From Data Analytics to Energy Management Action Plans: An Application for the Built Environment

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The catalyst and coordinator for cooperation on clean energy

The practical instrument for cooperation activities in the area of clean energy technologies:

1. Renewable Energy Technologies
2. Energy Efficiency and DSM
3. Clean Fossil Fuels
4. Carbon Capture, Storage and Usage
5. Regional Electricity Market Integration, and
6. Climate Change Policy.
The Network at a Glance (2/3)

- **Bridge**
  - Technical Site Visits
  - Facilitation of Exchange of Researchers
  - Joint Research Publications
  - Develop Project Ideas, Proposals

- **Source**
  - Training Seminars
  - Policy Studies, Technical Papers
  - Advanced website

- **Platform**
  - Working Groups Meetings
  - Workshops, Conferences
Who should join

- Governmental and policy making bodies;
- Energy Utilities, Regulators;
- Industry / Commercial actors;
- Research Institutes, Academia;
- International organisations, initiatives, projects;
- Industry Associations;
- Experts.
Contents

- Smart Energy Cities & Intelligent Energy Management Systems
- OPTIMUS Project, Package of Consulting Tools & Overall Procedure
- How OPTIMUS is your city / building?
- What is the potential of the city / building for optimization?
- How do you manage the data?
- “Data Driven” Decision Support
- Upscaling of the OPTIMUS approach…
Smart Energy Cities

- Energy grid + ICT = smart grid
- Smart grid + OR + big data = smart energy
Smart Energy Cities

Energy / facilities managers, utilities and energy consultancies incl. energy agencies
Intelligent Energy Management Systems

Decision Support System (DSS) as an integrated ICT platform

- Reduction of energy consumption.
- Reduction of energy cost.
- Reduction of CO₂ emissions.
- Increase of renewable energy production.

OPTIMUS Project (1/5)

OPTIMising the energy USE in cities with smart decision support systems (OPTIMUS)

Start: October 2013
End: November 2016
Duration: 36 months

Project Partners:

http://www.optimus-smartcity.eu

This project is co-funded by the European Union
Innovation (1/2)

OPTIMUS Project (3/5)

Innovation (2/2)

- OPTIMUS sits on the top of existing energy management systems, integrating five multidisciplinary data sources:
  - Weather.
  - Building monitoring.
  - Occupants’ feedback.
  - Energy prices.
  - Energy production.

- Short-term Action Plans for energy managers with the goal of reducing energy consumption and cost.
Thermal Comfort Validator
– TCV Web App
http://validator.optimus-smartcity.eu
WWW.OPTIMUS-SMARTCITY.EU
OPTIMUS Project (5/5)

Pilot Cities and Buildings

- **Campus**, Savona (Italy).
- **Colombo-Pertini School**, Savona (Italy).
- **Town Hall**, Sant Cugat (Spain).
- **Theatre**, Sant Cugat (Spain).
- **Town Hall**, Zaanstad (Netherlands).
OPTIMUS Package of Consulting Tools

How OPTIMUS is your city / building in terms of energy optimization?

OPTIMUS SCEAF Tool (ex-ante component)

What are the results after one year of application?

OPTIMUS Tracker

What is the potential of the city / building for optimization?

OPTIMUS SCEAF Tool (ex-post component)

What domains / action plans can OPTIMUS DSS support in your case?

OPTIMUS DSS
Multiscale evaluation

Current Status
How “OPTIMUS” is a city or a building in terms of energy optimization?
- Energy & Environmental Profile
- Political Field of Action
- Related Infrastructures - Energy & ICT

Potential
- Municipal Building Sector
- Selection of Suitable Action Plans
- Calculation of DSS Indicators
- Theoretical Potential of the DSS

Installation & Configuration of the DSS

Application of Action Plans in different Domains within the Municipal Building Sector
- Sustainable Districts & Built Environment
- Integrated Infrastructures & Processes across Energy and ICT

Results
Effective evaluation of the DSS application

Objectives
- Application of advanced ICT systems
- Optimization of the energy use and increase of RES production
- Significant reduction of energy cost and CO₂ emissions

OPTIMUS SCEAF Tool (ex-ante)
OPTIMUS Tracker
Customization & Engagement
OPTIMUS DSS
Plug-in single buildings and/or buildings connected to energy production and other energy systems

Targets

WWW.OPTIMUS-SMARTCITY.EU
How OPTIMUS is your city / building?

OPTIMUS SCEAF Tool
“Smart City Energy Assessment Framework – SCEAF”


OPTIMUS Rating Chart

Ex-ante, 2013 (VL, +0.2)

Insignificant
Very Low
Low
Medium
Very High
High

Ex-post, 2016 (VH, +0.3)
How OPTIMUS is your city / building?

Data Collection

Fill SCEAF questionnaire

Evaluation

Visualization

SCEAF methodology

http://sceaf.optimus-smartcity.eu
How OPTIMUS is your city / building?

OPTIMUS Pilots - Final Scores

<table>
<thead>
<tr>
<th>Optimus Rating Scale</th>
<th>Pilot</th>
<th>Savona</th>
<th>Zaanstad</th>
<th>Sant Cugat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Axis 1: “Political Field of Action”</td>
<td>L - 0.38</td>
<td>VL - 0.17</td>
<td>VL - 0.03</td>
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<tr>
<td></td>
<td>Axis 2: “Energy &amp; Environmental Profile”</td>
<td>VL - 0.18</td>
<td>VL + 0.49</td>
<td>VL - 0.35</td>
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<tr>
<td></td>
<td>Axis 3: “Related Infrastructures &amp; ICT”</td>
<td>VL - 0.32</td>
<td>VL + 0.12</td>
<td>L + 0.23</td>
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<tr>
<td></td>
<td>Total Score</td>
<td>VL - 0.04</td>
<td>VL + 0.21</td>
<td>L - 0.47</td>
</tr>
</tbody>
</table>

OPTIMUS Ratings:
- **Optimus (O)**
- **Very High (VH)**
- **High (H)**
- **Medium (M)**
- **Low (L)**
- **Very Low (VL)**
- **Insignificant (I)**

How OPTIMUS is your city / building?
What is the potential of the city / building for optimization?

Municipal and educational buildings, office and entertainment buildings, sports facilities, etc.

www.optimus-smartcity.eu
What is the potential of the city / building for optimization?

“Action Plan Selection” Page

The page where the user selects the action plans that will be implemented at the building.
What is the potential of the city / building for optimization?

Municipal Buildings Sector Results


SANT CUGAT, Spain, 2016 (Baseline: 2015, Target: 2020)
OPTIMUS DSS

CITY level

BUILDING level

DSS

- Climate
- Renewable energy production
- Occupancy
- Social feedback
- Energy market

Target indicators (SCEAF+Tracker)

PREDICTIVE MODELS

RECOMMENDED ACTIONS
**OPTIMUS DSS**

**CITY level**

**BUILDING level**

- **DSS**
  - Climate
  - Renewable energy production
  - Occupancy Social feedback
  - Energy market
  - Monitoring

**Energy market**

**Occupancy**

**Social feedback**

**Renewable energy production**

**Energy costs**

**Building**

**Environment**

**To calculate predicted data**

**Derived from inference rules**

**Predictive Models**

**Recommended Actions**

**Target indicators (SCEAF+Tracker)**
OPTIMUS DSS

CITY level

BUILDING level

DSS

Target indicators (SCEAF+Tracker)

Impact evaluation

Training / refining prediction models

PREDICTIVE MODELS

RECOMMENDED ACTIONS

Actions modifying data

Energy market

Occupyancy

Social feedback

Renewable energy production

Monitoring

Building

People

Energy costs

Environment

Climate

Energy production

Actions
CURRENT SCENARIO

Nowadays, all rooms in a building are heated without taking into consideration climatic conditions of each room and their occupancy.

Some energy is wasted to heat spaces that are empty.

1. ADAPTING OCCUPANCY OF ROOMS TO CONSUMPTION
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Nowadays, all rooms in a building are heated without taking into consideration climatic conditions of each room and their occupancy.

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**CURRENT SCENARIO**

Nowadays, all rooms in a building are heated without taking into consideration climatic conditions of each room and their occupancy.

**OPTIMIZED SCENARIO**

Knowing the occupancy of the rooms and the climate it would be possible to adapt the consumption level to the forecasted conditions.

1. **ADAPTING OCCUPANCY OF ROOMS TO CONSUMPTION**
Some energy is wasted to heat spaces that are empty.

**CURRENT SCENARIO**
Nowadays, all rooms in a building are heated without taking into consideration climatic conditions of each room and their occupancy.

**OPTIMIZED SCENARIO**
Knowing the occupancy of the rooms and the climate it would be possible to adapt the consumption level to the forecasted conditions.

There is an energy reduction as a result of not heating the empty rooms.

1. ADAPTING OCCUPANCY OF ROOMS TO CONSUMPTION
Nowadays, the set-point is established for a fix time every day independently from the temperature and the thermal sensation of occupants.

Some energy is wasted because the external conditions are not taken into account.

2. ADAPTING SET-POINT TEMPERATURE TO THERMAL COMFORT
CURRENT SCENARIO

Nowadays, the set-point is established for a fix time every day independently from the temperature and the thermal sensation of occupants.

Some energy is wasted because the external conditions are not taken into account.

2. ADAPTING SET-POINT TEMPERATURE TO THERMAL COMFORT
CURRENT SCENARIO
Nowadays, the set-point is established for a fix time every day independently from the temperature and the thermal sensation of occupants

OPTIMIZED SCENARIO
Knowing the thermal sensation of occupants and the climate conditions we could change the set point temperature

Some energy is wasted because the external conditions are not taken into account

2. ADAPTING SET-POINT TEMPERATURE TO THERMAL COMFORT
OPTIMUS DSS

CURRENT SCENARIO
Nowadays, the set-point is established for a fix time every day independently from the temperature and the thermal sensation of occupants.

OPTIMIZED SCENARIO
Knowing the thermal sensation of occupants and the climate conditions we could change the set point temperature.

Some energy is wasted because the external conditions are not taken into account.

There is an energy reduction using less energy to keep the temperature and comfort levels.

2. ADAPTING SET-POINT TEMPERATURE TO THERMAL COMFORT
Indoor conditions

Set points

Calculation of the Predicted Mean Vote (PMV)

Predicted Values

Actual Values

Thermal Sensation

Deviation

Inference Rules

Analysis and evaluation of user’s feedback

Reconsider set point temperature...

http://validator.optimus-smartcity.eu

CURRENT SCENARIO

Nowadays, we might be selling all the produced renewable energy to the grid whereas it could be used by the system.

We are selling energy to the market that we could use.

3. LOAD SHIFTING BASED ON RENEWABLE ENERGY PRODUCTION
CURRENT SCENARIO

Nowadays, we might be selling all the produced renewable energy to the grid whereas it could be used by the system.

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**CURRENT SCENARIO**

Nowadays, we might be selling all the produced renewable energy to the grid whereas it could be used by the system.

**OPTIMIZED SCENARIO**

Knowing the prices of the energy in the market (selling and buying) and the consumption load it can make sense to shift some loads to use renewable energy instead of selling it.

---

**3. LOAD SHIFTING BASED ON RENEWABLE ENERGY PRODUCTION**
OPTIMUS DSS

CURRENT SCENARIO
Nowadays, we might be selling all the produced renewable energy to the grid whereas it could be used by the system.

OPTIMIZED SCENARIO
Knowing the prices of the energy in the market (selling and buying) and the consumption it might make sense to shift some loads to use renewable energy instead of selling it.

We replace bought energy with produced energy thus flattening the energy load of the building.

3. LOAD SHIFTING BASED ON RENEWABLE ENERGY PRODUCTION
How the OPTIMUS DSS works (1/6)

Available data

- Weather forecast
- De-centralized sensor (BEMS)
- Occupants feedback
- Energy prices
- RES production

Data is captured from the buildings and their context. Semantic framework integrates the different data sources using semantic web technologies.
How the OPTIMUS DSS works (2/6)

<table>
<thead>
<tr>
<th>Available data</th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather forecast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>De-centralized sensor (BEMS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupants feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RES production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prediction models use historical data to forecast the building behaviour for the following 7 days.
How the OPTIMUS DSS works (3/6)

Available data
- Weather forecast
- De-centralized sensor (BEMS)
- Occupants feedback
- Energy prices
- RES production

Prediction models

Inference rules use the predicted and monitored data to suggest short-term actions plans to the final user.
How the OPTIMUS DSS works (4/6)

Available data
- Weather forecast
- De-centralized sensor (BEMS)
- Occupants feedback
- Energy prices
- RES production

Sunday Monday Tuesday Wednesday Thursday Friday Saturday

Prediction models

Energy Models

Inference rules

- Raise set point temperature
- Shift loads at 11 am
- Partial free cooling at 16 am
- Start heating system at 7 am

Short-terms actions plans are presented to the user in a simple and clear manner.
How the OPTIMUS DSS works (5/6)

Available data
- Weather forecast
- De-centralized sensor (BEMS)
- Occupants feedback
- Energy prices
- RES production

OPTIMUS DSS INTERFACES

End-users interfaces display the monitored, forecasted data and the short-term plans in order to support experts’ decisions.

OPTIMUS DSS INTERFACES

- Raise set point temperature
- Shift loads at 11 am
- Partial free cooling at 16 am
- Start heating system at 7 am
How the OPTIMUS DSS works (6/6)

Available data
- Weather forecast
- De-centralized sensor (BEMS)
- Occupants feedback
- Energy prices
- RES production

OPTIMUS DSS INTERFACES

The results of the implementation of the actions in each pilot city will modify the data sources

- Raise set point temperature
- Shift loads at 11 am
- Partial free cooling at 16 am
- Start heating system at 7 am
### Action Plans

<table>
<thead>
<tr>
<th>Category</th>
<th>Action Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy</td>
<td>AP 1  Scheduling and management of the occupancy</td>
</tr>
<tr>
<td>Heating and cooling</td>
<td>AP 2  Scheduling the set-point temperature</td>
</tr>
<tr>
<td></td>
<td>AP 3  Scheduling the ON/OFF of the heating system</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>AP 4  Management of the air side economizer</td>
</tr>
<tr>
<td>Generation and On-site renewable production</td>
<td>AP 5  Scheduling the photovoltaic (PV) maintenance</td>
</tr>
<tr>
<td></td>
<td>AP 6  Scheduling the sale/consumption of the electricity produced through the PV system</td>
</tr>
<tr>
<td></td>
<td>AP 7  Scheduling the operation of heating and electricity systems towards energy cost optimization</td>
</tr>
</tbody>
</table>
**End-user environment: Tracker**

OPTIMUS tracker supports energy managers to assess the potential of your city for energy optimization. It provides information of the users' targets (grey), their theoretical potential (blue) and their current status (light blue).

### Reduction of energy consumption

<table>
<thead>
<tr>
<th>Category</th>
<th>User's Target (20%)</th>
<th>Potential (10.7%)</th>
<th>Current Status (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER'S TARGET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reduction of CO2 emissions

<table>
<thead>
<tr>
<th>Category</th>
<th>User's Target (20%)</th>
<th>Potential (10.7%)</th>
<th>Current Status (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER'S TARGET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reduction of energy cost

<table>
<thead>
<tr>
<th>Category</th>
<th>User's Target (20%)</th>
<th>Potential (15.2%)</th>
<th>Current Status (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER'S TARGET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Increase of renewable energy use

<table>
<thead>
<tr>
<th>Category</th>
<th>User's Target (20%)</th>
<th>Potential (8.2%)</th>
<th>Current Status (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER'S TARGET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DSS graphical user interfaces (2/9)

*End-user environment: City Dashboard*

The dashboard displays the DSS indicators values of the buildings in the last 7 days.
End-user environment: Buildings

The building dashboard displays the DSS Indicators values in the last 7 days.

<table>
<thead>
<tr>
<th>Town hall</th>
<th>Energy cost (£)</th>
<th>CO2 (kgCO2)</th>
<th>Energy consumption (kWh)</th>
<th>Produced renewable energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAST WEEK</td>
<td>▲ 778.6</td>
<td>▲ 12410.1</td>
<td>▲ 31777.3</td>
<td>▲ 674.2</td>
</tr>
<tr>
<td>PREVIOUS WEEK</td>
<td>458.5</td>
<td>7982.5</td>
<td>20511.5</td>
<td>505.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theatre</th>
<th>Energy cost (£)</th>
<th>CO2 (kgCO2)</th>
<th>Energy consumption (kWh)</th>
<th>Produced renewable energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAST WEEK</td>
<td>▲ 389.3</td>
<td>▲ 6205</td>
<td>▲ 15888.6</td>
<td>▲ 337.1</td>
</tr>
<tr>
<td>PREVIOUS WEEK</td>
<td>229.2</td>
<td>3991.2</td>
<td>10255.7</td>
<td>252.5</td>
</tr>
</tbody>
</table>
End-user environment: Building Dashboard

The building dashboard displays the DSS indicators values in the last 7 days and the average of the last month.

<table>
<thead>
<tr>
<th>Town hall</th>
<th>Energy cost (€)</th>
<th>CO2 (kgCO2)</th>
<th>Energy consumption (kWh)</th>
<th>Produced renewable energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>last week</td>
<td>364.2</td>
<td>3607.3</td>
<td>23041.4</td>
<td>438.8</td>
</tr>
<tr>
<td>previous week</td>
<td>664.5</td>
<td>6720.1</td>
<td>31024.2</td>
<td>561.8</td>
</tr>
</tbody>
</table>
DSS graphical user interfaces (5/9)

End-user environment: Action Plans

Description section Action Plans

Scheduling the set-point temperature
Support of the energy manager in adjusting the temperature set-point, taking into consideration thermal comfort parameters. The target is to optimize energy use, while maintaining comfort levels in accepted ranges (using the Predicted Mean Vote - PMV - index and the Adaptive Comfort Concept).

Scheduling the ON/OFF of the heating system
Optimization of the boost time of the heating/cooling system taking into account the forecasting of the outdoor air temperature and the occupancy of the building.

Scheduling the PV Maintenance
Detection of the need for maintenance of the PV system and communication with the user with an alert prompting for appropriate maintenance actions; identification of abnormalities and possible problems can be facilitated.
### End-user environment: Action Plans

#### COLOMBO-PERTINI SCHOOL

**Scheduling the set-point temperature**

Support of the energy manager in adjusting the temperature set-point, taking into consideration thermal comfort parameters. The target is to optimize energy use, while maintaining comfort levels in accepted ranges (using the Predicted Mean Vote - PMV - index and the Adaptive Comfort Concept).

<table>
<thead>
<tr>
<th>Building</th>
<th>Sun 18-09</th>
<th>Mon 19-09</th>
<th>Tue 20-09</th>
<th>Wed 21-09</th>
<th>Thu 22-09</th>
<th>Fri 23-09</th>
<th>Sat 24-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZONE 6</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZONE 1</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZONE 5</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZONE 2</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
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<tr>
<td>ZONE 4</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZONE 3</td>
<td>25.7</td>
<td>25.6</td>
<td>25.4</td>
<td>25.3</td>
<td>25.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please confirm the action plan:

- Unknown
- Accepted
- Declined
DSS graphical user interfaces (7/9)

End-user environment: Historical Data
DSS graphical user interfaces (8/9)

End-user environment: Weekly Report

<table>
<thead>
<tr>
<th>W</th>
<th>PERIODS</th>
<th>ENERGY CONSUMPTION (KWH)</th>
<th>ENERGY COST (€)</th>
<th>USER ACTIONS</th>
<th>REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>2016-09-19 / 2016-09-25</td>
<td>4791.45</td>
<td>0</td>
<td>10</td>
<td>2016-09-17</td>
</tr>
<tr>
<td>36</td>
<td>2016-09-12 / 2016-09-18</td>
<td>23799.3</td>
<td>368.96</td>
<td>3</td>
<td>2016-09-10</td>
</tr>
<tr>
<td>35</td>
<td>2016-09-05 / 2016-09-11</td>
<td>26554.39</td>
<td>434.9</td>
<td>5</td>
<td>2016-09-03</td>
</tr>
<tr>
<td>34</td>
<td>2016-08-29 / 2016-09-04</td>
<td>19675.42</td>
<td>396.22</td>
<td>0</td>
<td>2016-08-27</td>
</tr>
<tr>
<td>34</td>
<td>2016-08-22 / 2016-08-28</td>
<td>26595.38</td>
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<td>652.24</td>
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</table>
DSS graphical user interfaces (9/9)

End-user environment: Weekly Report

Responsibility person: admin admin.
Week: 2016-05-23 / 2016-05-29

DSS implementation
Did you experience any general difficulties with the DSS operation due to malfunctioning during this week (e.g., problems with data, with sensors, etc.)? How were these overcome?

Fill in ...

Did you experience any recurrent episode that suggests to act on the calibration of the data flows or of the models (e.g., forecast always different from real conditions)?

Fill in ...

Did you experience any peculiar event (e.g., particular meteorological phenomena, strike or other social issue, black-out, etc.)?

Fill in ...
# RESULTS

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Savona Campus</td>
<td>-29.4</td>
<td>-4.0</td>
<td>-2.8</td>
<td>13.3</td>
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<tr>
<td>Savona School</td>
<td></td>
<td>-5.3</td>
<td>-7.8</td>
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<td>10.2</td>
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<tr>
<td>Average</td>
<td>-34.8</td>
<td>-14.8</td>
<td>-22.3</td>
<td>-22.2</td>
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**Optimus Rating Scale**

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Sant Cugat Town Hall</th>
<th>Sant Cugat Theater</th>
<th>Savona School</th>
<th>Savona Campus</th>
<th>Zaanstad Town Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex-ante</td>
<td>L-0,35 (1.65)</td>
<td>VL-0,20 (0.80)</td>
<td>VL-0,04 (0.96)</td>
<td>VL+0,14 (1.14)</td>
<td>VL+0,21 (1.21)</td>
</tr>
<tr>
<td>Ex-post</td>
<td>M-0,35 (2.65)</td>
<td>M-0,19 (2.80)</td>
<td>M-0,33 (2.67)</td>
<td>VL+0,32 (1.32)</td>
<td>M-0,21 (2.79)</td>
</tr>
<tr>
<td>Increase</td>
<td>+1,00</td>
<td>+2,00</td>
<td>+1,71</td>
<td>+0,18</td>
<td>+1,58</td>
</tr>
</tbody>
</table>
SCALABILITY

Adding more buildings (not only owned by the municipality)

OPTIMUS DSS

Renewable energy production

Climate

Occupancy

Social feedback

Energy market

Monitoring

Renewable energy production

Climate

Occupancy

Social feedback

Energy market

Monitoring
Adding more data sources at other scales (city level)
Thank you for your attention!

Haris Doukas
h_doukas@epu.ntua.gr