Annex D5.1.ODYSSEUS Validation Methodology

Deliverable data

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1 Odysseus Validation Methodology

The Odysseus project is about reducing energy consumption in urban areas by means of decision making support (strategic, tactical and operational) with the provision of a holistic energy management vision of neighbourhoods. This management requires a complete and right information picture of the area in terms of energy nodes (e-Nodes) and their energy interactions.

This making-decision support will be conducted in two pilot cases in Manchester and Rome with the objective to prepare, implement, monitor and asses use cases with the scale of (level of detail) building oriented and neighbourhood oriented.

Within Odysseus D5.1 we propose the Odysseus validation methodology. Because of the nature of the project and the ECMs (Energy Conservation Measures) that will be implemented, ICT PSP methodology is considered the most suitable methodology in which Odysseus might be supported. The Odysseus validation methodology is planned to be developed by upgrading ICT PSP principles with the inclusion of the neighbourhood point of view.

The Odysseus proposed validation methodology has been summarised in 12 steps that covers the demonstration plan for both pilot cases in several phases. Phases proposed include: monitoring plan, baseline analysis, ECMs definition, extended boundaries to e-Network, reporting period and evaluation period. Each of these phases will be covered in the pilot cases of the cities of Manchester and Rome.

Next table summarises the 12 steps and phases of the validation methodology. Also, next figure provides a timeline based vision of the methodology.

Steps	Description	Phase
1	Define the set of project boundaries for the pilot site: energy-system(s)/e-Node(s) definition.	• Monitoring plan
2	Select the predictor variables to be applied on the pilot site.	• Monitoring plan
3	Set the baseline period for the pilot site without improvements and optimization at neighbourhood level.	• Monitoring plan
4	Deploy monitoring hardware (e.g. gateways, sensors and actuators) for energy-systems /energy nodes (e-Nodes) at facilities level in the pilot site (e.g. floors, buildings) in order to monitor predictor variables (e.g. energy data).	• Monitoring plan
5	Collect and store raw data of predictor variables at energy-systems	• Monitoring plan

	/ e-Node (facilities level scale) (M13-M24)	• Baseline analysis
6	Transform raw data into dEPC information structure (M21: Monitoring tool).	• Monitoring plan • Baseline analysis
7	Perform initial baseline analysis at energy-system/e-Node level (facilities level) (M21: decision-making tools). Define ECMs.	• Baseline analysis • ECMs definition
8	Connect e-Nodes to the aggregation layer of the Odysseus Cloud Platform. From e-Node to e-Network (building /neighbourhood/district) (M24).	• Extended boundaries to e-Network
9	Send e-Node dEPC information (real information) to the Odysseus Cloud Platform to compose the e-Network level (simulated). Analyse and conclude the neighbourhood baseline period for the pilot site with this information). **Note:** At this step we will have a neighbourhood level scale vision.	• Extended boundaries to e-Network • Baseline analysis
10	Apply the identified ECMs at e-Node level (facilities level scale) (e.g. building). **Note:** This step implies the start of the reporting period for the pilot site.	• ECMs • Reporting period
11	Apply the identified ECMs at e-Network level (Odysseus Cloud Platform simulation). **Note:** At this step we expect to have the Odysseus Cloud Platform and the integrated versions of energy efficiency tools. We will provide a holistic energy management vision of the neighbourhood.	• Extended boundaries to e-Network • ECMs • Reporting period
12	Evaluate the obtained results at e-Node level (facilities level) and e-Network level (neighbourhood level) by comparing baseline and reporting periods.	• Evaluation period

Table 1 - Odysseus validation methodology steps

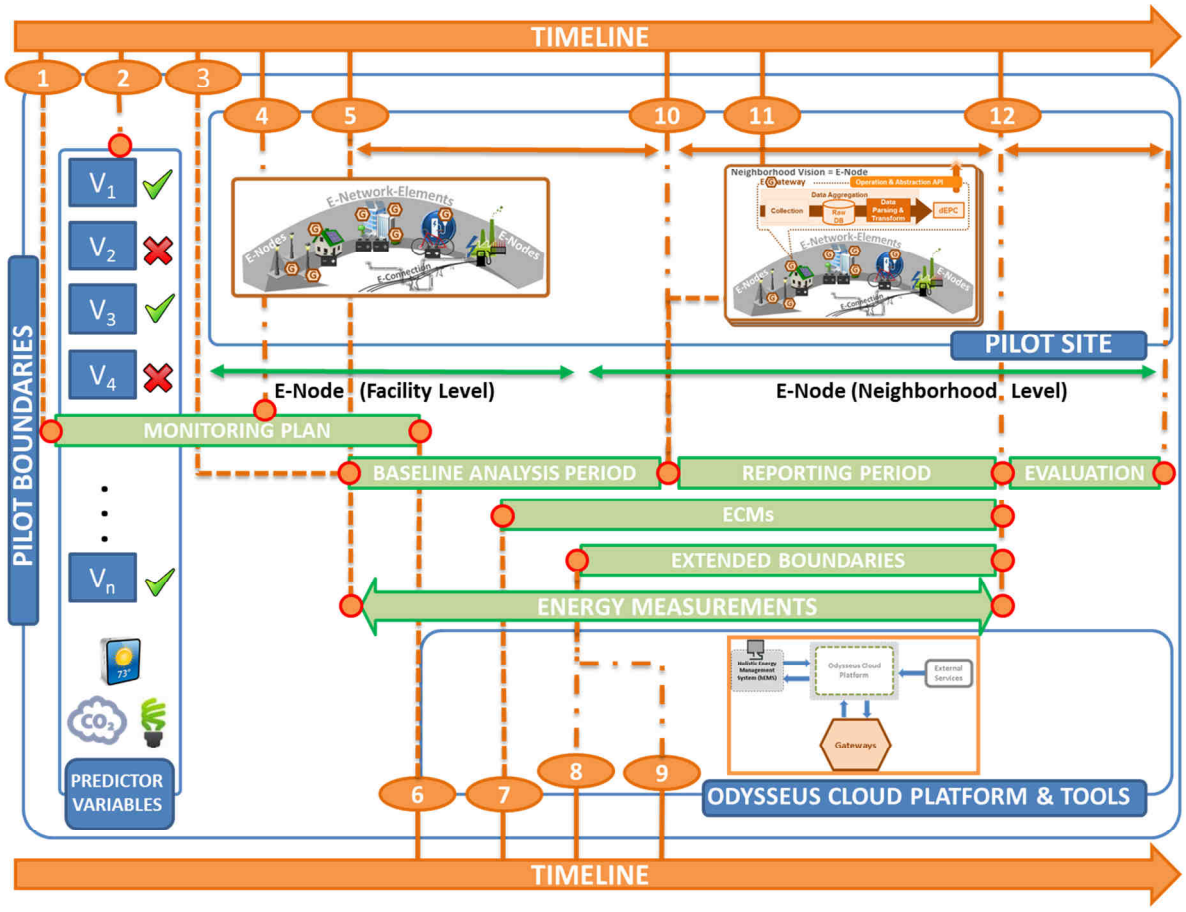

Figure 1 - Odysseus validation timeline

The Odysseus validation methodology tries to address the question on how to go from facilities level (like buildings) towards an upper level scale like the neighbourhood of a city. In this sense, Odysseus tools and solutions will be deployed for monitoring e-Nodes and energy systems levels in pilot sites for the application of the ECMs at facilities level. Simulation approaches will be mainly conducted when the Odysseus Cloud Platform and the decision making tools enters into scene for the application of ECMs at neighbourhood level.

This deliverable includes a description and tries to set-up the basis of:

- The definition of the Odysseus boundaries based on pilot cases specificities
- The set of relevant predictor variables, by considering energy data, simulated variables, independent variables, (like weather conditions and energy tariff prices) and static factors for both pilot cases
- A baseline definition that summarises the energy flows, the identification of the boundaries of these energy flows, a proposal for the relevant KPIs and the

monitoring equipment and devices for implementation of use cases at Manchester and Rome pilots cases

- Baseline analysis to be applied by the identification of ECMs, their commissioning and finally the set of conditions to which ECMs will be adjusted
- How will be carried out the reporting period in terms of monitoring /measurement, reporting and analysis activities.

Boundaries definition

The measurement boundary for the pilot case must be clearly defined.

Project boundaries definition	
Scope	Identify “Facility” or “Facilities” involved and details of the geospatial area
Baseline period	Indicate the baseline period in case it is required (e.g. a quarter, a year, …) for the pilot case and how it is affected by the particularities of the pilot case
Reporting period	State what are the measurements requirements or if there will exit any control group.

Predictor variables

Predictor variables are each measurable factor that has a significant impact on energy consumption at the pilot site. These predictor variables are monitored data that must follow the information structure to be pushed to the Odysseus Cloud Platform from pilot sites. These variables must have a specific time stamp with an appropriate accuracy.

Predictor variables will be categorized and classified in the following subsections:

- Energy data that provides measures of sub-meter information from deployed monitoring systems both indoor (energy sources, comfort parameter or other parameter), or outdoor (mainly weather),
- Simulated variables that provide simulated measures of energy data based on simulation approaches,
- Independent variables, parameters that are expected to change regularly (like weather conditions and energy tariff prices) and has a measurable impact on the energy use of a system or facility, meanwhile are independent of the system or facility

- Static factors, those that do not change during the implementation phase of the evaluation to be applied following the validation methodology (like space heated, building characteristics, facility usage, …).

Baseline definition

The baseline definition will deal with the identification of relevant information concerning to:

- What is the current situation of **the energy flows** for the facilities; by considering all the energy sources, their current usage and their key features regarding to the energy lifecycle (production, consumption, storage) and their energy figures in terms of yearly production, consumption. Moreover, will be identified what are their energy exchange capabilities; including the existing technical infrastructure, like PV panels, CHP installation, heating systems, …, and their relevant energy characteristics (e.g. energy production by PV panels).
- What are the **boundaries of the energy flows** in relation to the proposed energy objectives to be addressed taking into account the ECMs to be applied.
- What are the relevant **Key Performance Indicators** (KPIs) for supporting the decision making by the stakeholders (e.g. city energy managers, building energy managers). Identified KPIs must be defined both at building and neighbourhood scale, accordingly with pilot case proposed scenarios and use cases. At use case level, KPIs are built in order to provide a precise and quantitative measure of what we are saving in terms of energy (and costs). Each KPI will provide us with key information: goodness of actions taken based on developed tools; and in case of negative feedback information, possible corrections of the taken measures.
- What are the **monitoring metering devices and equipment** to be employed in the proposed use cases at facilities (building) and neighbourhood levels.
    - At facilities level scale, a specification of the metering points and monitoring timing (continuous or scheduled) and how the calibration of the metering devices will be based must be provided.
    - At neighbourhood level scale we will use expected simulation capabilities provided by project Platform and developed tools for addressing the proposed use cases.

Baseline analysis

The baseline analysis to be implemented in each pilot case must be described in the following terms by:

- The identification of the Energy Conservative Measures (ECMs). ECMs may have various forms. It can be simple recommendations like “improve building insulation” or “Replace white goods by their equivalent from higher rank in energy saving”.
- The proposal of the ECMs commissioning by identifying how the application of ECMs will be conducted (by human interactions or based on developed tools).
- The identification of the ECMS adjustments to be considered. Adjustments will be made taking into account the influence of parameters like weather and seasons, occupancy levels of zones of the facilities (buildings) and activities (meeting / screen based activities / others / …) on the overall energy consumption when comparing the baseline period and the period in which ECMs were applied.

Reporting period

The reporting period that we will apply in Odysseus can be divided between monitoring & measurement, reporting and analysis activities:

- Monitoring and measurement activities
    - We must define the operational verification procedures that will be used to verify successful implementation of each proposed ECM
    - How assessment measurements applied to each pilot case must be specified in order to conduct the assessment measurements during the reporting period for the performance of the facility as a whole (or parts of or devices in the facility) and not on specific ECM performance
    - It must be guarantee that the operational verification procedures should be such that the predictor variables can be measured for the time intervals in the reporting period (by taking into consideration aspects like time-scale to be considered, how the aggregation of the measured values will be conducted afterwards or on the fly, how the deviations (e.g. weather impact) are affecting the measured data).
    - Specificities of the reporting period for each pilot case must be identified
    - Make adjustments on the energy efficiency by accounting for in-door and out-door variables that might have a relatively strong influence on the

energy consumption/production.

- Before executing the various measurements during the reporting period, it should be verified that the ECMs are installed and operating properly and that they have the potential to generate savings. Operational verification may involve inspections, functional performance testing, and/or data trending with analysis.

- ECM quantification and reporting by specifying how results will be reported and organized.
  - The reports to be generated as a result of the measurement, validation and verification activities should include the baseline-period energy efficiency versus the reported-period energy efficiency or in the case of a control group the energy efficiency of the control group versus that of the group in which the ECMs have been taken.
  - The main part of the report should concentrate on various curves that can be derived from the measured data.
  - In addition, comparison curves between the baseline-period and the reporting-period should be included.
  - Furthermore, analysis results on the measured data should be presented in which the energy efficiency of the facility is defined and calculated.
  - Concluding statements on the comparison of the energy efficiency should be made at the end of the report.
- Analysis procedures and models by specifying data analysis procedures, algorithms and assumptions to be used in each savings report.
  - One of the key strategic objectives is to identify (re)usable models for the definition of energy efficiency for buildings/facilities/urban areas that can be used before and after the ECMs that we put into place.
  - The various KPI definitions to be described for the pilot cases can be used as basis for a model of how to define the energy efficiency. On top of that, we will look at specific patterns in the measured data.
  - What will be analysed regarding to the energy lifecycle (consumption, production and storage) in relation to the ECMs is closely related to the decisions to be made in the pilot cases.

Note. If you require further details regarding to the Odysseus Validation Methodology, take a look to the full deliverable "D5.1 Odysseus Validation Methodology" and to the "D5.2 Odysseus Demonstration Plan".

@Odysseus Web Site:

http://www.odysseus-project.eu/project-results/category/7-wp5-odysseus-validation.html