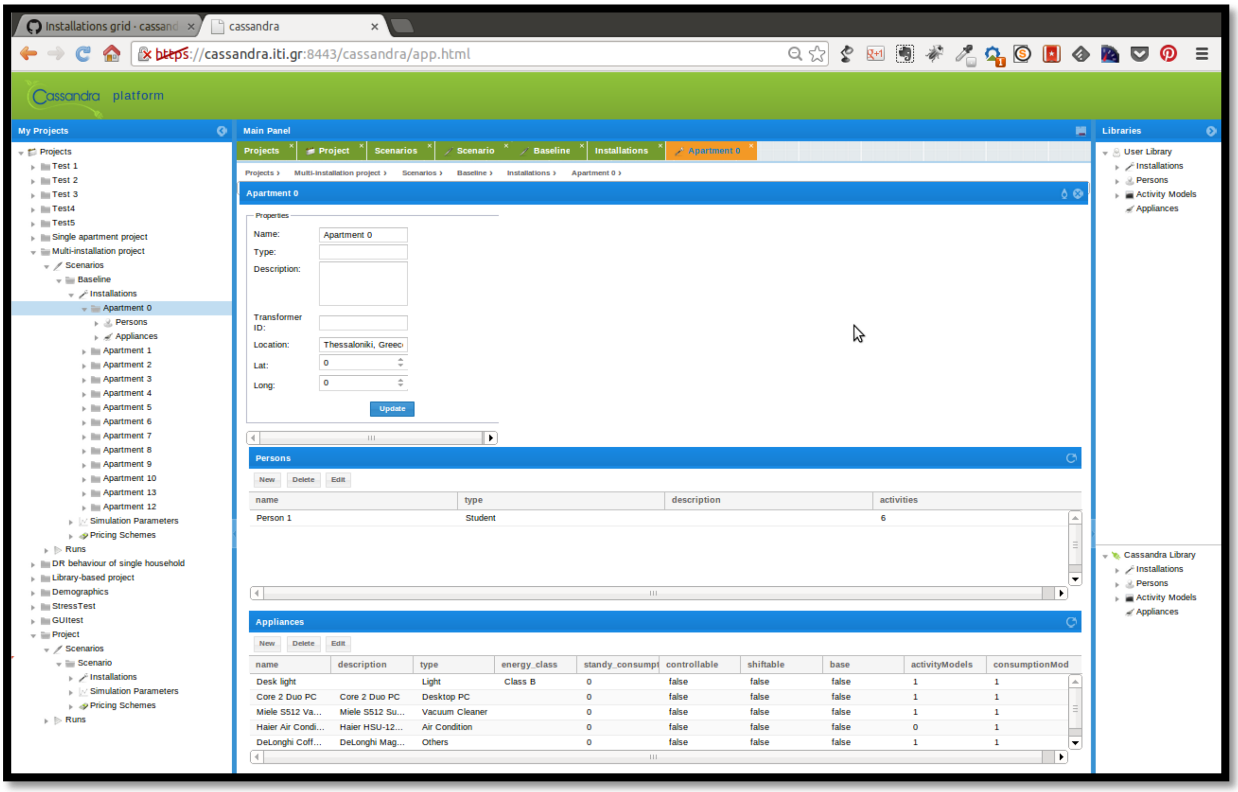
Persons

name	type	description	activities

Appliances

name	description	type	energy_class	standy_consumpt	controllable	shiftable	base	activityModels	consumptionMod

Figure 24: Installation form


https://cassandra.iti.gr:8443/cassandra/app.html
Cassandra platform
My Projects
Main Panel
Libraries
Projects › Multi-installation project › Scenarios › Baseline › Installations › Apartment 0 ›

Apartment 0

Properties

Name: Apartment 0

Type:

Description:

Transformer ID:

Location: Thessaloniki, Greec

Lat: 0

Long: 0

Update

Persons

name	type	description	activities
Person 1	Student		6

Appliances

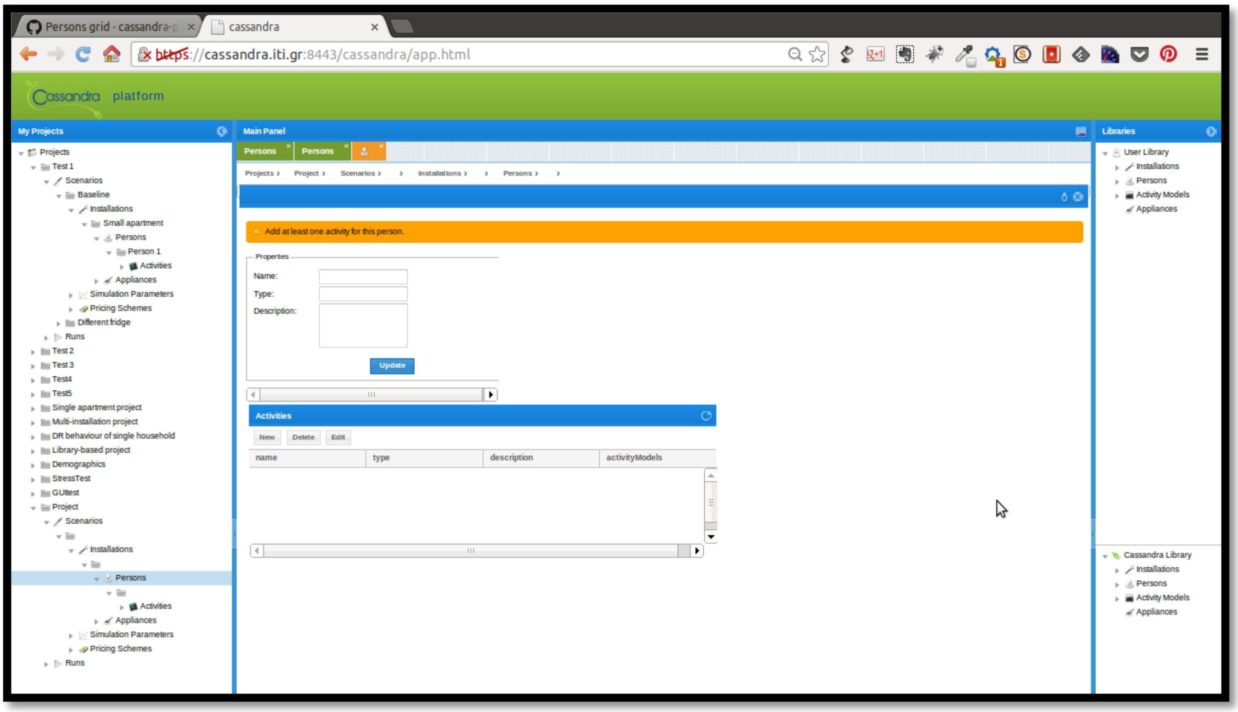
name	description	type	energy_class	standy_consumpt	controllable	shiftable	base	activityModels	consumptionMod
Desk light		Light	Class B	0	false	false	false	1	1
Core 2 Duo PC	Core 2 Duo PC	Desktop PC		0	false	false	false	1	1
Miele S512 Va...	Miele S512 Su...	Vacuum Cleaner		0	false	false	false	1	1
Haier Air Condi...	Haier HSU-12...	Air Condition		0	false	false	false	0	1
DeLonghi Coff...	DeLonghi Mag...	Others		0	false	false	false	1	1

Figure 25: Completed installation form

2.20 Person

When creating/editing a person (**Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**, Figure 27), the user enters the following data:

- Name: the name of the person
- Type: the type of the person
- Description: a short description of the person



Add at least one activity for this person.

Properties

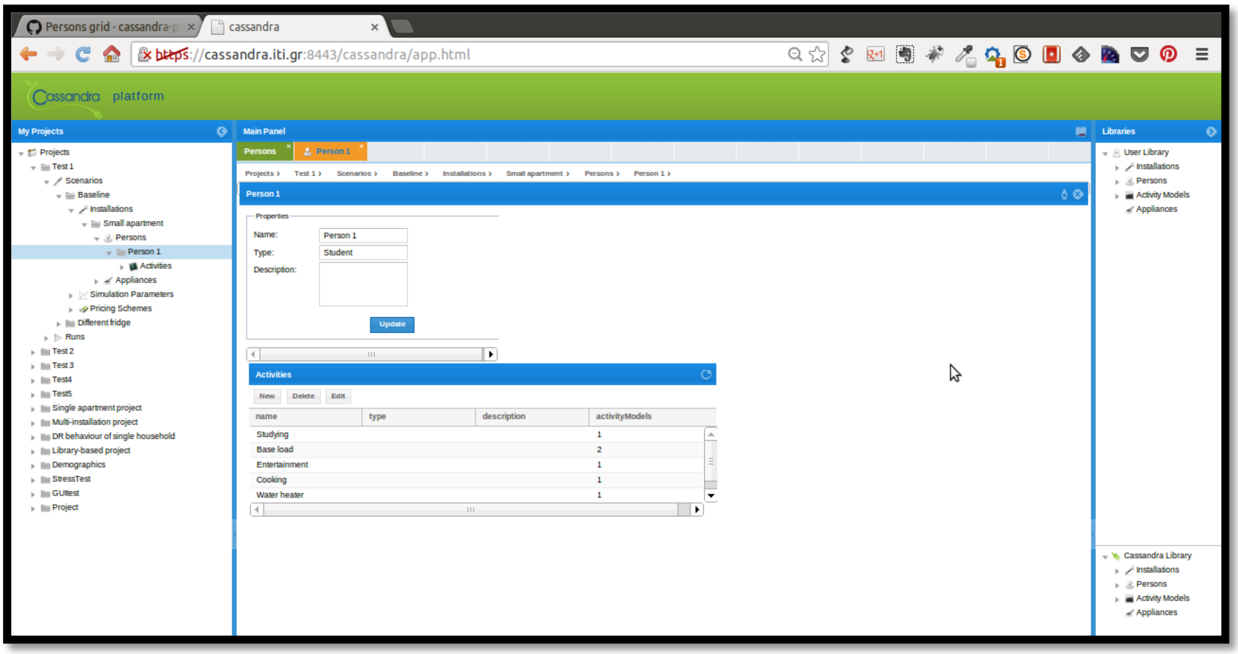
Name:

Type:

Description:

name	type	description	activityModels

Figure 26: Person form



Person 1

Properties

Name:	Person 1
Type:	Student
Description:	

Update

Activities

New Delete Edit

name	type	description	activityModels
Studying			1
Base load			2
Entertainment			1
Cooking			1
Water heater			1

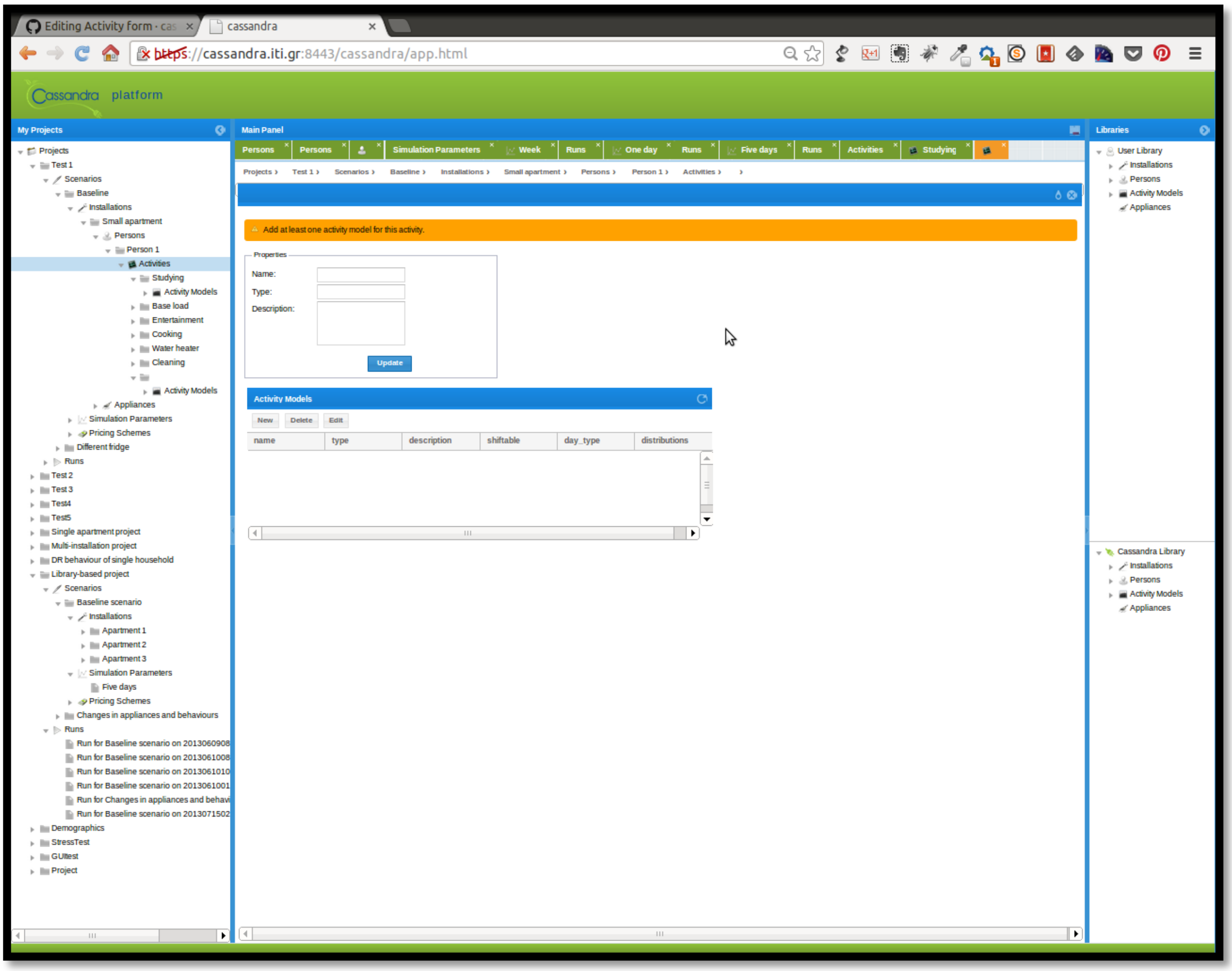
Figure 27: Completed person form

2.21 Activity

When creating/editing an activity (Figure 28, Figure 29), the user enters the following data:

- Name: the name of the activity
- Type: the type of the activity
- Description: a short description of the activity

Each activity should have at least one activity model defining the probabilistic behavior of the person using the appliances participating in the activity.

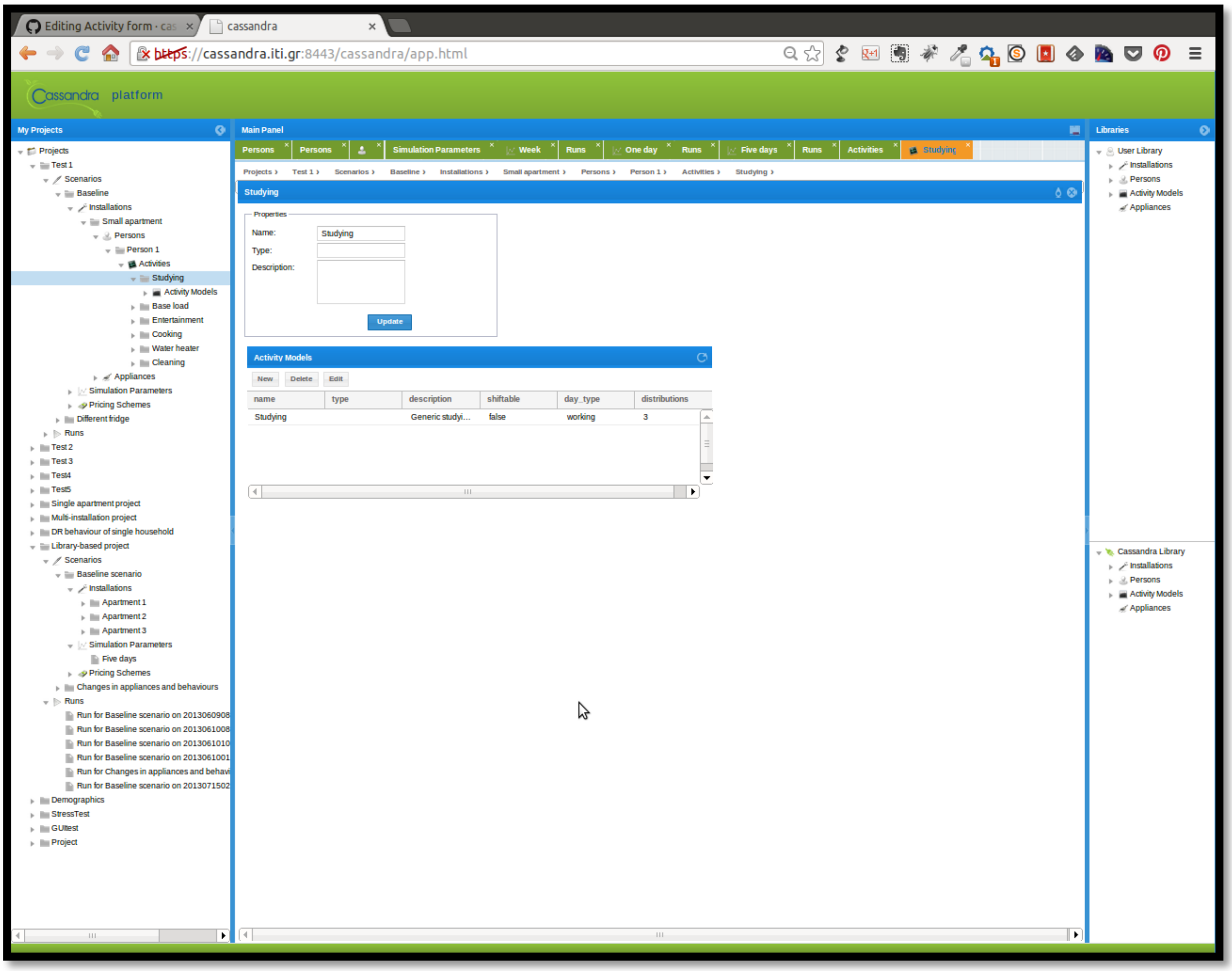


Add at least one activity model for this activity.

Name:
Type:
Description:

name	type	description	shiftable	day_type	distributions

Figure 28: Activity form



Name: Studying

Type:

Description:

name	type	description	shiftable	day_type	distributions
Studying		Generic studyi...	false	working	3

Figure 29: Completed activity form

2.22 Activity Model

When creating/editing an activity model (Figure 30, Figure 31), the user enters the following data:

- Name: the name of the activity model
- Type: the type of the activity model
- Description: a short description of the activity model
- Day type: the day type the activity model corresponds to:
    - any day
    - weekday or weekend
    - abbreviations of specific weekdays, i.e. [Mon, Tue, Sat]
    - specific days formated as 1/12, 31/10 etc.
- Shiftable: whether the activity model can be considered shiftable or not

It is important to note that for every activity and every time tick only one activity model is fired.

So if you have specified in an activity one activity model of Day type any and one of Day type weekdays and the simulation day is Monday then the more specific of the two will be fired, i.e. the activity model with Day type weekdays.

For every activity model the user can drag-n-drop appliances that participate in it.

To complete the activity model the user must provide the properties and parameters of three distributions that specify an activity model:

- *Duration,*
- *Start-time*, and
- *Number of times per day*,

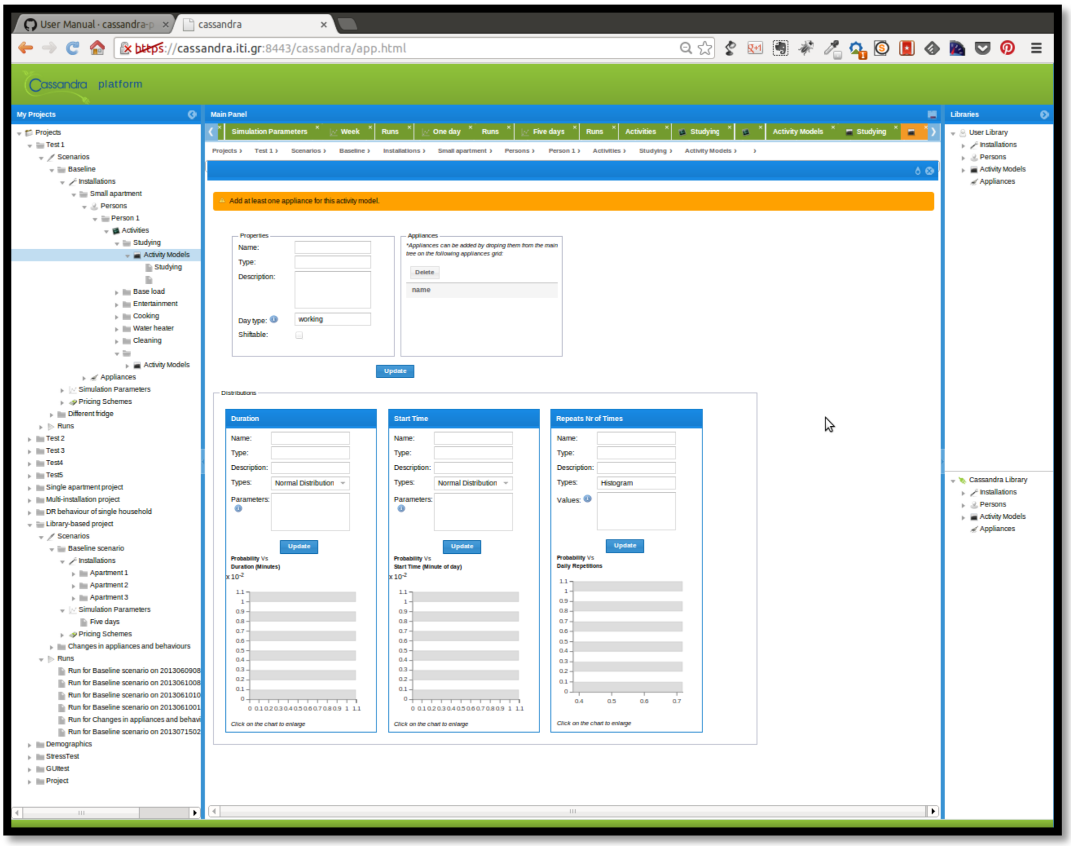
All the above are probabilistic models of how long the activity takes, at what time in day it starts and how many times per day is executed.

For the first two characteristics the user can select between several types of distributions:

- Uniform Distribution, in the form of an expression with start and end values: [{"start":100,"end":200}]
- Histogram, in the form of values: [1,2,3,4...]
- Normal Distribution, in the form of an expression with mean and std values: [{"mean":45,"std":10}]
- Gaussian Mixture Models, in the form of tuples of w, mean and std: [{"w":0.5 , "mean":45,"std":10}, {"w":0.5 , "mean":100,"std":10}]

Another important note is that in GMMs weights should sum up to 1.

Under normal system operation, these distributions will be automatically computed via measurements obtained from the actual installation, or by altering an *Activity Model* found in the *Libraries*.



Add at least one appliance for this activity model.

Properties

Name:

Type:

Description:

Day type: working

Shiftable: □

Appliances

*Appliances can be added by droping them from the main tree on the following appliances grid:

Delete

name

Update

Distributions

Duration

Name:

Type:

Description:

Types: Normal Distribution

Parameters:

Update

Start Time

Name:

Type:

Description:

Types: Normal Distribution

Parameters:

Update

Repeats Nr of Times

Name:

Type:

Description:

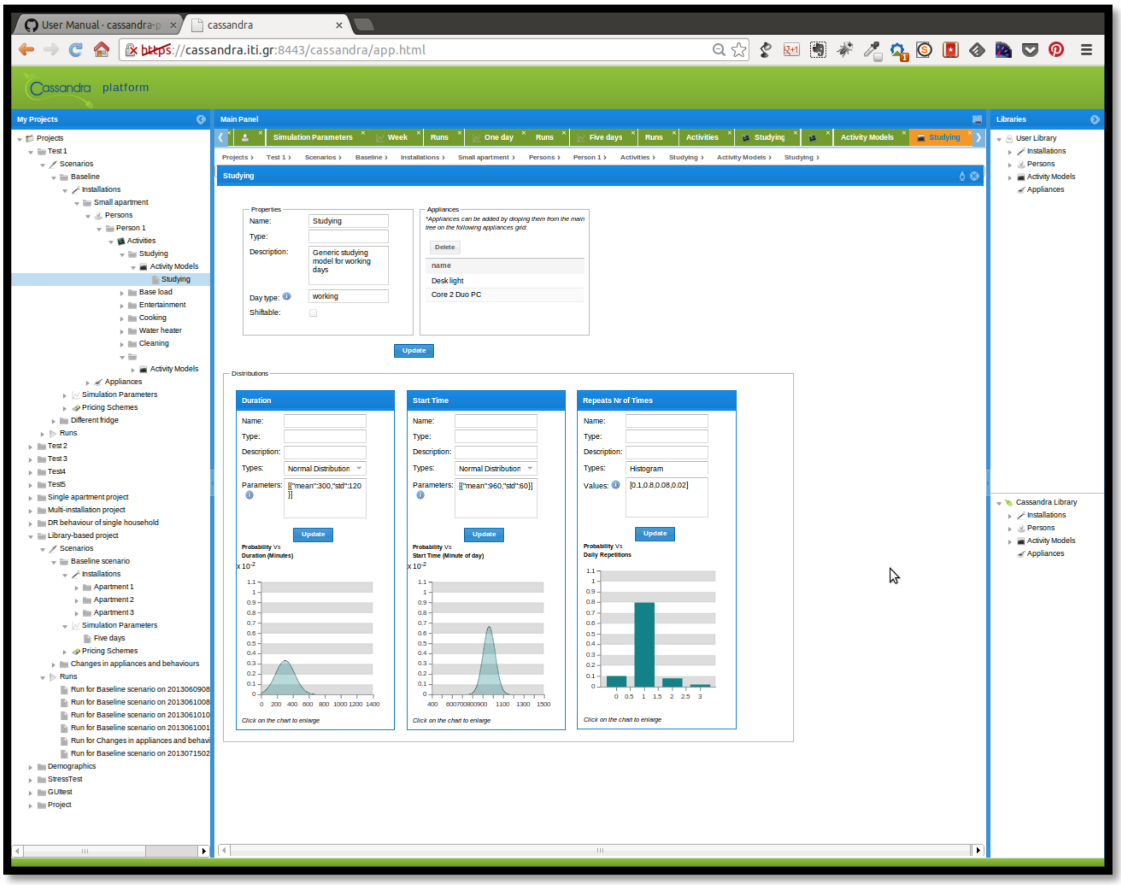
Types: Histogram

Values:

Update

Probability vs Duration (Minutes)
Probability vs Start Time (Minute of day)
Probability vs Daily Repetitions
Click on the chart to enlarge

Figure 30: Activity Model form


https://cassandra.iti.gr:8443/cassandra/app.html
Cassandra platform
My Projects
Main Panel
Libraries
Simulation Parameters
Week
Runs
One day
Runs
Five days
Runs
Activities
Studying
Activity Models
Studying
Projects › Test 1 › Scenarios › Baseline › Installations › Small apartment › Persons › Person 1 › Activities › Studying › Activity Models › Studying ›
Probability Vs Duration (Minutes)
Probability Vs Start Time (Minute of day)
Probability Vs Daily Repetitions
Click on the chart to enlarge

Studying

Properties

Name: Studying

Type:

Description: Generic studying model for working days

Day type: working

Shiftable: □

Appliances

*Appliances can be added by droping them from the main tree on the following appliances grid:

Delete

name
Desk light
Core 2 Duo PC

Update

Distributions

Duration

Name:

Type:

Description:

Types: Normal Distribution

Parameters: [{"mean":300,"std":120 }]

Update

Start Time

Name:

Type:

Description:

Types: Normal Distribution

Parameters: [{"mean":960,"std":60}]

Update

Repeats Nr of Times

Name:

Type:

Description:

Types: Histogram

Values: [0.1,0.8,0.08,0.02]

Update

Figure 31: Completed activity model form

2.23 Appliance and Consumption Model

When creating/editing an appliance (Figure 32, Figure 33), the user enters the following data:

- Name: the name of the appliance
- Type: the type of the appliance
- Description: a short description of the appliance
- Energy Class: the energy class of the appliance
- Stand By: the stand-by consumption power
- Base: whether the appliance constitutes a base load
- Shiftable: whether the appliance is shiftable
- Controllable: whether the appliance is controllable

and with respect to the consumption model:

- Name: the name of the consumption model
- Description: a short description of the consumption model
- P-Expression: the expression that provides the active power curve
- Q-Expression: the expression that provides the re-active power curve

P-Expression and *Q-Expression* have the following form:

$$\{m\ \{n_1\ [p_1,d_1,s_1]\ [p_2,d_2,s_2]\},\ \{n_2\ [p_3,d_3,s_3]\},\ ...\}$$

and

$$\{m\ \{n_1\ [q_1,d_1,s_1]\ [q_2,d_2,s_2]\},\ \{n_2\ [q_3,d_3,s_3]\},\ ...\}$$

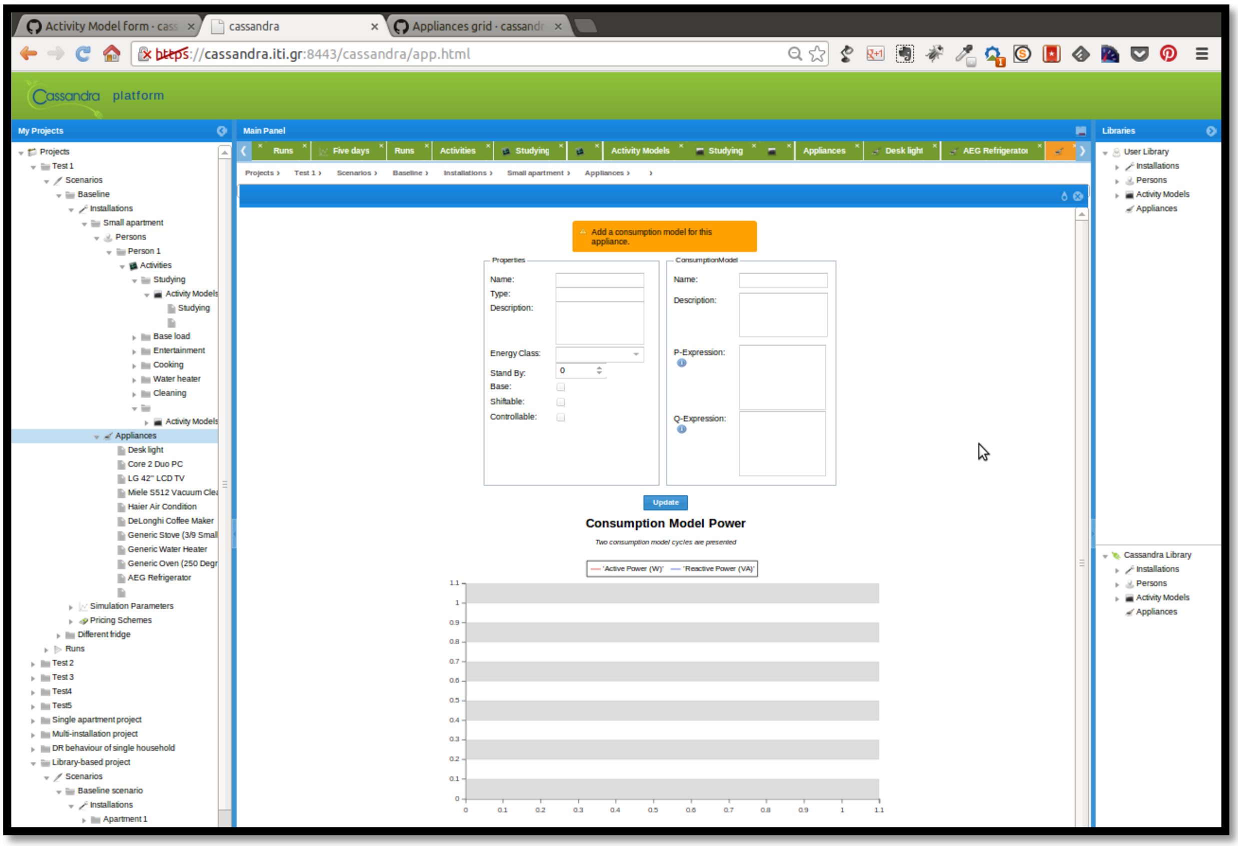
respectively, with:

- *p*: active power
- *q*: reactive power
- *d*: duration in minutes
- *s*: slope

Tuples p_1 and p_2 will be executed for n_1 timesteps and then p_3 tuple for n_2 timesteps. Those n_1*2+n_2 timesteps (since there will be n_1 steps for p_1/q_1 and n_1 steps for p_2/q_2) will be executed *m* times. Of course there can be n_3, n_4 etc. For loops we can set either *m* or *n* to 0. For example, lamp: {m=0 {n_1=1 [60,1,0]}}, refrigerator:

{"n":0,"params":[{"n":1,"values":[{"p":140,"d":20,"s":0},{"p":117,"d":18,"s":0},{"p":0,"d":73,"s":0}]}]}

Every appliance should have a consumption model.



Add a consumption model for this appliance.

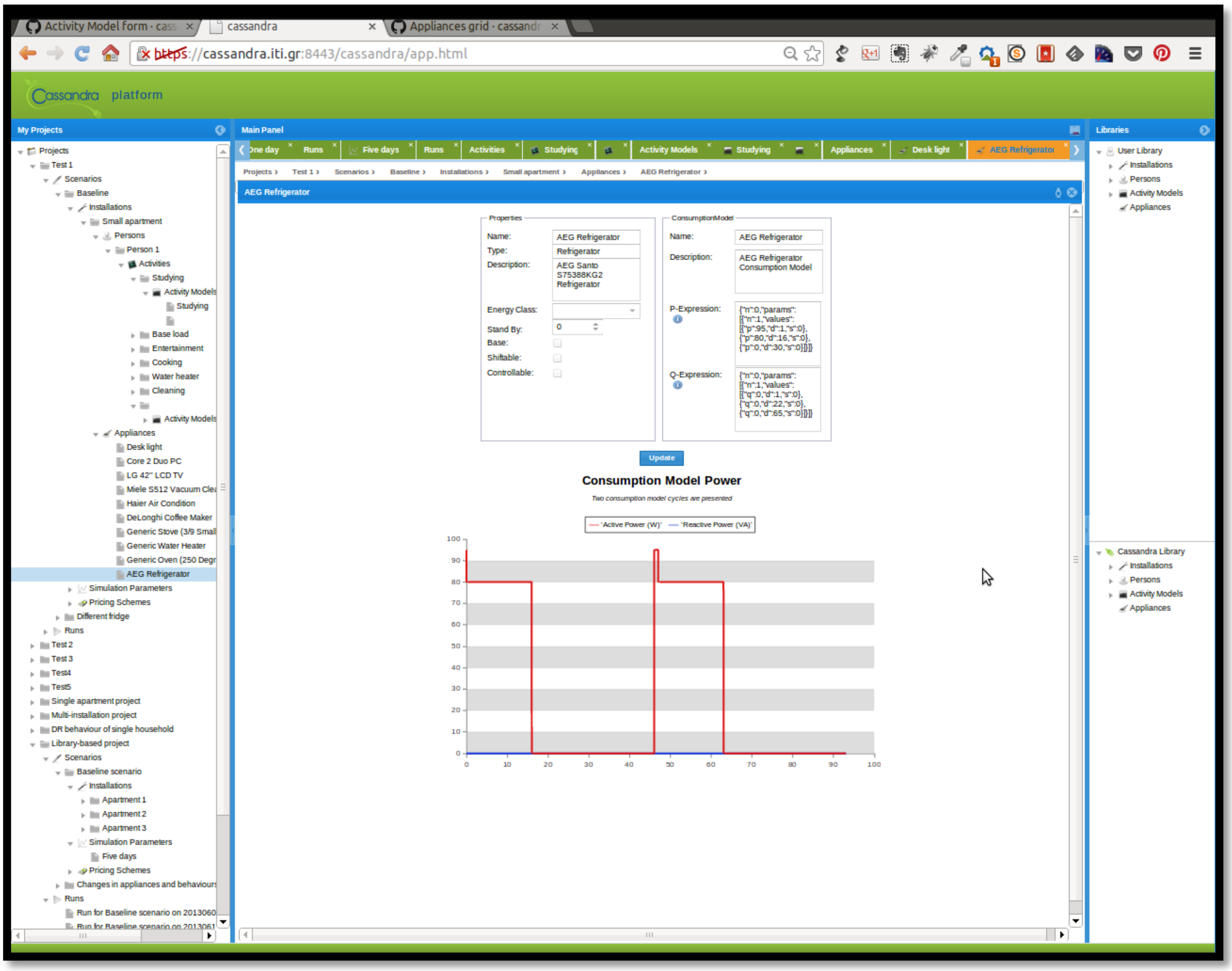
Properties

Name:
Type:
Description:
Energy Class:
Stand By: 0
Base: □
Shiftable: □
Controllable: □

ConsumptionModel

Name:
Description:
P-Expression:
Q-Expression:

Figure 32: Appliance form



Properties

Name:	AEG Refrigerator
Type:	Refrigerator
Description:	AEG Santo S75388KG2 Refrigerator
Energy Class:	
Stand By:	0
Base:	□
Shiftable:	□
Controllable:	□

ConsumptionModel

Name:	AEG Refrigerator
Description:	AEG Refrigerator Consumption Model
P-Expression:	{"n":0,"params":[{"n":1,"values":[{"p":95,"d":1,"s":0},{"p":80,"d":16,"s":0},{"p":0,"d":30,"s":0}]}]}
Q-Expression:	{"n":0,"params":[{"n":1,"values":[{"q":0,"d":1,"s":0},{"q":0,"d":22,"s":0},{"q":0,"d":65,"s":0}]}]}

Consumption Model Power

Two consumption model cycles are presented

Figure 33: Completed appliance form

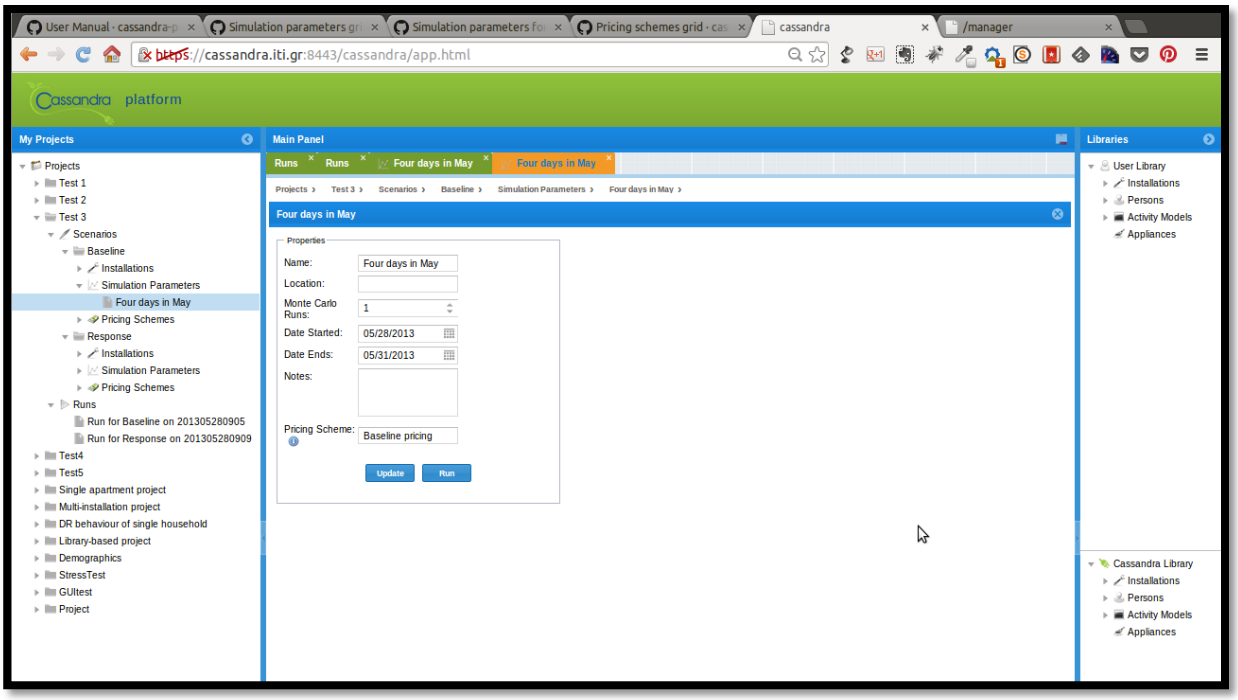
2.24 Simulation Parameters (Form)

When creating/editing simulation parameters (Figure 34), the user enters the following data:

- Name: the name of the parameters set
- Location: the location of the simulation
- Monte Carlo Runs: how many times will the simulation run
- Date Started: the starting date of the simulation
- Date Ends: the ending date of the simulation
- Response Type: Choices are *None*, *Optimal*, *Normal* and *Discrete*. Consult the theoretical models deliverable for specifics on each one of the choices.
- Notes: notes on the simulation parameters set
- CO2 factor per KWh: this factor is multiplied per KWh in order to provide th CO2 emissions KPI in the results.
- Pricing Scheme: the pricing scheme under which the energy consumption of the installations will be billed. The pricing scheme is inserted through drag'n'drop from the Pricing Schemes nodes.

- Baseline Pricing Scheme: pricing scheme needed when the user would like to have a demand response scenario. The pricing scheme is inserted through drag'n'drop from the Pricing Schemes nodes.

In order to perform a DR simulation Response Type should be other than *None* and both Pricing Scheme and Baseline Pricing Scheme should be present.



Properties

Name: Four days in May

Location:

Monte Carlo Runs: 1

Date Started: 05/28/2013

Date Ends: 05/31/2013

Notes:

Pricing Scheme: Baseline pricing

Figure 34: Simulation parameters form

2.25 Pricing Scheme

The CASSANDRA platform at the moment supports five pricing schemes:

- Scalar Energy Pricing
- Scalar Energy Pricing with Off-peak time zones
- Combined Energy and Power Pricing
- All-Inclusive Pricing
- Time-Of-Use Pricing

The schemes are presented in the Sections below along with examples.

2.25.1 Scalar Energy Pricing

The properties that need to be filled by the user are (Figure 35):

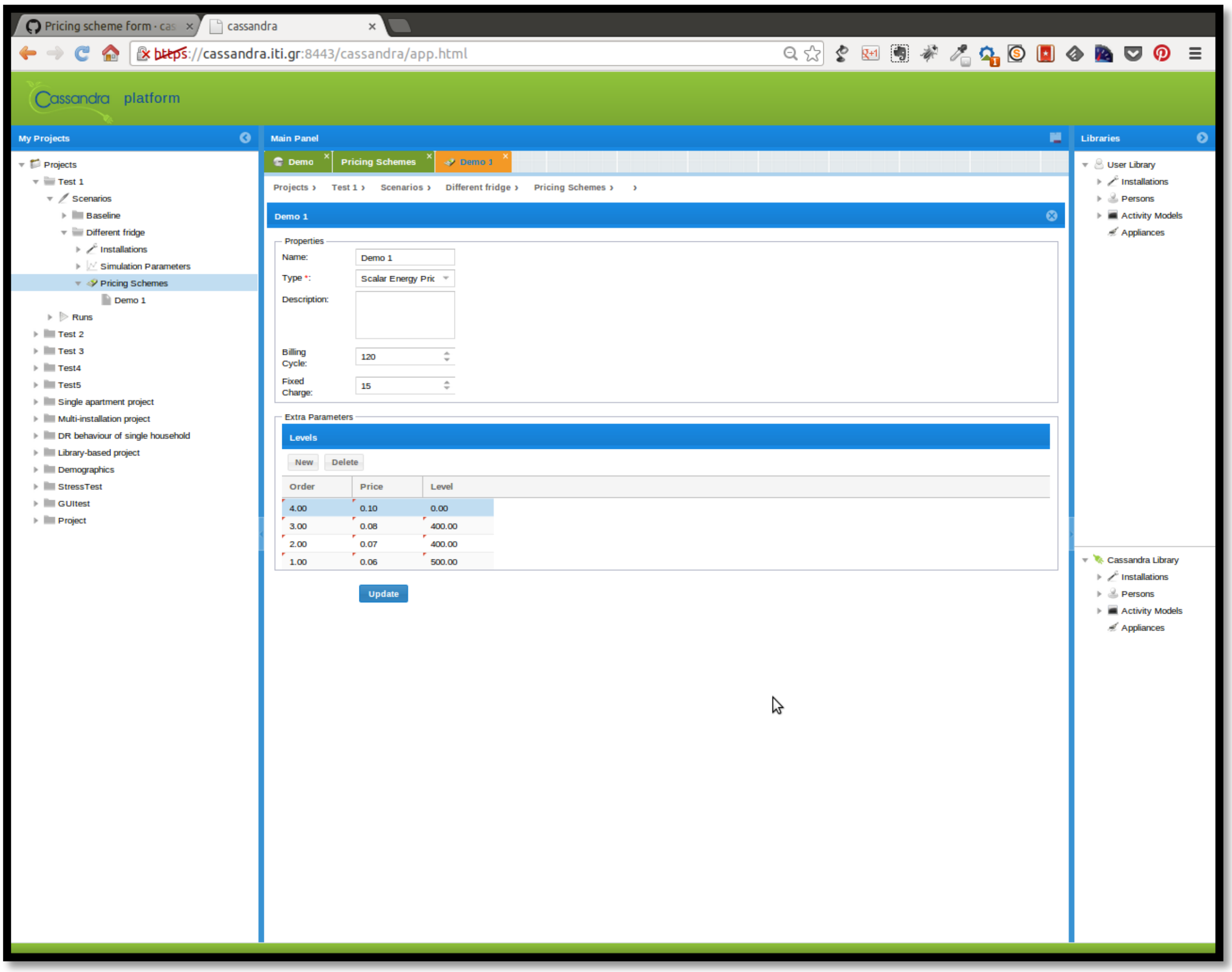
- Name: the name of the scheme
- Type: Scalar Energy Pricing
- Description: a short description of the scheme

- Billing Cycle: in days
- Fixed Charge: fixed charge for every billing cycle
- Levels: pairs of price and energy levels

For example:

- Billing cycle: 4 months
- Measured consumption: 1500 kWh
- Fixed charge: 15
- Price Level 1: [500 Kwh,0.06]
- Price Level 2: [400 Kwh,0.07]
- Price Level 3: [400 Kwh,0.08]
- Price Level 4: [0.1]

$$Cost = 0.06 * 500 + 0.07 * 400 + 0.08 * 400 + 0.01 * 200 + 15 = 125$$



Demo 1

Properties

Name: Demo 1
Type *: Scalar Energy Pric
Description:
Billing Cycle: 120
Fixed Charge: 15

Extra Parameters

Levels

New Delete

Order	Price	Level
4.00	0.10	0.00
3.00	0.08	400.00
2.00	0.07	400.00
1.00	0.06	500.00

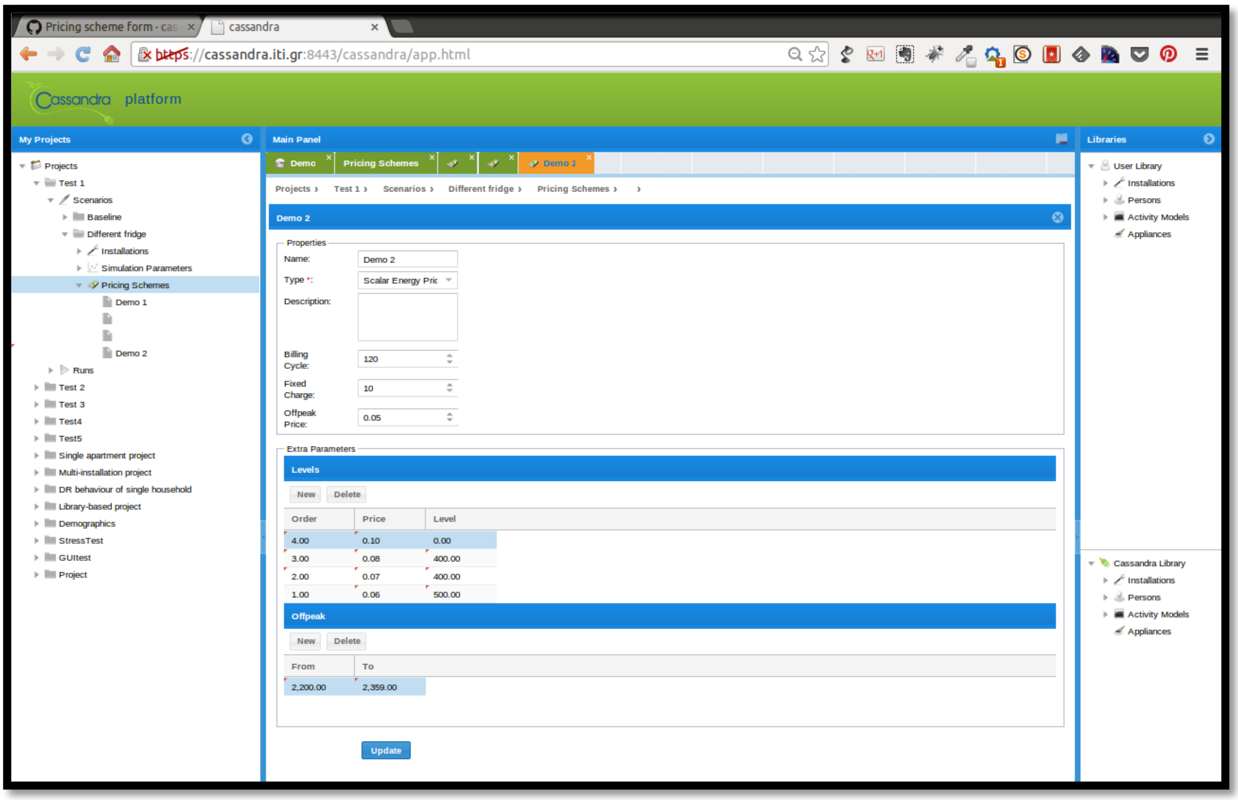
Update

Figure 35: Scalar Energy Pricing form

2.25.2 Scalar Energy Pricing Time Zones

The properties that need to be filled by the user are (Figure 36):

- Name: the name of the scheme
- Type: Scalar Energy Pricing Time Zones
- Description: a short description of the scheme
- Billing Cycle: in days
- Fixed Charge: fixed charge for every billing cycle
- Levels: pairs of price and energy levels
- Offpeak: define the off peak hours of pricing



Demo 2

Properties

Name:	Demo 2
Type *:	Scalar Energy Pric
Description:	
Billing Cycle:	120
Fixed Charge:	10
Offpeak Price:	0.05

Extra Parameters

Levels

New Delete

Order	Price	Level
4.00	0.10	0.00
3.00	0.08	400.00
2.00	0.07	400.00
1.00	0.06	500.00

Offpeak

New Delete

From	To
2,200.00	2,359.00

Update

Figure 36: Scalar Energy Pricing Time Zones form

For example:

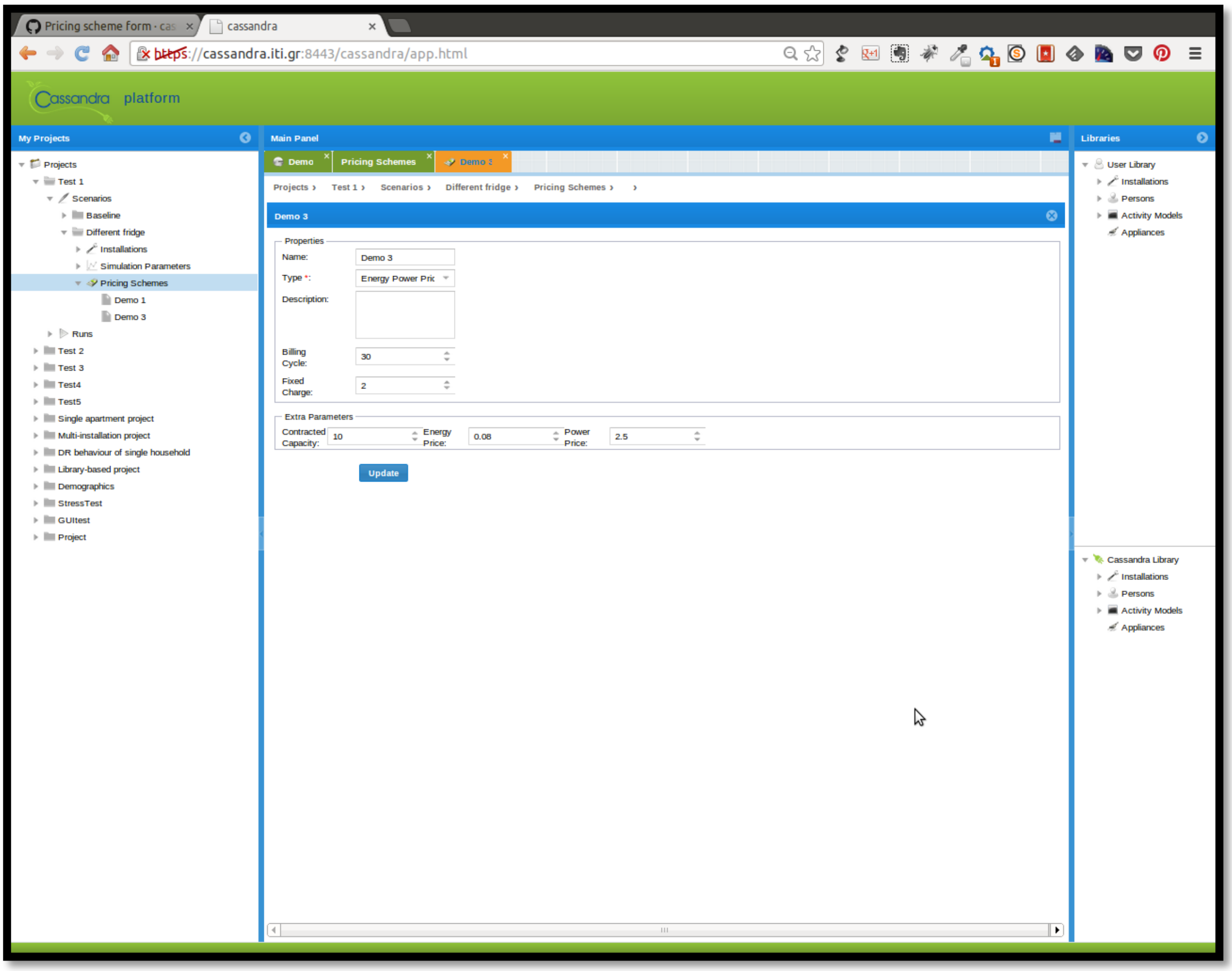
- Billing cycle: 4 months
- Measured consumption: 1000 kWh in peak and 500 Kwh in off-peak
- Fixed charge: 15
- Price Level 1: [500 Kwh,0.06]
- Price Level 2: [400 Kwh,0.07]
- Price Level 3: [400 Kwh,0.08]
- Price Level 4: [0.1]
- Offpeak price: [0.05]

$$Cost = 0.06 * 500 + 0.07 * 400 + 0.08 * 100 + 0.05 * 500 + 15 = 105$$

2.25.3 Combined Energy and Power Pricing

The properties that need to be filled by the user are (Figure 37):

- Name: the name of the scheme
- Type: Combined Energy and Power Pricing
- Description: a short description of the scheme
- Billing Cycle: in days
- Fixed Charge: fixed charge for every billing cycle
- Contracted Capacity: The contracted power capacity
- Energy Price: The price of energy consumed
- Power Price: The power pricing of the contracted capacity



Demo 3

Properties

Name: Demo 3

Type *: Energy Power Pric

Description:

Billing Cycle: 30

Fixed Charge: 2

Extra Parameters

Contracted Capacity: 10

Energy Price: 0.08

Power Price: 2.5

Figure 37: Combined Energy and Pricing form

For example:

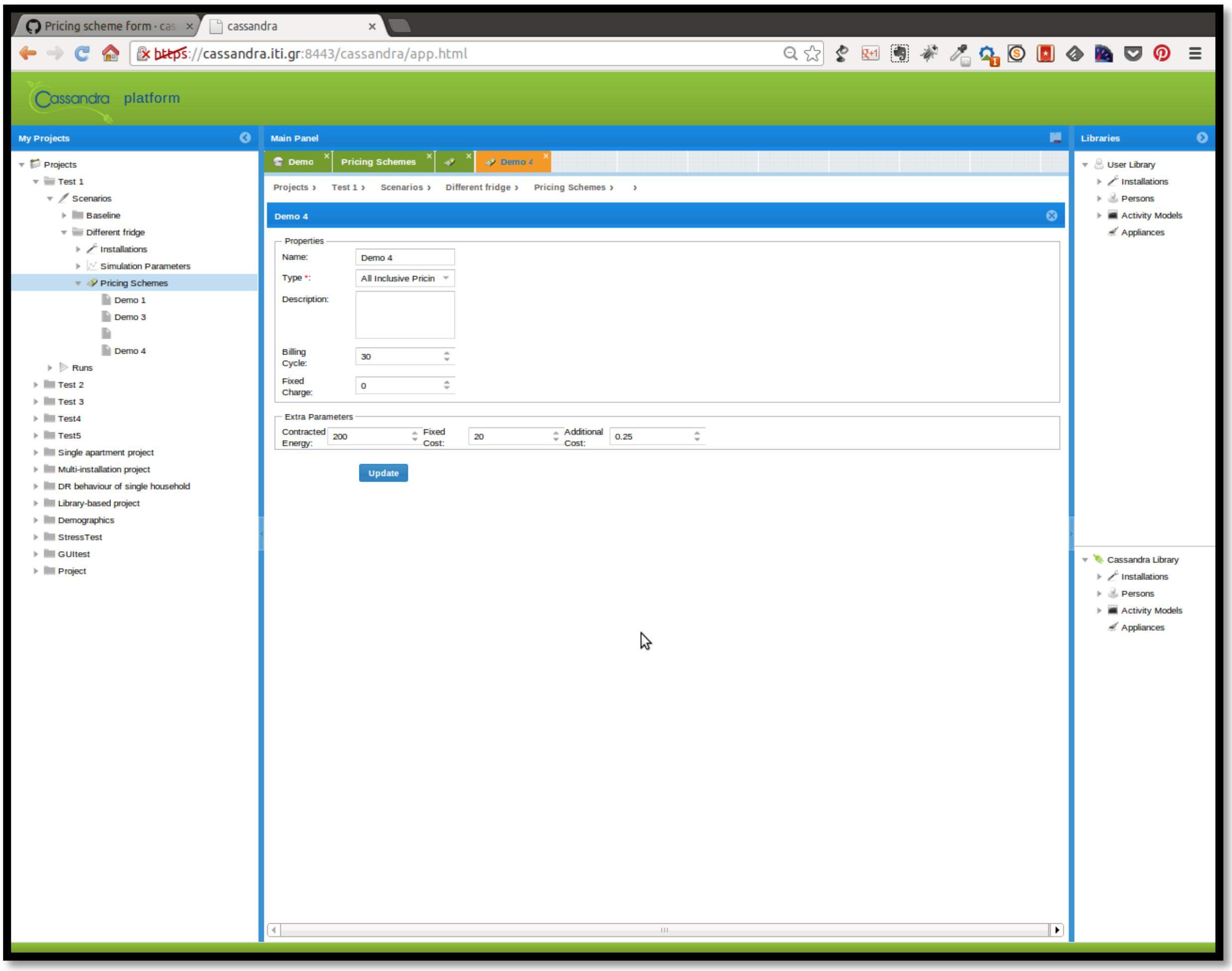
- Billing cycle: 1 month
- Measured consumption: 350 kWh with contracted capacity of 10kW
- Fixed charge: 2
- Energy price: 0.08
- Power price: 2.5

$$\text{Cost} = 0.08 * 350 + 2.5 * 10 + 2 = 55$$

2.25.4 All-inclusive pricing

The properties that need to be filled by the user are (Figure 38):

- Name: the name of the scheme
- Type: All-inclusive pricing
- Description: a short description of the scheme
- Billing Cycle: in days
- Fixed Charge: fixed charge for every billing cycle
- Contracted Energy: The contracted energy
- Fixed cost: The price of energy contracted
- Additional cost: The price of additional energy



Demo 4

Properties

Name: Demo 4

Type *: All Inclusive Pricin

Description:

Billing Cycle: 30

Fixed Charge: 0

Extra Parameters

Contracted Energy: 200

Fixed Cost: 20

Additional Cost: 0.25

Update

Figure 38: All Inclusive Pricing form

For example:

- Billing cycle: 1 month
- Fixed charge: 0
- Measured consumption: 300 kWh
- Fixed cost for contracted kWh consumption: 20
- Energy price for additional consumption above the contracted: 0.25
- Contracted consumption: 200

$$\text{Cost} = 20 + 0.25 * 100 + 0 = 45$$

2.25.5 Time-Of-Use pricing

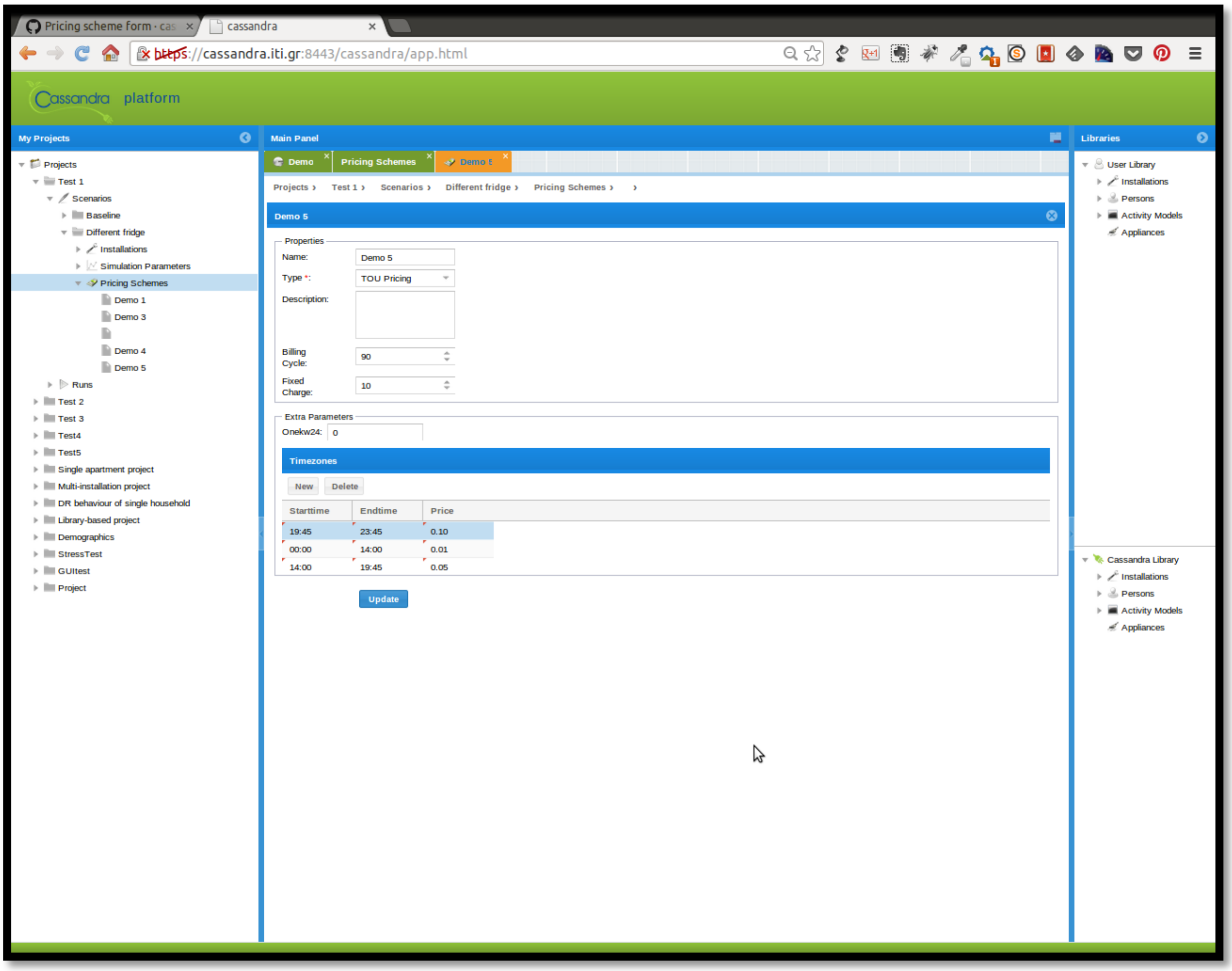
The properties that need to be filled by the user are (Figure 38):

- Name: the name of the scheme
- Type: TOU pricing
- Description: a short description of the scheme

- Billing Cycle: in days
- Fixed Charge: fixed charge for every billing cycle
- Timezones: price of energy in specific timezones

In order to set the timezones right, you should end one time zone with an hour (for example 18:00) and start the other timezone with the ending time (18:00 in the example). So a valid scheme would be:

- 00:00 - 17:00
- 17:00 - 23:00
- 23:00 - 00:00



Demo 5

Properties

Name: Demo 5

Type *: TOU Pricing

Description:

Billing Cycle: 90

Fixed Charge: 10

Extra Parameters

Onekw24: 0

Timezones

New Delete

Starttime	Endtime	Price
19:45	23:45	0.10
00:00	14:00	0.01
14:00	19:45	0.05

Update

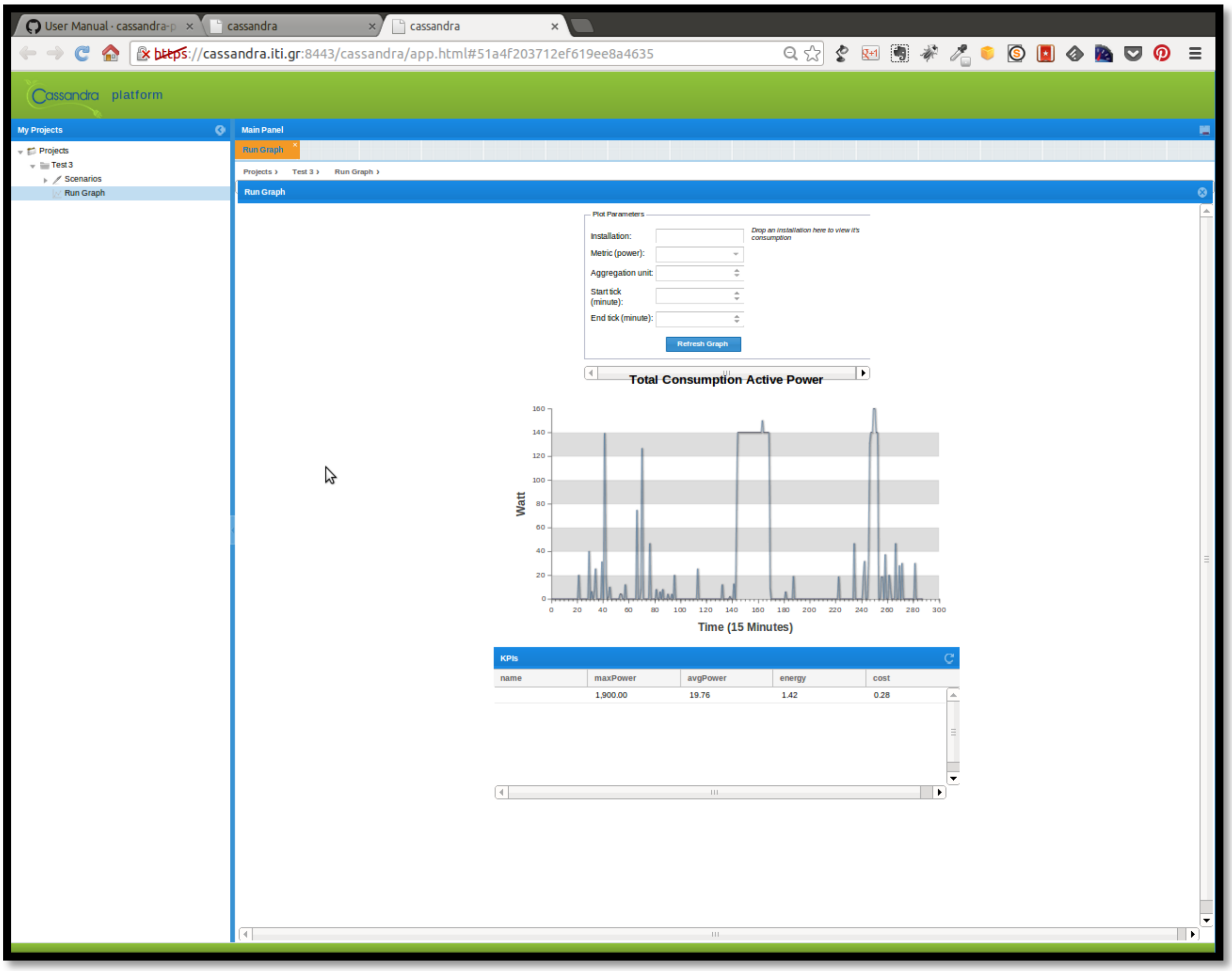
Figure 39: TOU pricing form

2.26 Run

When double-clicking on a *Run*, the platform opens a new tab in the browser where the user can see the results of the simulation (Figure 40). In particular the user is presented with:

- Load curves
- Initial KPIs
  - Max Power (W)
  - Avg Peak (W)
  - Avg Power (W)
  - Energy consumed (KWh)
  - Cost
  - CO_2 (kg/KWh)

The run also includes a snapshot of the scenario entities, the moment it was ordered to run by the user.



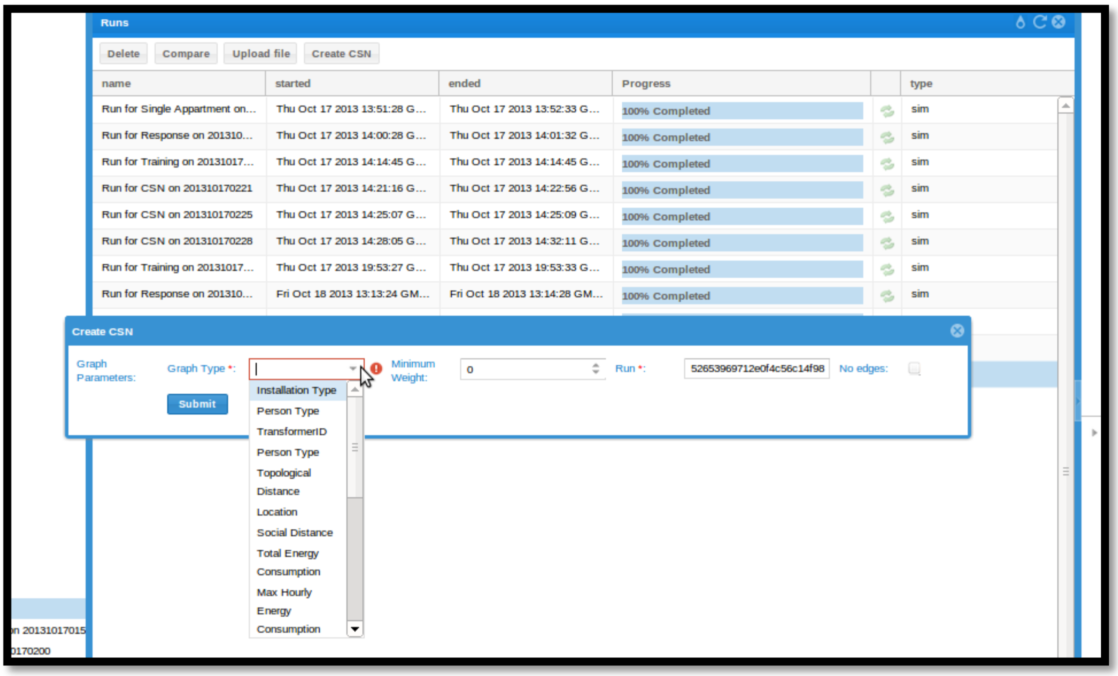
name	maxPower	avgPower	energy	cost
	1,900.00	19.76	1.42	0.28

Figure 40: Run window

2.27 CSN

In the Runs grid the user can select a Run and create a CSN. The first step is to input the parameters for graph clustering:

- Graph Type
- Minimum Weight
- Run ID (inserted by default)
- No edges (Boolean)



name	started	ended	Progress		type
Run for Single Appartment on...	Thu Oct 17 2013 13:51:28 G...	Thu Oct 17 2013 13:52:33 G...	100% Completed		sim
Run for Response on 201310...	Thu Oct 17 2013 14:00:28 G...	Thu Oct 17 2013 14:01:32 G...	100% Completed		sim
Run for Training on 20131017...	Thu Oct 17 2013 14:14:45 G...	Thu Oct 17 2013 14:14:45 G...	100% Completed		sim
Run for CSN on 201310170221	Thu Oct 17 2013 14:21:16 G...	Thu Oct 17 2013 14:22:56 G...	100% Completed		sim
Run for CSN on 201310170225	Thu Oct 17 2013 14:25:07 G...	Thu Oct 17 2013 14:25:09 G...	100% Completed		sim
Run for CSN on 201310170228	Thu Oct 17 2013 14:28:05 G...	Thu Oct 17 2013 14:32:11 G...	100% Completed		sim
Run for Training on 20131017...	Thu Oct 17 2013 19:53:27 G...	Thu Oct 17 2013 19:53:33 G...	100% Completed		sim
Run for Response on 201310...	Fri Oct 18 2013 13:13:24 GM...	Fri Oct 18 2013 13:14:28 GM...	100% Completed		sim

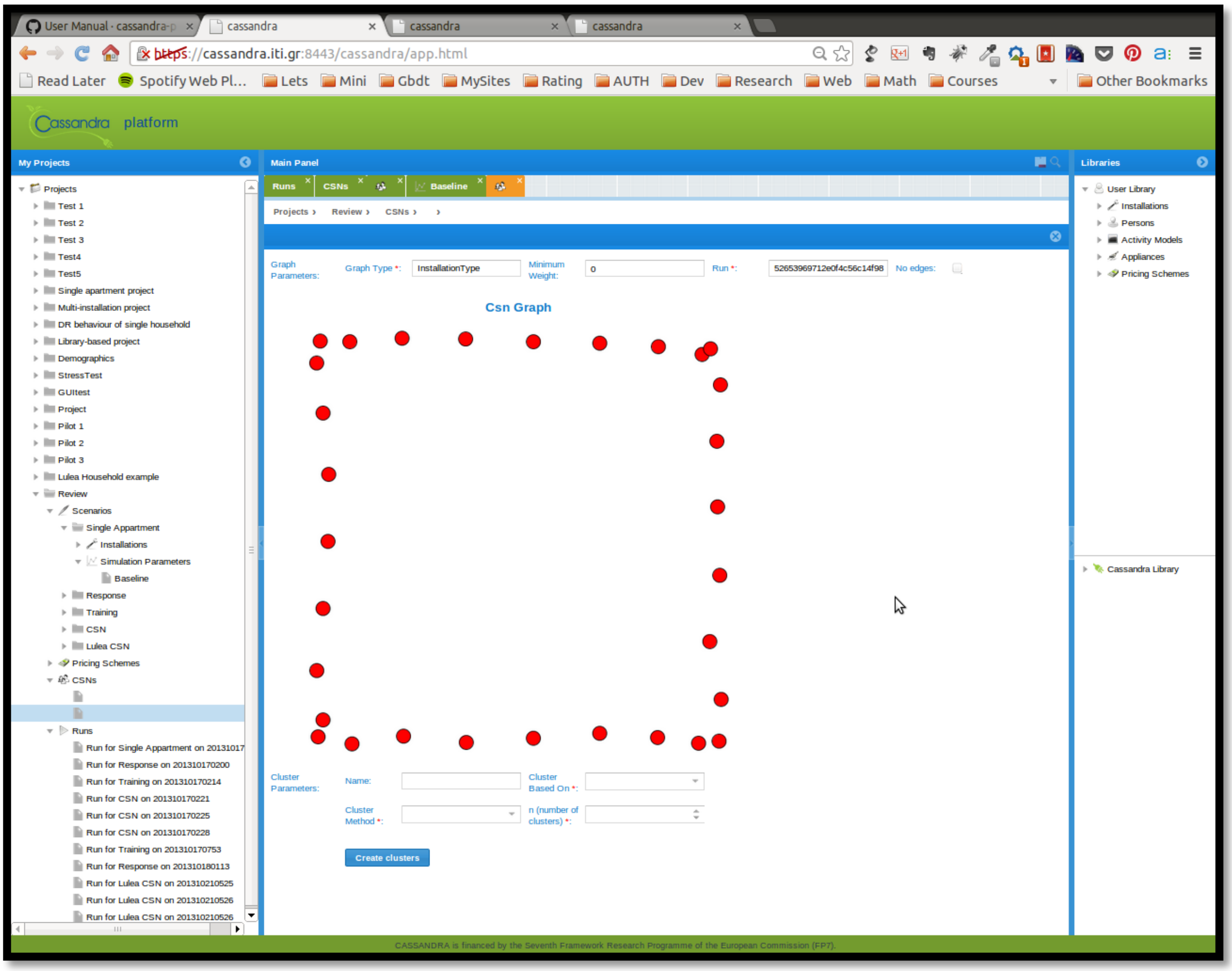
Create CSN

Graph Parameters: Graph Type *: | Minimum Weight: 0 | Run *: 52653969712e0f4c56c14f98 | No edges: □

Figure 41: CSN graph creation

After the CSN graph is created, clustering takes place. The clustering parameters are:

- Name
- Cluster Based On
- Cluster Method, select between *Kmeans*, *Hierachical*, *Graph edge betweenness*
- n (number of clusters)



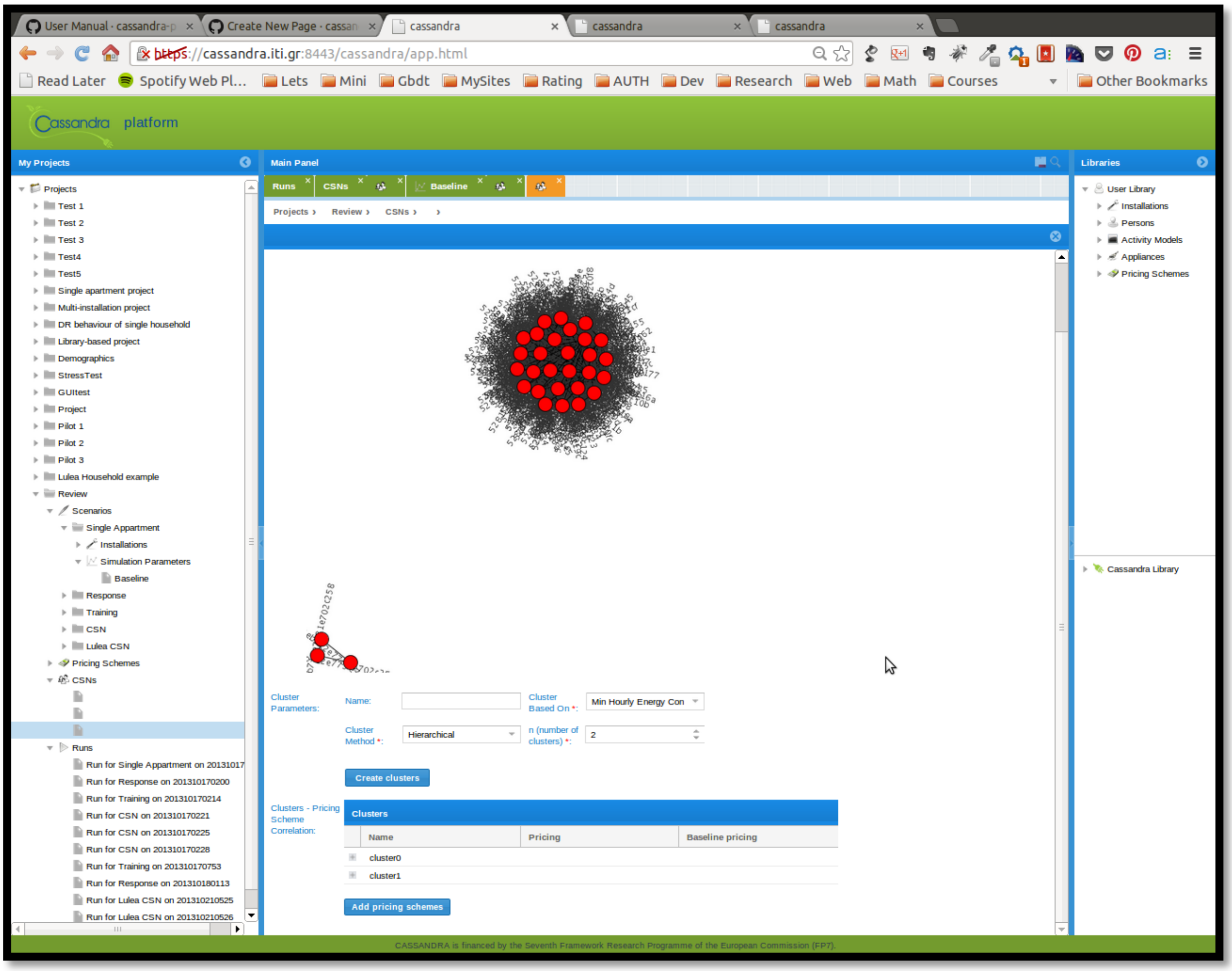
Graph Parameters: Graph Type *: InstallationType Minimum Weight: 0 Run *: 52653969712e0f4c56c14f98 No edges: □

Cluster Parameters: Name: Cluster Based On *: Cluster Method *: n (number of clusters) *:

CASSANDRA is financed by the Seventh Framework Research Programme of the European Commission (FP7).

Figure 42: CSN clustering

After clustering takes place the user can choose to provide different pricing schemes (main and baseline) to each cluster in order to have more targeted demand response simulations.


cassandra platform
My Projects
Projects
Test 1
Test 2
Test 3
Test4
Test5
Single apartment project
Multi-installation project
DR behaviour of single household
Library-based project
Demographics
StressTest
GUItest
Project
Pilot 1
Pilot 2
Pilot 3
Lulea Household example
Review
Scenarios
Single Appartment
Installations
Simulation Parameters
Baseline
Response
Training
CSN
Lulea CSN
Pricing Schemes
CSNs
Runs
Run for Single Appartment on 20131017
Run for Response on 201310170200
Run for Training on 201310170214
Run for CSN on 201310170221
Run for CSN on 201310170225
Run for CSN on 201310170228
Run for Training on 201310170753
Run for Response on 201310180113
Run for Lulea CSN on 201310210525
Run for Lulea CSN on 201310210526
Main Panel
Runs
CSNs
Baseline
Projects › Review › CSNs ›
Libraries
User Library
Installations
Persons
Activity Models
Appliances
Pricing Schemes
Cassandra Library
Create clusters
Add pricing schemes
CASSANDRA is financed by the Seventh Framework Research Programme of the European Commission (FP7).

Cluster Parameters:

Name:

Cluster Based On *: Min Hourly Energy Con

Cluster Method *: Hierarchical

n (number of clusters) *: 2

Clusters - Pricing Scheme Correlation:

Clusters

Name	Pricing	Baseline pricing
cluster0		
cluster1		

Figure 43: CSN result

3 Training Module

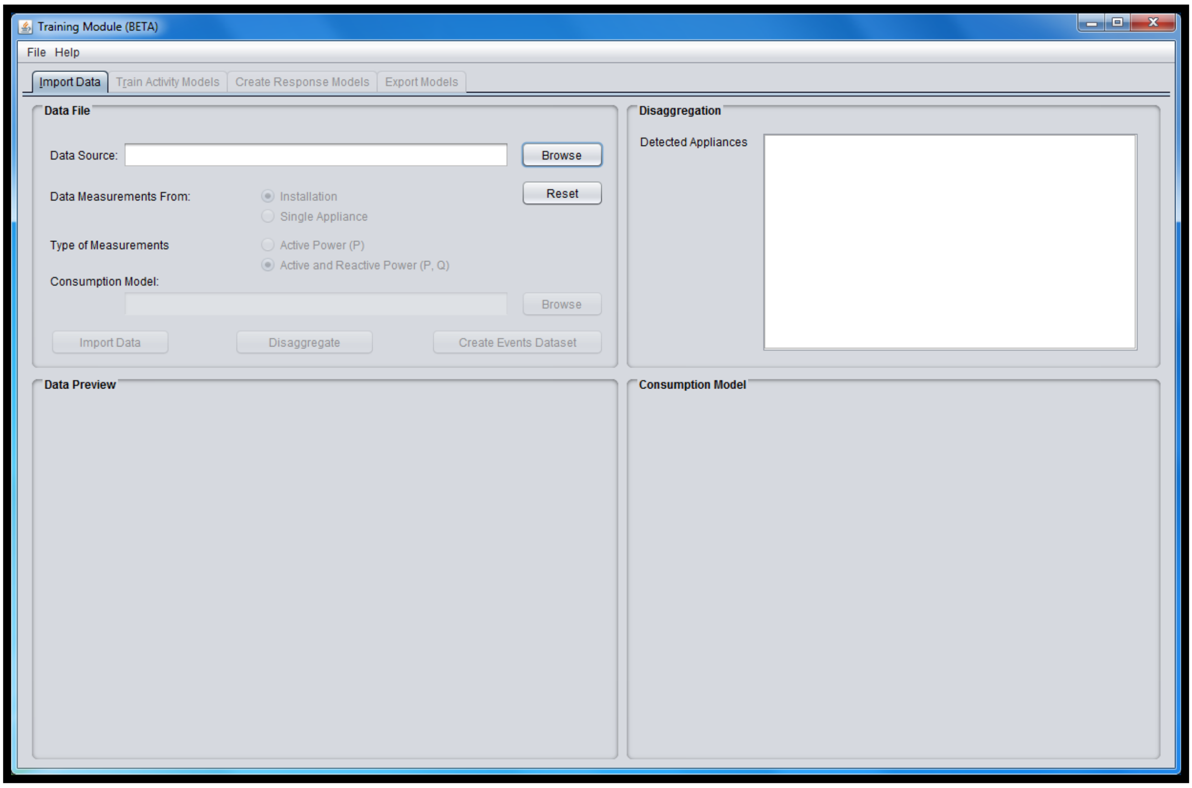
This section focuses on the *Cassandra Training Module*. The *Training Module* is a useful add-on to the main *Cassandra* platform, creating *Entity* models (*Installations*, *Appliances*, *Persons* etc.) semi-automatically, using consumption datasets provided by the user. In detail, the *Training Module* can be used for:

- *Importing installation measurements*, for automatic appliances' identification and consumption patterns via *Disaggregation*.
- *Training Activity Behaviour Models* from detected consumption events.
- *Implementing Response Models,* given the basic behaviour model, pricing scheme and the response type as inputs.
- *Exporting Entity Models* to the main platform.

This process can make the use of CASSANDRA much easier for a naïve user, who may not be an expert on Power Systems.

The Training Module user interface is separated into four tabs (as seen in Figure 44):

1. *Import Data*
2. *Training Activity Models*
3. *Create Response Models*
4. *Export Models*



Data Measurements From: ● Installation ○ Single Appliance

Type of Measurements ○ Active Power (P) ● Active and Reactive Power (P, Q)

Figure 44: Training Module's Main Screen

The user should note that not all of the tabs are enabled when launching the *Training Module*, in order to guide the user over the procedure, making sure that the correct steps are followed.

3.1 Import Data Tab

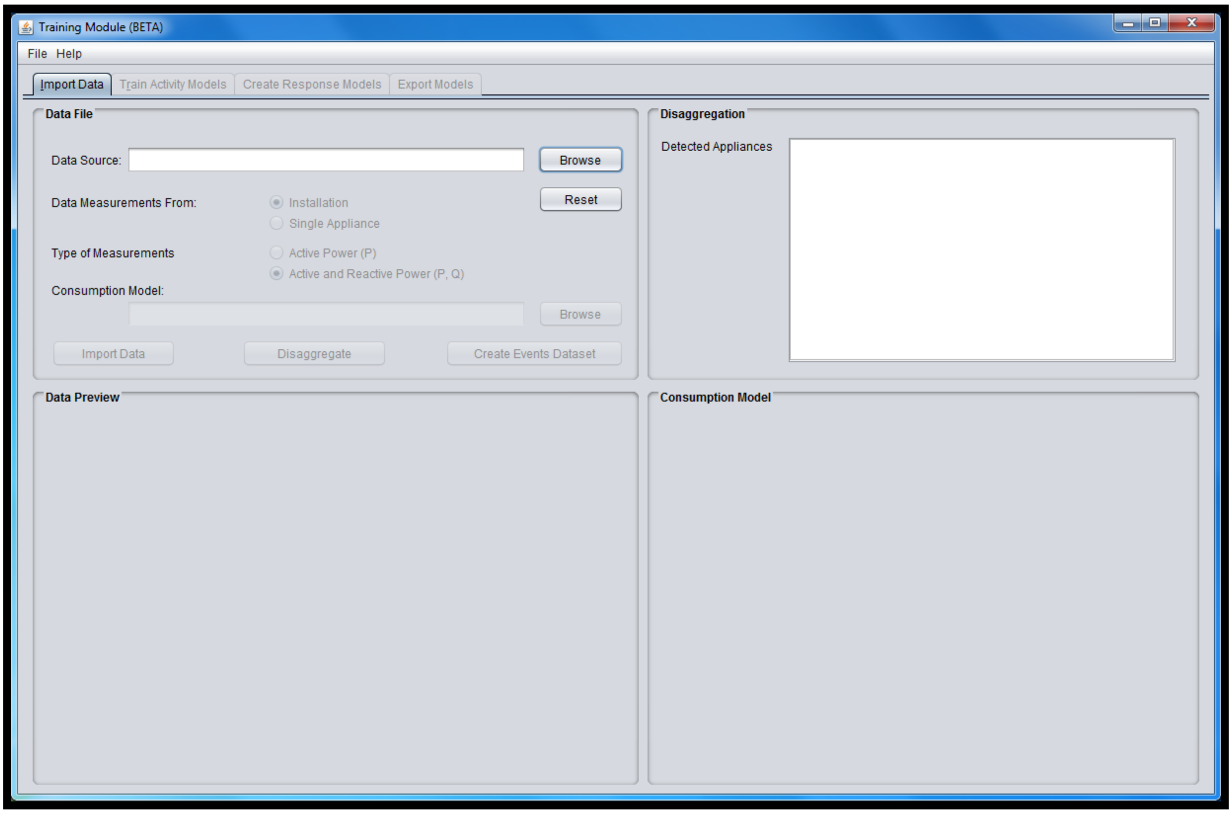
Import Data Tab is used in order to import available installation consumptions into the Training Module. It is comprised by 4 different panels, each used for choice selection or data visualization (Figure 45).

- *Data File Panel:* This panel is used for choosing the data files of the available installation measurements, as well as several data attributes, which will help parsing the data set. The dataset can contain either consumption data from a single appliance (if plug-wise measurements are available) or from an installation as a whole.
  It is recommended that the measurements included in the file are both of active and reactive power, in order for the disaggregation to work optimally. In case only active power measurements are available, the resulting appliance identification shall be suboptimal.
  In case of a single appliance, the consumption model of the appliance should be provided, in order to create the consumption event dataset.

- *Disaggregation Panel:* This panel contains the detected appliance(s) from the disaggregation process.

- *Data Preview Panel:* The consumption data contained in the file is visualized in this panel, so that the user has a first overview over the selected data set. The visualization shows the time series of the active and the reactive power, if available.

- *Consumption Model Panel:* In this panel, the consumption model of the selected appliance from the (detected) appliances list is presented here. The visualization shows both the consumption pattern for the active and the reactive power of the model.



Data Measurements From: ● Installation ○ Single Appliance

Type of Measurements ○ Active Power (P) ● Active and Reactive Power (P, Q)

Figure 45: Import Data Tab

3.1.1 Usage workflow

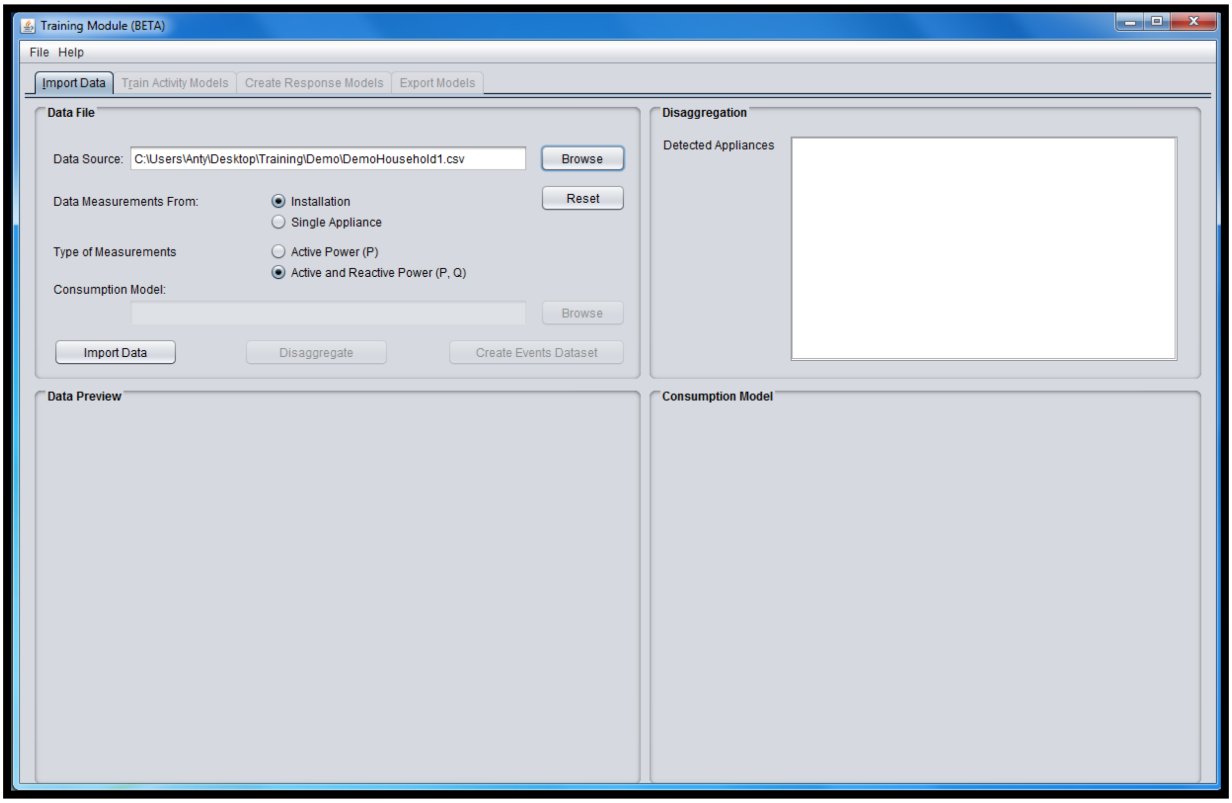
The main usage workflow is as follows:

1. The user browses through her files to choose the data file with the consumption measurements of an installation or a single appliance. The allowed file types for the consumption data sets are .xls (excel files) and .csv (comma separated files). More details on the structure of the files can be found in the Specifications Document [D3.6].

2. The file selection enables the *Data Parameters* buttons (Figure 46). These buttons allow for the user to provide some more details on the data contained within the chosen file: The source of data measurements (installation or single appliance in case of plug-wises) and the type of measurements (Active and Reactive Power).

   After setting the parameters, the user should press the import button which is responsible for parsing the provided file and visualizing the data. In case of an error in the data file, the parser returns an error message, including the line where the error was found, to help the user fix the erroneous data entry.

   Also, the *Export* tab is enabled, even though the only exportable entities up to now should be the installation and the equivalent person inhabiting it.



Data Source: C:\Users\Anty\Desktop\Training\Demo\DemoHousehold1.csv

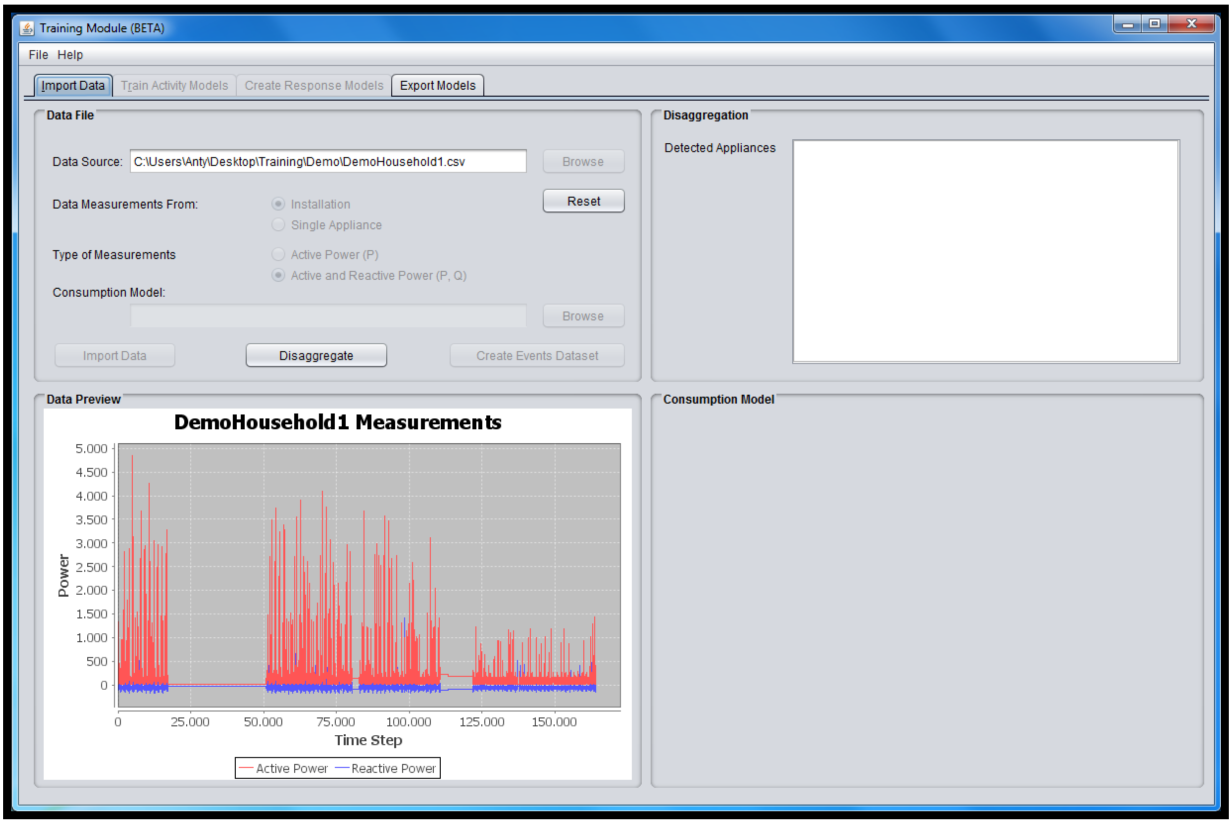
Data Measurements From: ● Installation ○ Single Appliance

Type of Measurements ○ Active Power (P) ● Active and Reactive Power (P, Q)

Consumption Model:

Figure 46: Enabled setting after selecting the data file

3. Given the choice of measurements' source, one of two buttons is enabled:
   - In case of installation, the *Disaggregation* button is enabled (Figure 47).



Data Source: C:\Users\Anty\Desktop\Training\Demo\DemoHousehold1.csv

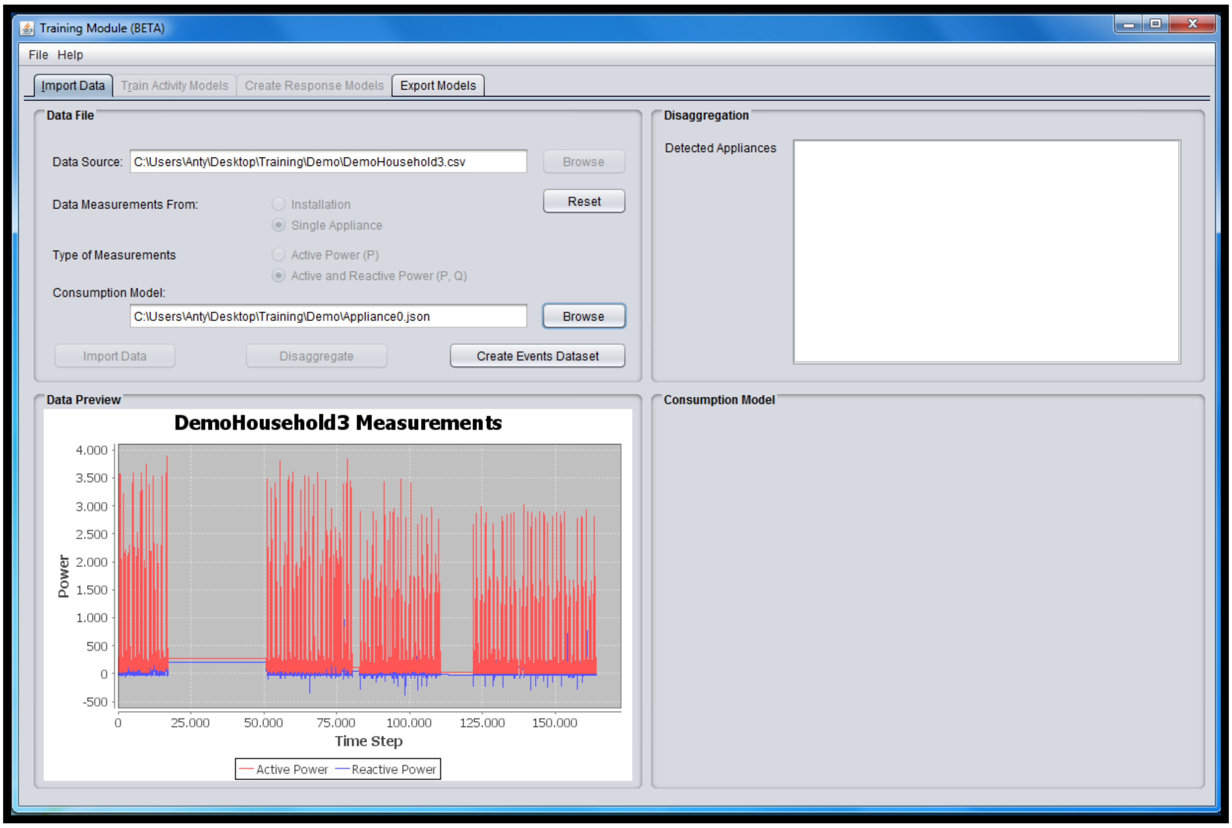
Data Measurements From: ● Installation ○ Single Appliance

Type of Measurements: ○ Active Power (P) ● Active and Reactive Power (P, Q)

Consumption Model:

Figure 47 Imported data in case of installation

- In case of a single appliance, the user must provide the file containing the appliance’s *Consumption Model*. After that, the *Create Event* button is enabled (Figure 48).



Data Source: C:\Users\Anty\Desktop\Training\Demo\DemoHousehold3.csv

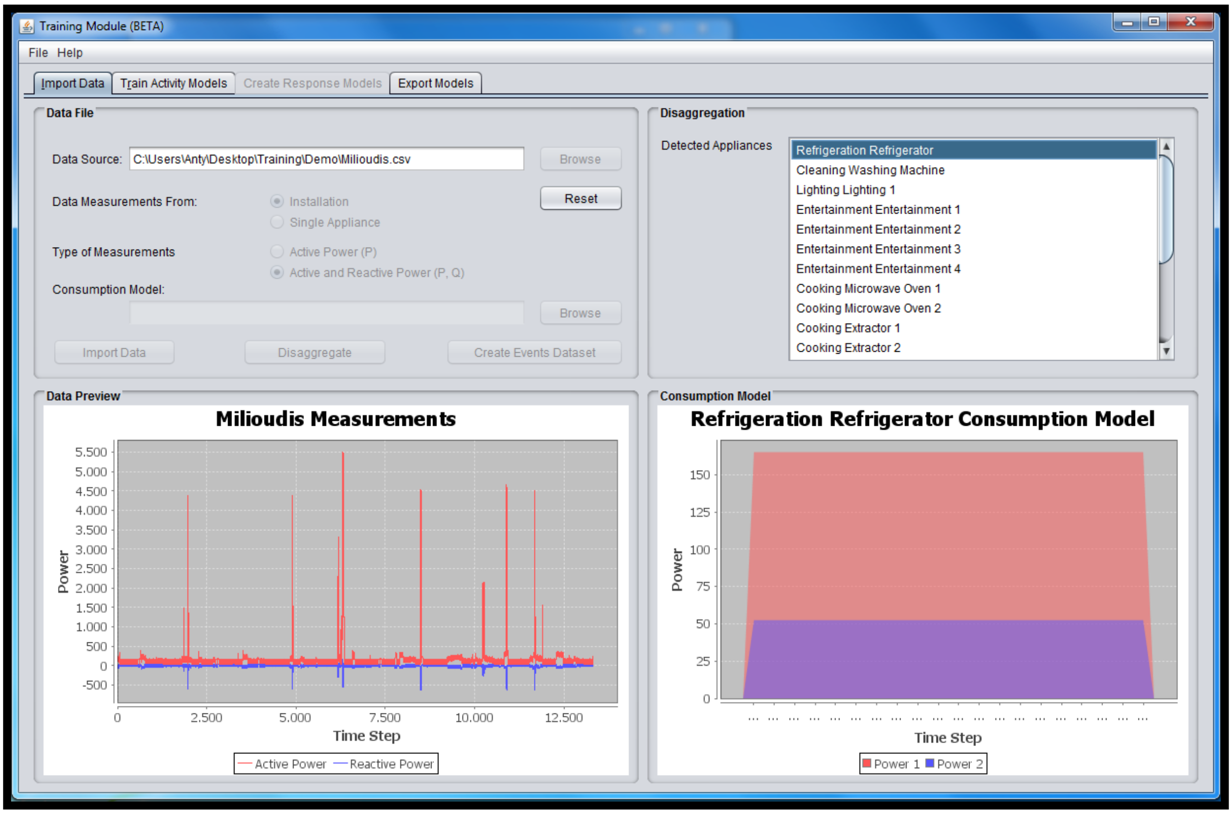
Data Measurements From: ○ Installation ● Single Appliance

Type of Measurements ○ Active Power (P) ● Active and Reactive Power (P, Q)

Consumption Model: C:\Users\Anty\Desktop\Training\Demo\Appliance0.json

Figure 48 Imported data in case of single appliance

4. After pressing the corresponding button for each case, a list of the *Detected Appliances* is presented on the *Disaggregation* panel. When the user clicks on an appliance, the appliance's *Consumption Model* appears on the lower right panel (Figure 49).



Data Source: C:\Users\Anty\Desktop\Training\Demo\Milioudis.csv

Data Measurements From: ● Installation ○ Single Appliance

Type of Measurements ○ Active Power (P) ● Active and Reactive Power (P, Q)

Consumption Model:

Detected Appliances
- Refrigeration Refrigerator
- Cleaning Washing Machine
- Lighting Lighting 1
- Entertainment Entertainment 1
- Entertainment Entertainment 2
- Entertainment Entertainment 3
- Entertainment Entertainment 4
- Cooking Microwave Oven 1
- Cooking Microwave Oven 2
- Cooking Extractor 1
- Cooking Extractor 2

Figure 49: Disaggregation results

After the appliances identification, the data import procedure has been completed. The *Training* tab is activated. More details over this tab can be on the next section.

3.2 Training Activity Models Tab

Training Activity Models tab is used to create activity models from the events imported or detected for each appliance. This tab is also comprised by 4 different panels, each used for different choice selections or data visualizations (Figure 50).

- *Training Parameters Panel:* This panel is used for choosing the distributions used for each behaviour model attribute at model training. There are 3 alternative choices: *Histogram*, *Normal Distribution* and *Gaussian Mixture*.

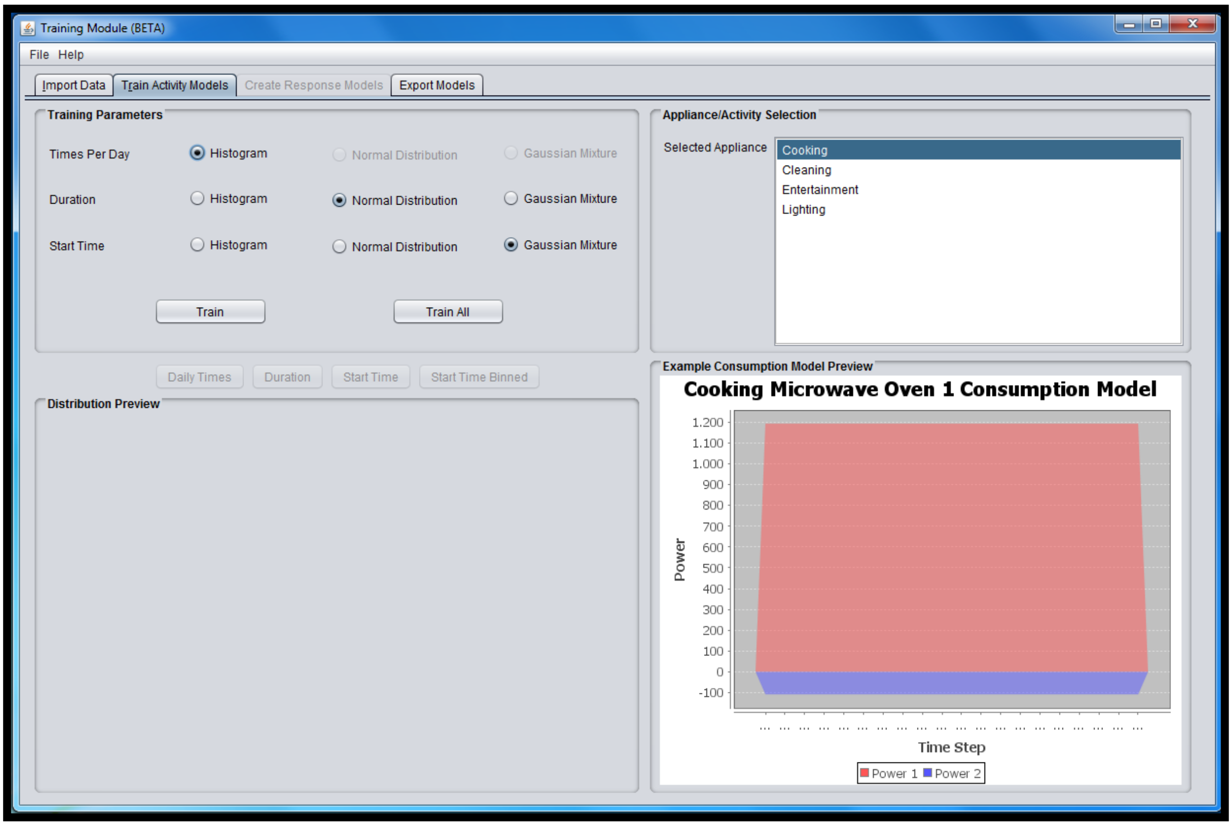
  For the *Times per Day* attribute, Histogram Distribution is the only available choice, since the values are discrete and small in number. The usage of the other two options would produce suboptimal results for this variable.

- *Appliance/Activity Selection Panel:* In this panel, the list of the detected appliances is presented.

  In case of a single appliance, the list contains the same appliance with the appliance on the previous tab. In case of an installation, the activities that were identified as a result of the disaggregation process are presented. These activities encapsulate all the installation's detected appliances presented in the previous tab.

- *Distribution Preview Panel:* After training behaviour models, this panel presents the distributions produced during the training procedure for the selected appliance/activity. There are 4 buttons, each corresponding to a different activity attribute: *Daily Times, Duration, Start Time* and *Start Time Binned Distribution.*
  The last distribution is produced by aggregating the *Start Time Distribution* in 10-minutes intervals and is used only for better visualization purposes (meaning this distribution is not used in the modelling of the activities/appliances)

- *Example Consumption Model Panel:* Same as the previous page. In case of an activity, the panel presents the consumption model of the first appliance in the activity's appliance list, in order to give a representative sample of the activity’s consumption.



Training Parameters

Times Per Day ● Histogram ○ Normal Distribution ○ Gaussian Mixture

Duration ○ Histogram ● Normal Distribution ○ Gaussian Mixture

Start Time ○ Histogram ○ Normal Distribution ● Gaussian Mixture

Appliance/Activity Selection

Selected Appliance: Cooking
Cleaning
Entertainment
Lighting

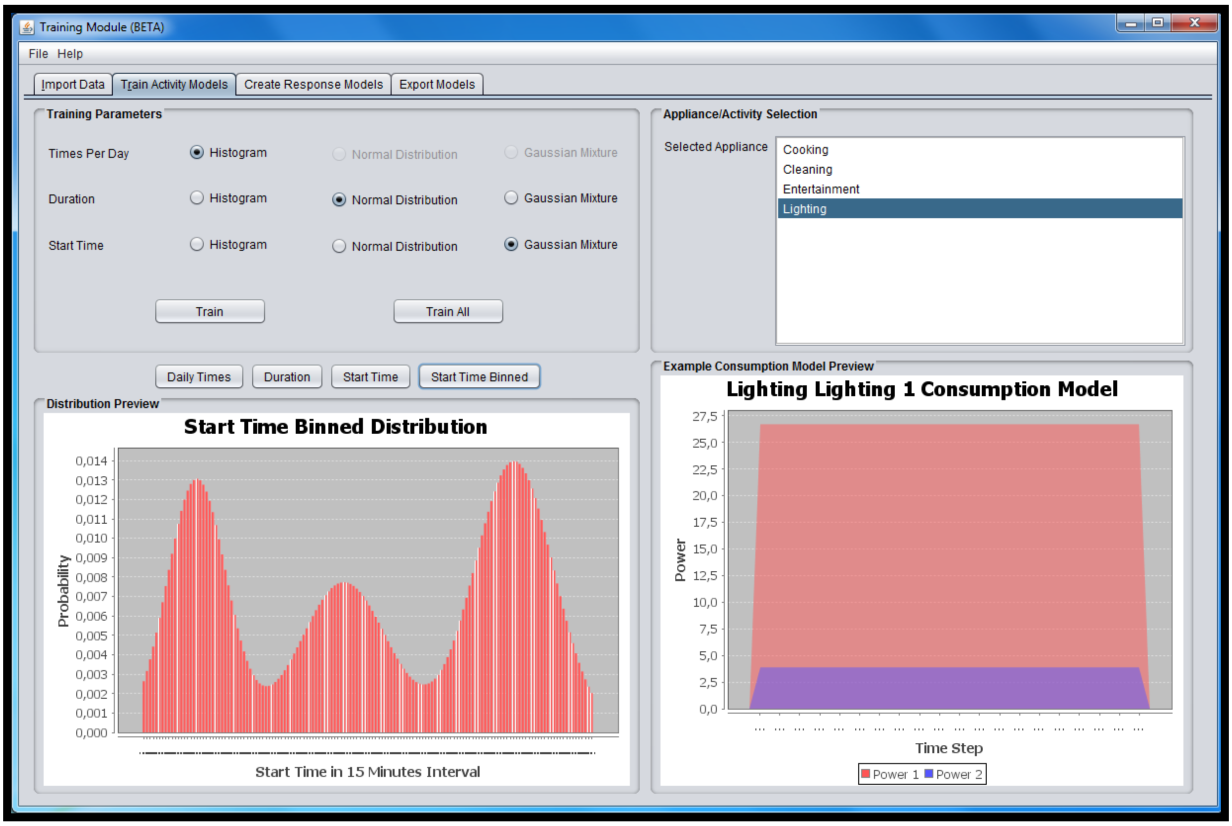
Figure 50: Training Tab

3.2.1 Usage workflow

The main usage workflow is as follows:

1. The user selects an appliance/activity from the list as well as the type of distributions of her preference for the training procedure. Then, she either presses the *Train* or *Train All* button to produce the expected behaviour models for a single appliance/activity or for all the detected appliances/activities.

2. After the completion of the training procedure, the distributions are graphically presented in the *Distribution Preview* panel and the buttons for choosing which distribution should become enabled (Figure 51).



Training Parameters

Times Per Day ● Histogram ○ Normal Distribution ○ Gaussian Mixture

Duration ○ Histogram ● Normal Distribution ○ Gaussian Mixture

Start Time ○ Histogram ○ Normal Distribution ● Gaussian Mixture

Appliance/Activity Selection

Selected Appliance: Cooking, Cleaning, Entertainment, Lighting (selected: Lighting)

Figure 51: Results of training an example behaviour model

Also, the *Create Response Models* tab is activated. More details on this tab can be found in the next section.

3.3 Create Response Models Tab

Create Response Models tab is responsible for the creation of new behaviour models resulting from providing monetary incentives to the customer in order to change her consumption patterns. In order to do so, the pricing scheme and the response type must be provided.

It comprises 5 different panels, each used for choice selection or data visualization, as before (Figure 52).

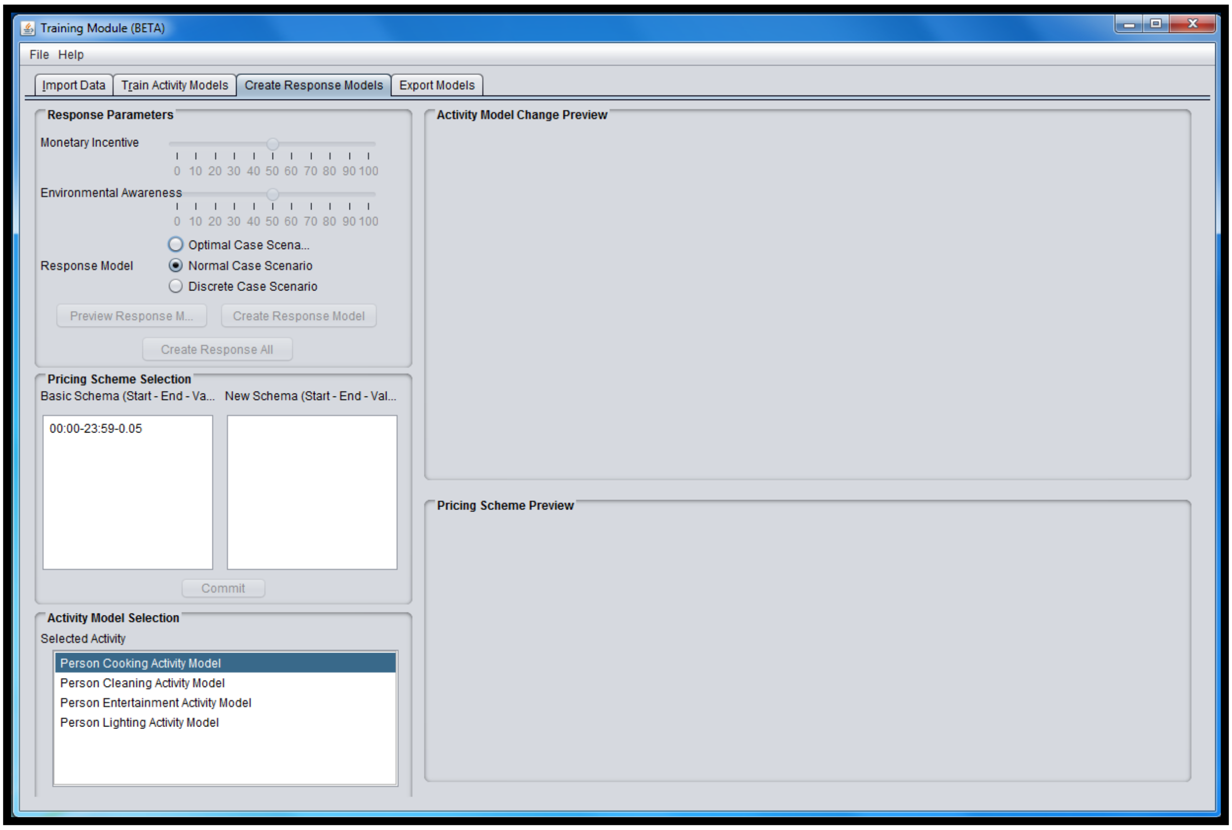
- *Response Parameters Panel:* This panel is used for choosing the parameters that matter as far as the response of the customer to certain incentives (monetary or otherwise) is concerned. The user may select the model's sensitivity to money or its environmental awareness, as well as which case scenario the response trainer will use: *Optimal, Normal* or *DiscreteCase Scenario.* More details on the response types can be found in the Theoretical Modeling Deliverable [D3.4.2]

- *Activity Model Selection Panel:* In this panel, the list of the behaviours that are already produced by the training process (from the previous tab) is presented. The user can choose which one will be her baseline behaviour on which the new pricing scheme will be applied.

- *Pricing Scheme Selection Panel:* This panel gives user the capability to set up the base pricing schema, as well as the new pricing policy she wants to test over the behaviour models. There is a parser that checks for the correctness of the schema and provides help in case of an error.

- *Activity Model Change Preview Panel:* This panel is responsible for the visualization of the behavioural change when the user wants to preview the result of the pricing policy to the selected behaviour. The attribute that is affected by the pricing scheme is the *Start Time Distribution,* so the panel presents a comparative chart of the start time distribution with the basic and the new pricing schemes.

- *Pricing Scheme Preview Panel:* This panel presents a comparative chart of the two pricing schemes provided by the user, in order to make sure that the input is the correct one.



Basic Schema (Start - End - Va...: 00:00-23:59-0.05

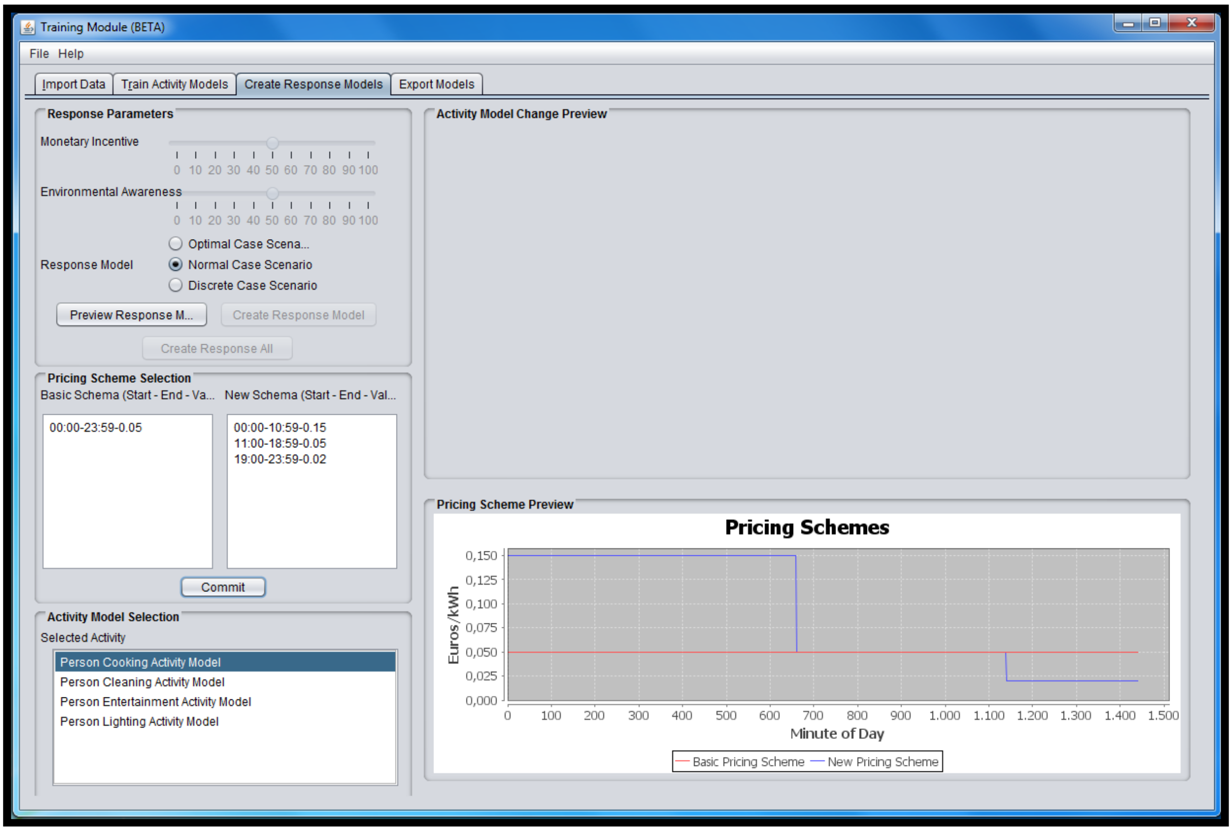
Selected Activity:
- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model

Figure 52 Create Response Models tab

3.3.1 Usage workflow

The main usage workflow is as follows:

1. The user chooses an activity model from the list. Next, she types in the pricing schemes (as shown in the Figure 53) as a triplet of starting time – ending time – price (suitable only for TOU Pricing scheme). More details on the specifications of the pricing scheme used in the Training Module can be found at the Specification Deliverable [D3.6].



Monetary Incentive

Environmental Awareness

Response Model
○ Optimal Case Scena...
● Normal Case Scenario
○ Discrete Case Scenario

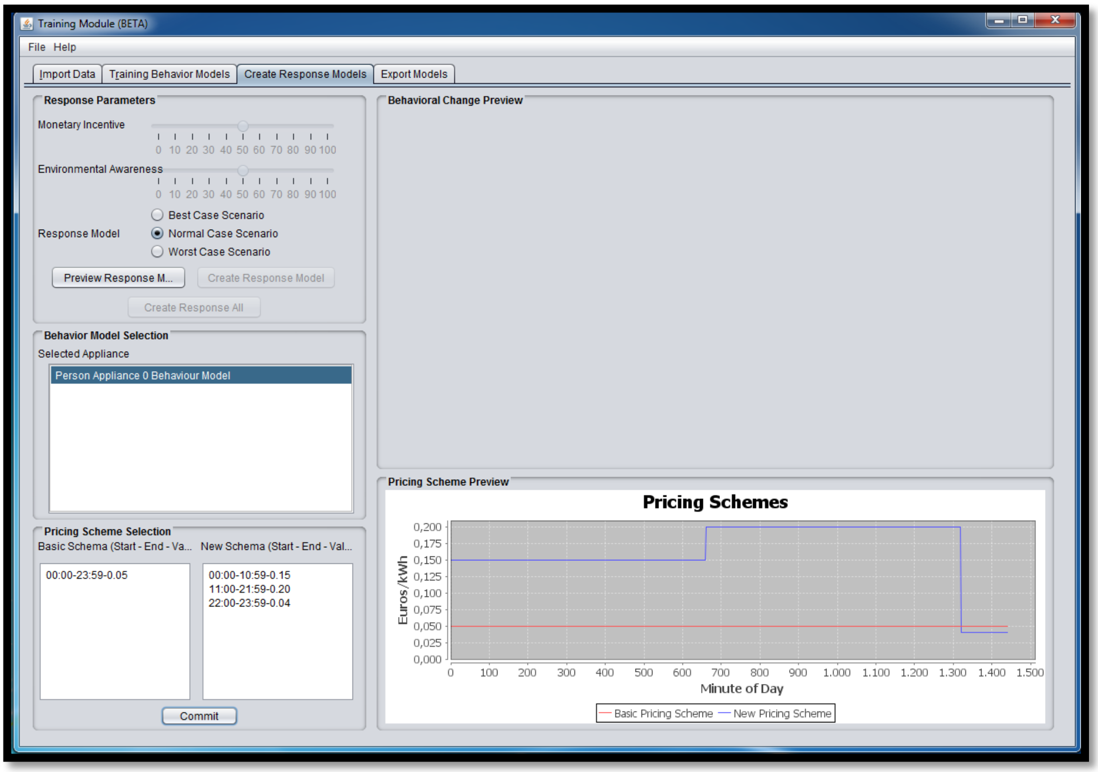
Basic Schema (Start - End - Va...
00:00-23:59-0.05

New Schema (Start - End - Val...
00:00-10:59-0.15
11:00-18:59-0.05
19:00-23:59-0.02

Selected Activity
- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model

Figure 53 Committing the pricing scheme

By pressing the *Commit* button the schemes are visualized in the *Pricing Scheme* panel (Figure 54). Also, the *Preview Response* button is enabled.



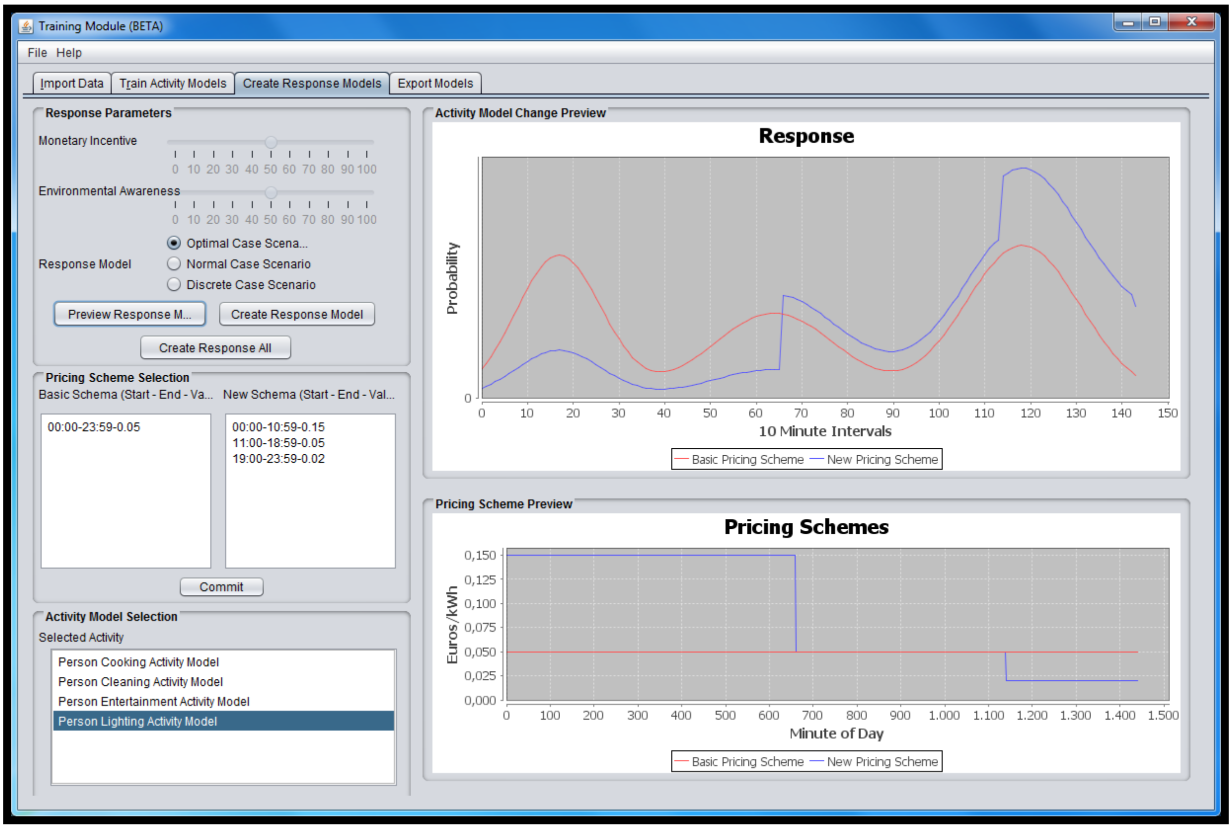
Response Model
○ Best Case Scenario
● Normal Case Scenario
○ Worst Case Scenario

Selected Appliance
Person Appliance 0 Behaviour Model

Basic Schema (Start - End - Va...	New Schema (Start - End - Val...
00:00-23:59-0.05	00:00-10:59-0.15 11:00-21:59-0.20 22:00-23:59-0.04

Figure 54 Visualizing pricing scheme and choosing response model

2. The user can now select the parameters for her response model from the *Response Parameters* panel. Then, she can press the *Preview Response* button to see the resulting model's *Start Time* distribution (Figure 55).



Response Model
● Optimal Case Scena...
○ Normal Case Scenario
○ Discrete Case Scenario

Pricing Scheme Selection

Basic Schema (Start - End - Va...	New Schema (Start - End - Val...
00:00-23:59-0.05	00:00-10:59-0.15 11:00-18:59-0.05 19:00-23:59-0.02

Activity Model Selection

Selected Activity

- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model

Figure 55 Response Preview

3. After visualising the response model preview, the user can choose to create the response models for the behaviour selected by pressing the *Create Response Model* button, or she can use the same parameters to create new response models for all the available behaviours on the list, by pressing the *Create Response All* button.

The newly created response models are passed to the *Export Models* tab. More details about this tab can be found in the next section.

3.4 Export Models Tab

Export Models tab is responsible for connecting *Training Module* to the main *Cassandra Platform* and adding the created entities (installations, persons, appliances, behaviour (activity) and response) models to the user's library.

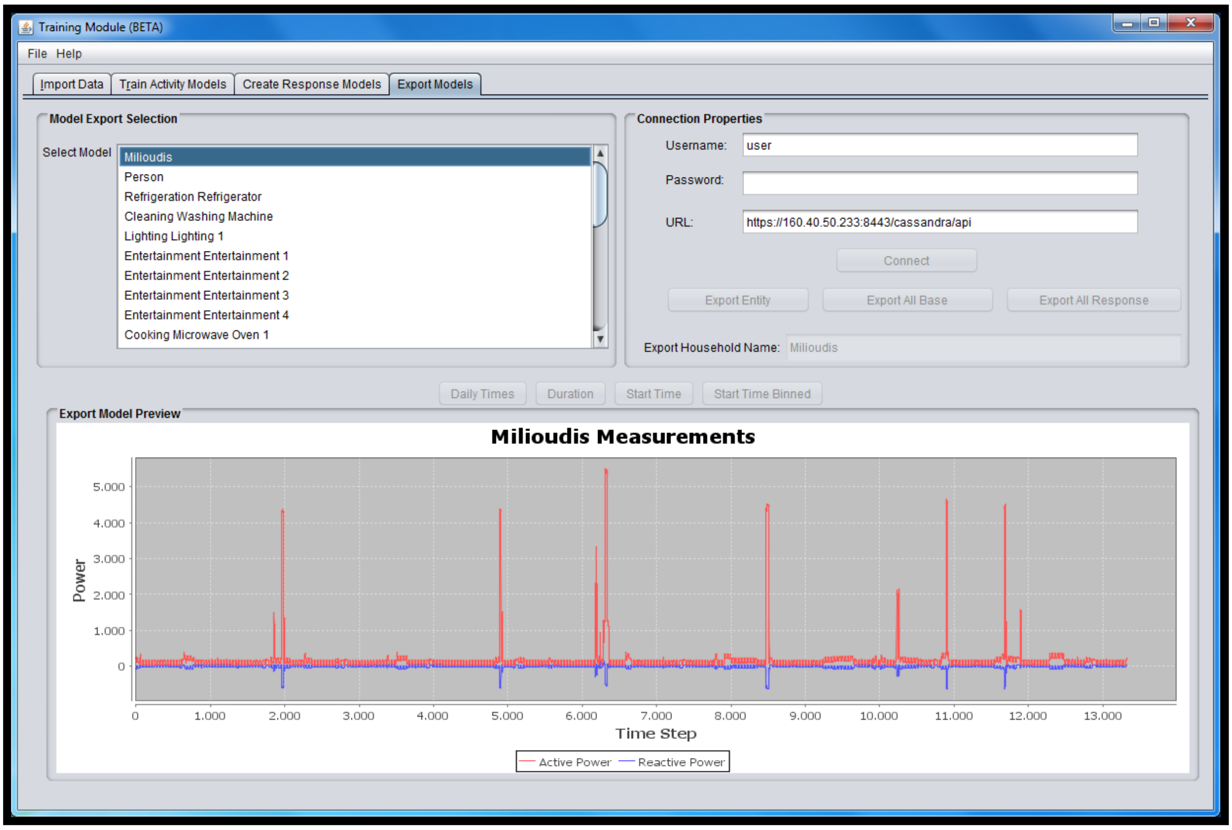
It is comprised by 3 different panels, each used for choice selection or data visualization (Figure 56).

- *Export Model Selection Panel:* This panel presents the list of the entities available for export. These can be any kind of entity (Installation, Person, Appliance, Behaviour (Activity) and Response) models.

- *Export Model Preview Panel:* This panel is responsible for visualizing the most appropriate attributes of the selected entity from the list above. The visualization is customized differently for each entity type selected.

- *Connection Properties Panel:* In this panel, the user can input her authentication credentials to the platform and then export the models she had created by selecting them from the entity model list.

  The authentication credentials are the same that are provided to the user for logging in the main Cassandra Platform and they are provided by the administrator of the Cassandra Server.



Select Model

- Milioudis
- Person
- Refrigeration Refrigerator
- Cleaning Washing Machine
- Lighting Lighting 1
- Entertainment Entertainment 1
- Entertainment Entertainment 2
- Entertainment Entertainment 3
- Entertainment Entertainment 4
- Cooking Microwave Oven 1

Username: user

Password:

URL: https://160.40.50.233:8443/cassandra/api

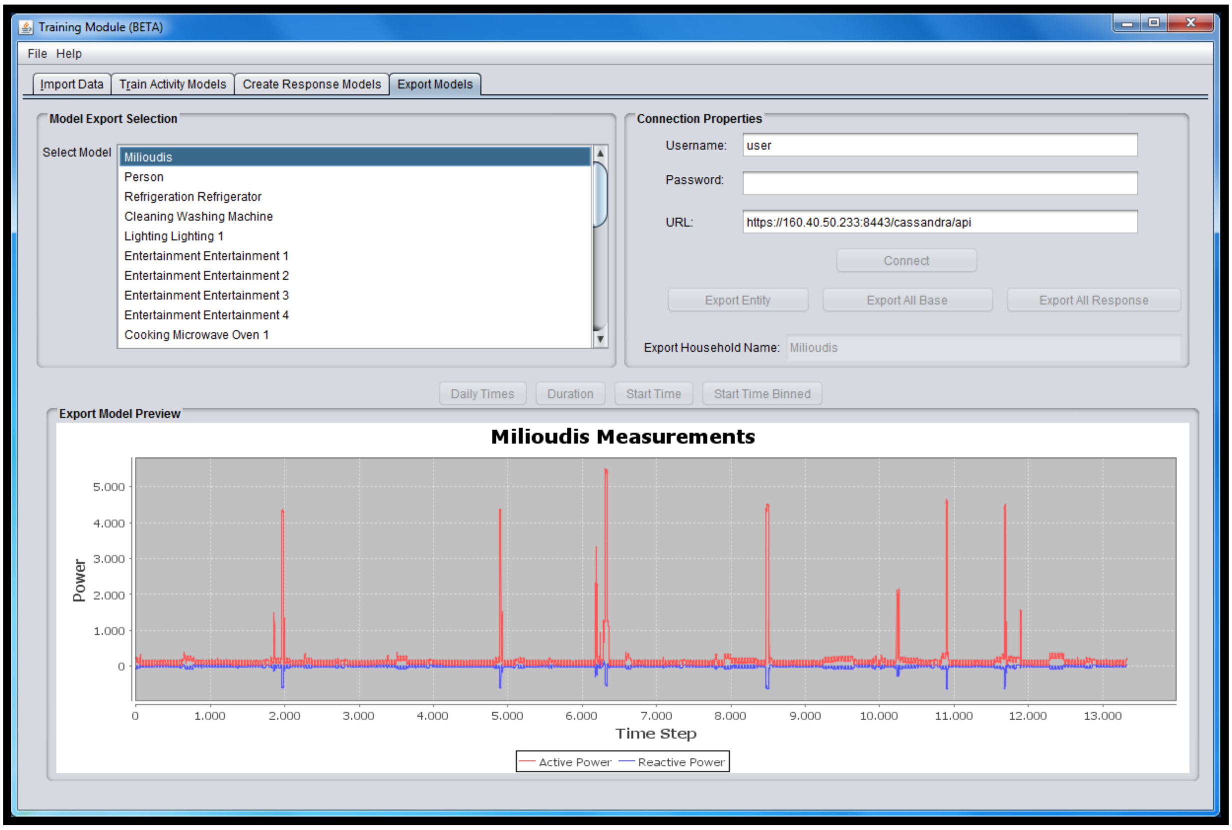
Export Household Name: Milioudis

Figure 56 Export Models tab

3.4.1 Usage workflow

The main usage workflow is as follows:

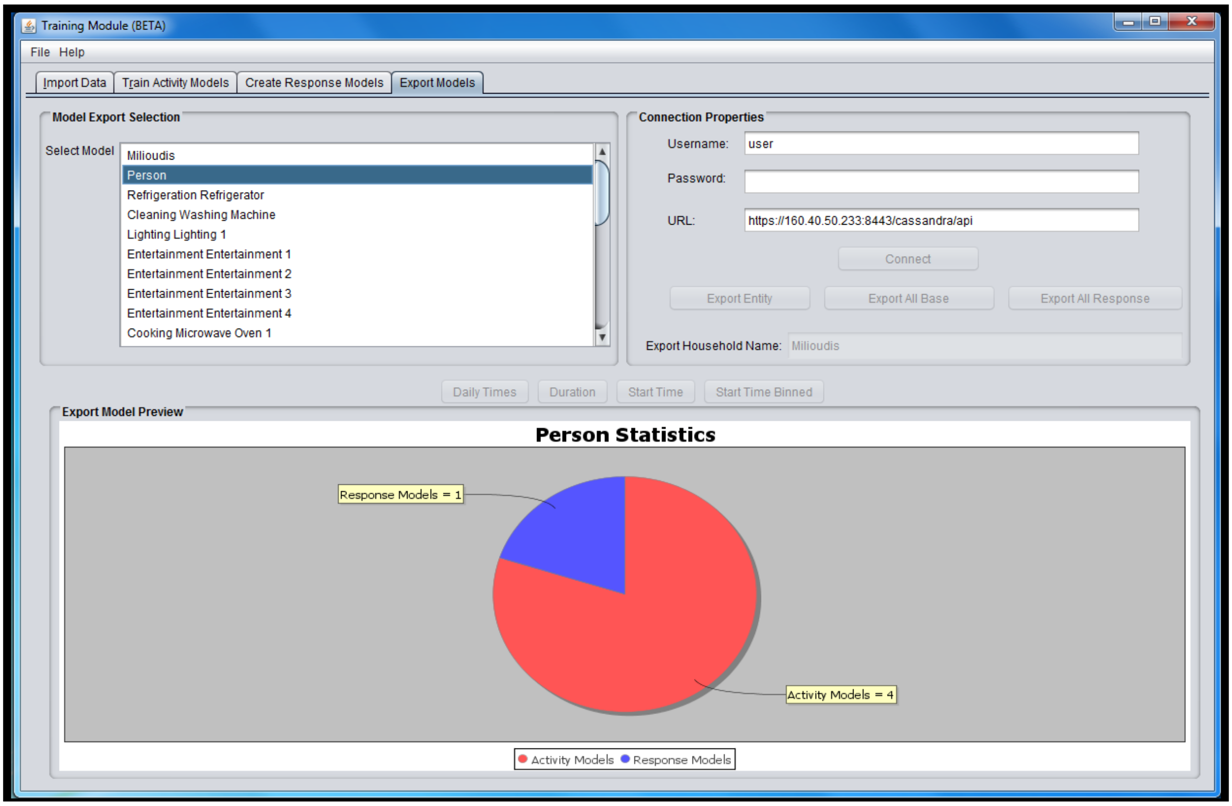
1. The user selects the entity that she wants to export to the main platform. The visualization of the entity's properties is presented differently for each entity type. Some examples can be found in the figures below.



Select Model
- Milioudis
- Person
- Refrigeration Refrigerator
- Cleaning Washing Machine
- Lighting Lighting 1
- Entertainment Entertainment 1
- Entertainment Entertainment 2
- Entertainment Entertainment 3
- Entertainment Entertainment 4
- Cooking Microwave Oven 1

Username: user
Password:
URL: https://160.40.50.233:8443/cassandra/api
Export Household Name: Milioudis

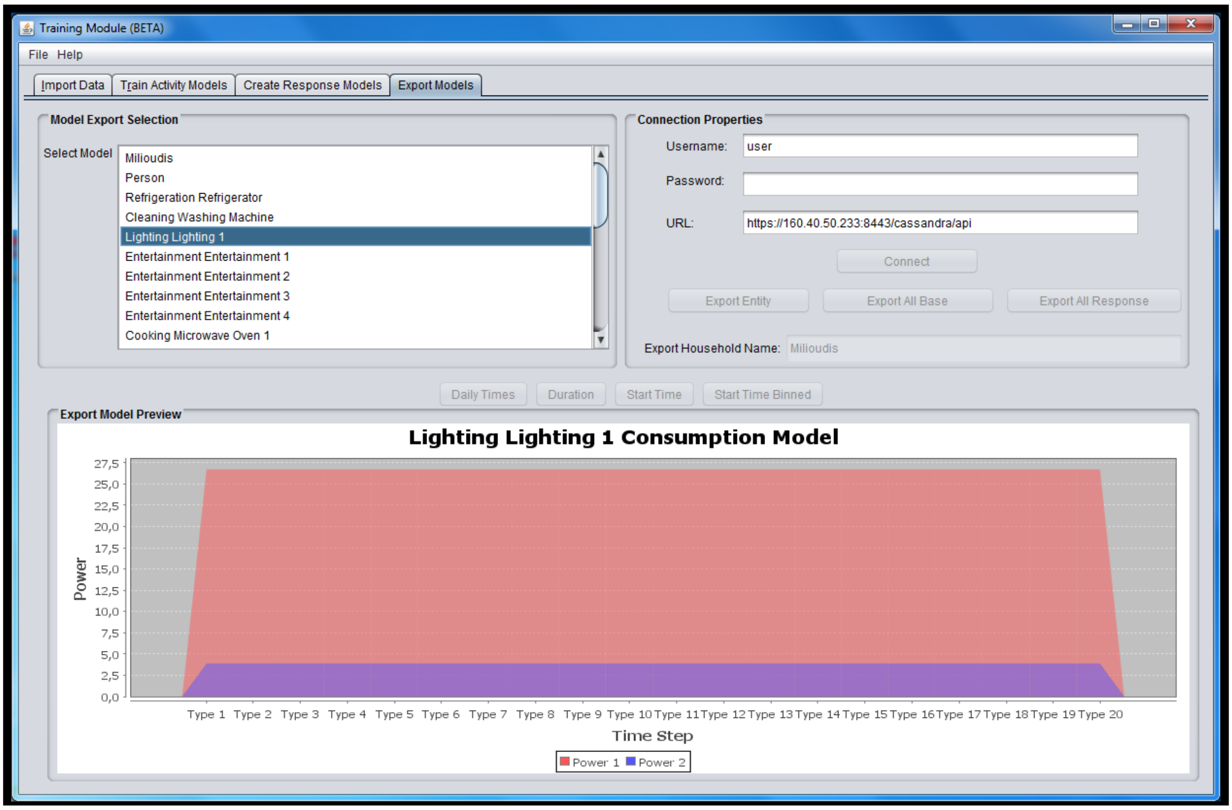
Figure 57 Export Installation models



Select Model
- Milioudis
- Person
- Refrigeration Refrigerator
- Cleaning Washing Machine
- Lighting Lighting 1
- Entertainment Entertainment 1
- Entertainment Entertainment 2
- Entertainment Entertainment 3
- Entertainment Entertainment 4
- Cooking Microwave Oven 1

Username: user
Password:
URL: https://160.40.50.233:8443/cassandra/api
Export Household Name: Milioudis

Figure 58 Export Person models



Select Model:

- Milioudis
- Person
- Refrigeration Refrigerator
- Cleaning Washing Machine
- Lighting Lighting 1
- Entertainment Entertainment 1
- Entertainment Entertainment 2
- Entertainment Entertainment 3
- Entertainment Entertainment 4
- Cooking Microwave Oven 1

Username: user

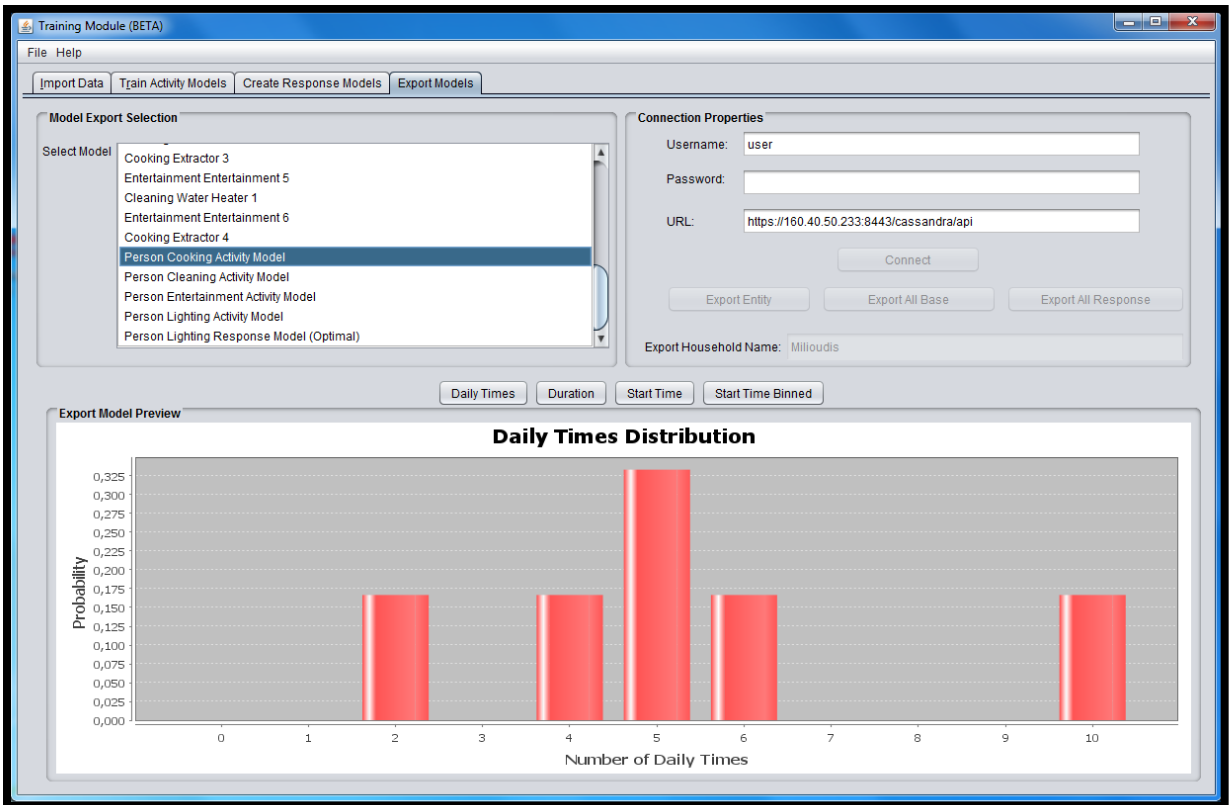
Password:

URL: https://160.40.50.233:8443/cassandra/api

Export Household Name: Milioudis

Lighting Lighting 1 Consumption Model

Figure 59 Export Appliance models



Select Model:

- Cooking Extractor 3
- Entertainment Entertainment 5
- Cleaning Water Heater 1
- Entertainment Entertainment 6
- Cooking Extractor 4
- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model
- Person Lighting Response Model (Optimal)

Username: user

Password:

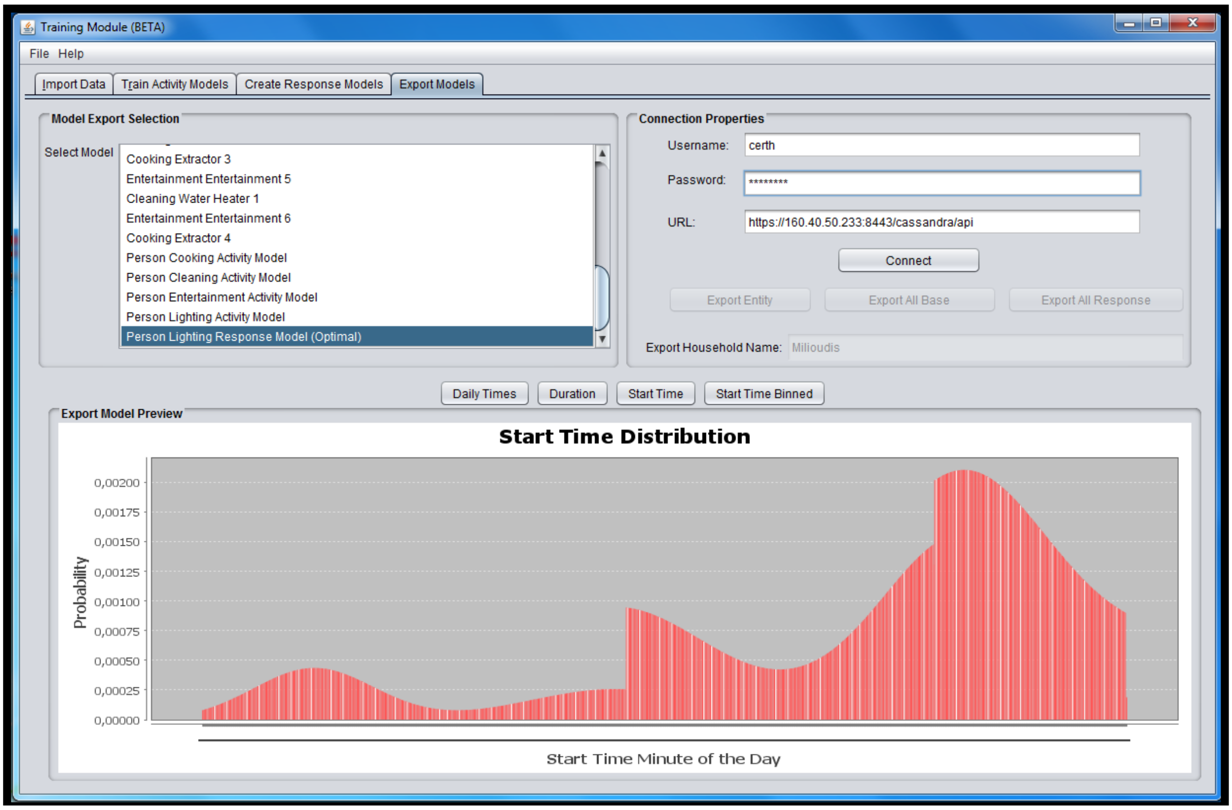
URL: https://160.40.50.233:8443/cassandra/api

Export Household Name: Milioudis

Daily Times Distribution

Figure 60 Export Activity/Response models

2. The user can type in her credentials and press the *Connect* button.



Select Model
- Cooking Extractor 3
- Entertainment Entertainment 5
- Cleaning Water Heater 1
- Entertainment Entertainment 6
- Cooking Extractor 4
- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model
- Person Lighting Response Model (Optimal)

Username: certh

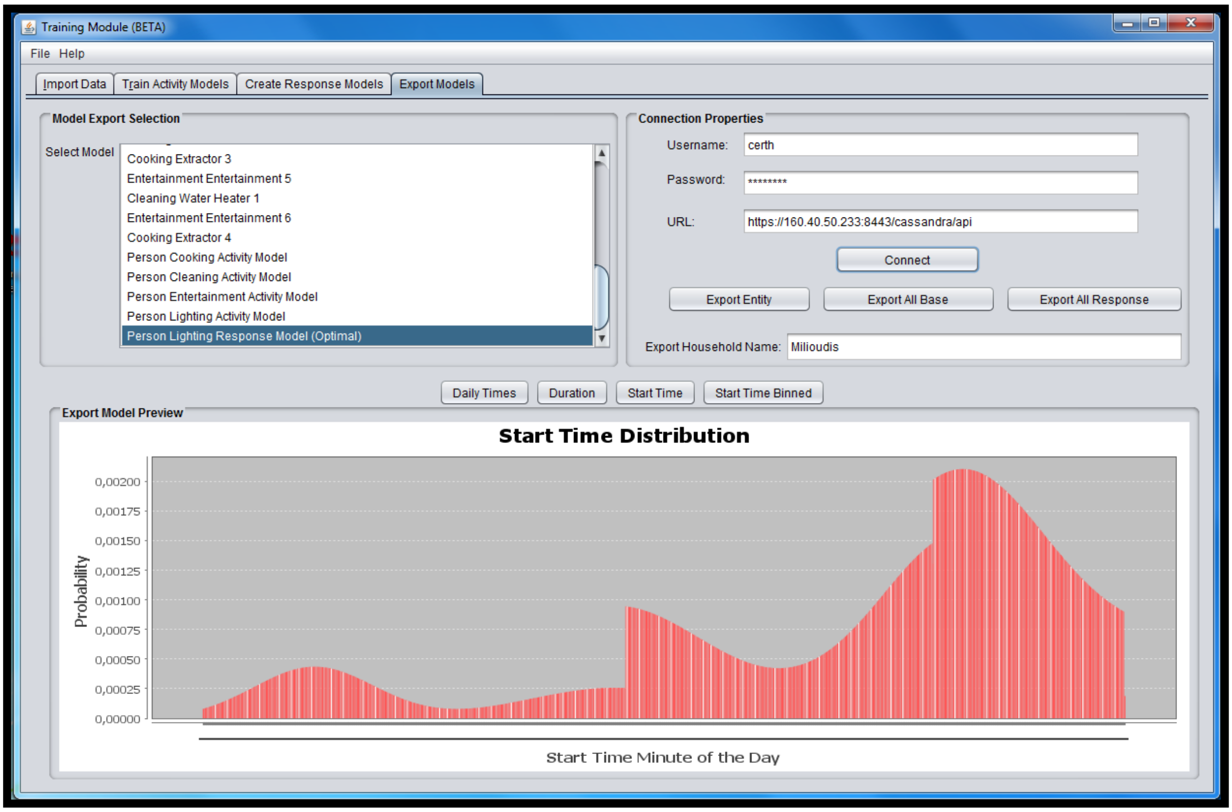
Password: ********

URL: https://160.40.50.233:8443/cassandra/api

Export Household Name: Milioudis

Figure 61 Connect to the Cassandra Server

3. After successfully connecting to the Cassandra Server, the user can choose to either export a single model by pressing the Export button, export all the available models as a whole base installation (using only the activity models) by pressing the *Export All Base* button, or he can export all the available models as a whole response installation (using only the response models) by pressing the *Export All Response* button.



Select Model
- Cooking Extractor 3
- Entertainment Entertainment 5
- Cleaning Water Heater 1
- Entertainment Entertainment 6
- Cooking Extractor 4
- Person Cooking Activity Model
- Person Cleaning Activity Model
- Person Entertainment Activity Model
- Person Lighting Activity Model
- Person Lighting Response Model (Optimal)

Username: certh

Password: ********

URL: https://160.40.50.233:8443/cassandra/api

Export Household Name: Milioudis

Figure 62 Exporting models as Base or Response installation

4 Installation Manual

The following steps will help you installing the cassandra platform on your system:

1. Install MongoDB on your system.
2. Install Tomcat on your system (The platform was developed using Tomcat 7).
1. Make sure that you start Tomcat using Java 7. A solution to accomplish this create a ``setenv.sh`` file in ``CATALINA_HOME`` adding ``JRE_HOME=/path/to/your/java7/installation``. Then make it executable ``chmod 755 setenv.sh``. Check-out http://localhost:8080 to test if Tomcat is working.
3. Secure Tomcat (see next sub-section in the current section)
4. Download the Cassandra platform bundle
5. Configure the environment variables in the application's web.xml ``mongo.host.address`` and ``mongo.db`` and set them to the MongoDB **host address** and the MongoDB **database name** to use.
6. Build the platform using ``ant``. The [[CASSANDRA Ant]] page describes the specifics of the build process.
7. Start the Tomcat server. (``./startup.sh``)
8. Drop the ``cassandra.war`` file, found in the created ``dist`` directory of the built Cassandra platfrom bundle after using ``ant``, in the webapps directory of the tomcat installation. The war archive will self-extract and create the webapp directory.
9. Go to https://localhost:8443/cassandra and enjoy!
10. To shutdown Tomcat: ``./shutdown.sh``

4.1 Securing Tomcat

In this section we will secure Tomcat to listen only via https on port 8443:

1. Create a key:

``keytool -genkey -keyalg RSA -alias host -keystore keystore.jks -validity 999 -keysize 2048``

2. Add the following connector to Tomcat server.xml configuration file:

```
<Connector port="8443" protocol="HTTP/1.1" SSLEnabled="true"
       maxThreads="150" scheme="https" secure="true"
       clientAuth="false" sslProtocol="TLS"
       keystoreFile="path/to/keystore.jks"
          keystorePass="changeit"/>
```

3. Make sure port 8080 redirect to 8443 (server.xml again):

```
<Connector connectionTimeout="20000" port="8080"
    protocol="HTTP/1.1" redirectPort="8443"/>
```

4. Add the following xml snippet into **Tomcat's** web.xml configuration file:

```
<!-- SSL settings. only allow HTTPS access to tomcat -->
<security-constraint>
  <web-resource-collection>
    <web-resource-name>Entire Application</web-resource-name>
      <url-pattern>/*</url-pattern>
  </web-resource-collection>
  <user-data-constraint>
    <transport-guarantee>CONFIDENTIAL</transport-guarantee>
  </user-data-constraint>
</security-constraint>
```

4.2 Adding users

The procedure for adding users is as follows:

Insert a user document in the database through the console interface of MongoDB or any other UI MongoDB client (for example rockmongo):

1. { “username”: “demo”}
2. This document will have an ObjecID (for example “123”)
3. Run the tool *md5hashgen.jar* located under the folder *tools*

```
java –jar md5hashgen.jar secret 123
```

where secret is the chosen password and 123 the ObjectID

4. The tool will output a password in the console (for example “a1s2d3f4”)
5. Update the document in the MongoDB:

```
{
        “username”: “demo”,
       “password”: “a1s2d3f4”
}
```

Now the user can login with credentials demo and secret.

5 Summary

The aim of the present deliverable is to offer a manual to accompany the early version of the Cassandra platform. The up-to-date electronic version of this document can be found at: https://github.com/cassandra-project/platform/wiki/User-Manual, while the early prototype of the platform is located at: https://github.com/cassandra-project/platform.