Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology
H2020 - 678407

Construction Management, Cost Management and Implementation of the Innovative Technologies

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ZERO-PLUS - Management

- Objective: reduce initial costs of NZE buildings by at least 16%
- Approach: settlement-level application of NZE goals
- Challenge: larger scope brings increased complexity, which has to be carefully managed
ZERO-PLUS - Management

Careful integration and coordination of technologies, processes, tools and stakeholders

Technologies → Stakeholders

Processes and Tools
ZERO-PLUS - Management

Careful integration and coordination of technologies, processes, tools and stakeholders

Technologies  Stakeholders

Processes and Tools
Technologies

Reduced Energy Consumption
- Insulation
- HVAC

Renewable Energy Generation
- Thermo-solar
- Wind+PV

Energy Management
- BEMS
- Storage
 ZERO-PLUS - Management

Careful integration and coordination of technologies, processes, tools and stakeholders

 Technologies <-> Stakeholders

 Processes and Tools
Stakeholders

- Owners
- Designers
- Contractors
- Suppliers
- Occupants
- Maintenance pers.
ZERO-PLUS - Management

Careful integration and coordination of technologies, processes, tools and stakeholders
Design Processes and Tools

- Building Energy Simulation
- Settlement Micro-climate Simulation
- Design Optimization (Life Cycle Costs)
- Design Optimization (Initial Costs)
Management Processes and Tools

Cost Control

Commissioning

Change Management

Site Planning

Supply Logistics
Management Processes and Tools

Task

T6.1  Design Integration

T6.2  Cost Control  Cost Control Tool

T6.2  Change Management  Change Management Tool

T6.3  Supply Logistics  JIT Supply Logistics Plan

T6.4  Site Planning  Site Planning Process

T6.5  Implementation  Progress Tracking Platform

T6.6  Commissioning  Commissioning Plan
T6.1 Design Management

- Related design integration and optimization
- LCC Design Optimization Tool consequently developed (is also linked to cost control tool)
- Involved preparation of coordinated design plans

Costs in life cycle phases

<table>
<thead>
<tr>
<th>Life cycle phases</th>
<th>Lower bound</th>
<th>Most Likely</th>
<th>Upper bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End of life costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Cycle Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Euro/50 years

- Initial costs
- Operational costs
- Maintenance costs
- End of life costs
- Life Cycle Cost

Graph showing costs in different life cycle phases.
### T6.2: Cost Management

<table>
<thead>
<tr>
<th>KPI (Key Performance Indicator)</th>
<th>ZP Design</th>
<th>Required</th>
<th>Requirement Status</th>
<th>Relevant Calculations</th>
<th>Zero-Energy Reference building</th>
<th>ZERO-PLUS building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction percent of total average cost (€/m²) compared with reference</td>
<td>10.97%</td>
<td>≥16%</td>
<td>Not Fulfilled</td>
<td>Total average cost of all building energy technologies (€/m²)</td>
<td>433.10</td>
<td>385.58</td>
</tr>
<tr>
<td>Annual regulated energy consumption (kWh/m² per year)</td>
<td>-25.82</td>
<td>≤20</td>
<td>Fulfilled</td>
<td>Annual regulated energy consumption (kWh/m² per year)</td>
<td>-25.60</td>
<td>-25.82</td>
</tr>
<tr>
<td>Annual total average energy production (kWh/m² per year)</td>
<td>53.01</td>
<td>≥50</td>
<td>Fulfilled</td>
<td>Annual total average energy production from building integrated RES (kWh/m² per year)</td>
<td>61.30</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual total average energy production from community integrated RES (kWh/m² per year)</td>
<td>0.00</td>
<td>0.00</td>
<td>performance data</td>
<td>Annual total average energy production from community integrated RES (kWh/m² per year)</td>
<td>53.01</td>
<td></td>
</tr>
</tbody>
</table>

**Instructions:**
- Please fill the empty cells in the tables that have white background and are **NOT** surrounded by a broken line.

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**Instructions for use**

ZE reference building
T6.2: Cost Management

- Facilitate timely, consistent and comprehensive framework for preparation of cost assessments.
- Provide platform for analysis of assessed costs and tracking their status.
- **Cost Control Tool**
- Facilitate early identification of implications of changes on project cost, by linking the CC tool with a Change Management tool.
## T6.2: Cost Management

### Step 4

**Impact of the change on the project's Key Performance Indicators (KPI)**

Please check the impact of the proposed change on the project’s Key Performance Indicators by clicking the "Click here" button and then proceed to step 5.

<table>
<thead>
<tr>
<th>KPI</th>
<th>Value before change</th>
<th>Status before change</th>
<th>Value after change</th>
<th>Status after change</th>
</tr>
</thead>
</table>

### Step 5

**Impact of the change on other ZP technologies**

Please obtain the impact of the proposed change on other ZP technologies (as provided by the project owner) by clicking the "Click here" button and then proceed to step 6.

<table>
<thead>
<tr>
<th>Impacted technology</th>
<th>Type of connection</th>
<th>Description</th>
</tr>
</thead>
</table>
T6.3: Supply Logistics
T6.3: Supply Logistics

Complicating factors, such as:

• Costs of shipping, travel of supporting team
• Direct acquisition / indirect through local contractors
• Responsibility, warranty
• Local certification
• Etc.
### T6.5: Implementation of the ZP technologies

#### Progress Tracking - Granarolo, Bologna, Italy

Changes are highlighted

<table>
<thead>
<tr>
<th>Stage No.</th>
<th>Stage Name</th>
<th>Planned Date of Completion</th>
<th>Revised Date</th>
<th>Reason for Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specification:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a</td>
<td>Detailed design prepared and approved.</td>
<td>22/09/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b</td>
<td>Request for quotation completed by case study owner.</td>
<td>20/10/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1c</td>
<td>Bld given by technology provider.</td>
<td>27/11/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Procurement:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a</td>
<td>Subcomponents ordered by technology provider.</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2b</td>
<td>All subcomponents available at the technology provider’s site.</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2c</td>
<td>Product pre-assembled.</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2d</td>
<td>Product tested by technology provider.</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2e</td>
<td>Product ready for shipping.</td>
<td>29/11/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2f</td>
<td>Product shipped.</td>
<td>30/11/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2g</td>
<td>Product supplied to site.</td>
<td>01/12/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>On-site Activities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>On-site preparatory works completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td>Product installed.</td>
<td>06/12/2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3c</td>
<td>Functional testing completed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3d</td>
<td>Product connected to M&amp;E infrastructure and monitoring system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3e</td>
<td>System tested and delivered to owner.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
T6.5: Implementation of the ZP technologies

- Continuous tracking of progress in case studies
- Regular catch-up meetings
- Updates of project status on the cloud
- Case-studies documentation exchange system
T6.6: Commissioning of the ZP technologies

- Commissioning of **ZP technologies**
- Provide owners with **guidelines** for preparation of detailed commissioning
- **Ensure performance of technologies** in line with owners' requirements
- Building commissioning plan
## T6.6: Commissioning of the ZPB technologies

### Commissioning Plan:
- Checklists for the commissioning of each technology
- Monitoring protocols for measuring and verifying in the pre-occupancy phase
- Format for reporting results of the building envelope tests
- Results will be communicated through Web-GIS platform
- Template for planning the testing process, with all actions and tasks that case study owner should undertake

### Technology Monitoring platform:
- Complete installation of all monitoring devices for the indoor measurements (T,RH, room presence, door/window open/close, optional CO2, luminance)
- Complete instalation of the energy measurement devices (HVAC, domestic heat/cool, total building)
- Complete instalation of the KNX IP router
- Complete programming of the KNX IP router
- Test proper function of connected monitoring devices and verify that all quantities are measured correctly
- Complete test communication of the KNX IP router with the Web-GIS platform
- Complete installation of the meteorological station
- Complete test communication of the meteorological station with the Web-GIS platform

### Building diagnostics:
- Air permeability tests (obligatory)
- U-value tests (obligatory)
- Additional test (optional)

### 1st RES:
- Complete installation of the monitoring devices for the 1st RES technology
- Complete test communication of the monitoring devices of the 1st RES technology with the Web-GIS platform

### Nth RES:
- Complete installation of the monitoring devices for the Nth RES technology
- Complete test communication of the monitoring devices of the Nth RES technology with the Web-GIS platform

### Access to Web-GIS:
- Test accessing the measurements using the personal case study account on the Web-GIS platform
- Test accessing the house/appartment specific measurements using the personal house/appartment account on the Web-GIS platform

### Table

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Instrument used</th>
<th>Location of the instrument during the measurement</th>
<th>Has the measurement been recorded on Web-GIS platform?</th>
</tr>
</thead>
<tbody>
<tr>
<td>eg. Infrared thermography</td>
<td>eg. Infrared camera</td>
<td>eg. outside/around of the house</td>
<td>YES/NO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Measurement</th>
<th>Measurement unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/3/2015 9:00</td>
<td>dropbox url or image</td>
<td>image</td>
<td>front side of the building</td>
</tr>
</tbody>
</table>
Lessons Learned

For example:

• Need for flexible process that can accommodate frequent changes, yet ensure adherence to KPIs

• Challenges in obtaining permits from local authorities

• Challenges in installing shared energy generation and control technologies