Training manual for Water Utilities using the iWIDGET system
D331-Appendix 1

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12/11/2014
Title: Training manual for Water Utilities using the iWIDGET system

Please note that the research leading to these results/this report has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under the iWIDGET project, grant agreement no. 318272.

Report reference / number: D331-Appendix 1

Related project deliverable: D331

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Document history:

<table>
<thead>
<tr>
<th>Version</th>
<th>Author(s)</th>
<th>Status</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Enrico F. Creaco</td>
<td>First draft</td>
<td>14/05/2014</td>
<td>First draft sent to LVL (UNEXE) for comments</td>
</tr>
<tr>
<td>1</td>
<td>Z Kapelan and Lydia Vamvakeridou-Lyroudia</td>
<td>First Draft revised</td>
<td>16/05/2014</td>
<td>Provided comments on first draft</td>
</tr>
<tr>
<td>2</td>
<td>Enrico F. Creaco</td>
<td>First complete draft</td>
<td>12/11/2014</td>
<td>First complete draft sent to LVL and ZK</td>
</tr>
<tr>
<td>3</td>
<td>Z Kapelan</td>
<td>First Complete Draft Revision</td>
<td>13/11/2014</td>
<td>Provided comments</td>
</tr>
<tr>
<td>4</td>
<td>E Creaco</td>
<td>First draft updated</td>
<td>21/11/2014</td>
<td>Draft updated on the basis of Z Kapelan’s comments</td>
</tr>
</tbody>
</table>

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1. Introduction

1.1. iWIDGET project

iWIDGET is a European Commission FP7 collaborative project aimed at improved water efficiencies through the use of novel ICT technologies for integrated supply-demand side management. iWIDGET’s focus is a more integrated approach to water resources management and the project will contribute to delivering a sustainable, low-carbon society, helping progress towards the Europe 2020 targets on Climate and Energy.

The aim of iWIDGET is to advance knowledge and understanding about smart metering technologies in order to develop novel, robust, practical and cost-effective methodologies and tools to manage urban water demand in households across Europe, by reducing wastage, improving utility understanding of end-user demand and reducing customer water and energy costs.

The main scientific challenges for iWIDGET are the management and extraction of useful information from vast amounts of high-resolution consumption data, the development of customised intervention and awareness campaigns to influence behavioural change, and the integration of iWIDGET concepts into a set of decision-support tools for water utilities and consumers, applicable in differing local conditions. In order to meet these aims and challenges, iWIDGET will investigate: (i) how best to provide the dynamic accurate measurement and data transfer of useful information about end-user water consumption, (ii) how best to use consumption data to improve the operation of utilities and influence end-users to modify their behaviour, (iii) how to arrive at the best business model to convert a promising technology into a useful and cost-effective product, and (iv) how to demonstrate and validate the new methodologies on three case studies in the UK, Portugal and Athens.

1.2. Objective of this Document

This report is part of Work Package 3 (WP3), entitled: “Implementation and validation of the iWIDGET systems”, and, more specifically of Task 3.1: Engage with the householders and utilities at the case study sites.

The aim of this WP is to design and carry out real life full scale testing of the iWIDGET system, prototype developed in WP2, in close collaboration with utility stakeholders and household by implementing iWIDGET systems at utility level where it is possible, i.e. in Portugal and in the UK.
The iWIDGET Decision Support System (DSS) will be installed in households in three case studies and their corresponding real life operational water distribution systems (utilities). The DSS will consist of a number of “widgets”, which will make it possible to provide an on-demand instantaneous feedback to householders about their water consumption. The project partners will provide training and support to the personnel of the water utilities and the end-users for the duration of the tests, while the outcome of this WP will serve as input for WP4 (evaluation).

There is a difference between the training material for the personnel of the water utilities and for the end users. The latter is part of the general public, and therefore any training material should be devoid of technical jargon and fully explanatory as to the visualisation and the features of the iWIDGET system. By contrast the training material for the personnel need not conform to these norms. Technical terms (e.g. DMA) may be used, although advanced mathematical/ICT terms (e.g. artificial neural network) need to be avoided. Moreover there is a difference as to the contents, because the “widgets” for utilities and end-users are not the same, although they belong to the same system.

Thus, Milestone MS32, containing the training material is split in two parts:
   a. MS32-a, which targets the technical personnel at the water utilities; and
   b. MS32-b, which targets end-users.

This document targets the necessary instructions and training material for the water utilities personnel, in order to be able to access and make use of the iWIDGET system.
2. Using iWIDGET system at the water utilities

2.1. What is the iWIDGET system?

The iWIDGET is a system based on the adoption of the modern Information and Communication Technologies (ICTs) for the extraction and management of useful information from vast amounts of high-resolution consumption data, acquired by means of smart meters, positioned in correspondence to the customers’ households and to strategic positions of the network. The collected data are to be stored in a suitable database and to be made available to the water utility staff or to customers.

2.2. Why do the water utilities need it?

iWIDGET will enable utilities to better understand the behavioural patterns of their customers through the assembly of data and processed information at much higher resolutions than hitherto. This will enable more refined approach to the design and deployment of measures to improve the utilities’ performance and manage down demand, by performing, for instance, awareness campaigns to influence behavioural change in the customers. The benefits to the utility will include a better understanding and management of the most dynamic part of their operation (the behaviour of their customers) and also allow them to get more value out of data that they already collect (including network data from existing sensors). It will help water companies to reduce their non-revenue water and to set up the most suitable management strategies on the basis of the really observed demands in the various parts of the network and under the various operational conditions. Specifically, water utilities will be able to delay or avoid additional capital investments (for more production and distribution facilities to meet the increasing water demand), through improved rehabilitation, maintenance and operation.

2.3. What are the improvements iWIDGET system can bring to the water utility?

The iWIDGET system, at water utility level will enable the improvement in the management of water distribution systems, due to the use of the analysis of the real time acquired data about end-user water and energy consumption and network operation variables (pressure, rate of flow, pump status).
2.4. iWIDGET system overview

As shown in Figure 1, the iWIDGET system extracts useful information from high-resolution water consumption data and provides this information to individual consumers and utilities. In the proposed system, each analytic component reads and writes to the central database so that individual components do not have to communicate directly, though direct communication is not prohibited by the system. Results will be displayed through a user interface built on portlets. The iWIDGET central system is composed of a database, a web application server, and FTP client. There will be a different iWIDGET central database for each utility so that data from different utilities is kept separate. Project Partners access the user interface through the webserver on the central system. Householders and individual consumers can login through the utility or another project partner and access required data through a secure tunnel to the central system. This arrangement relies on the utility or most likely project partner UPL to support credential authentication of customers.

2.5. Input Data and Database

Data are collected at (near) real time from Automated Meter Readings (AMR) installed in households. The features of the meters used in the various case studies...
are reported in the Appendixes at the end of the report (Appendix A – Smart meters used in the UK case study, Appendix B – Smart meters used in the Portuguese case study, Appendix C – Smart meters used in the Greek case study).

2.6. System requirements for installing iWIDGET

For an initial deployment of the system on the use cases in the United Kingdom, Portugal and Greece, machines with the specification reported in the following table 1 are expected to be adequate. These two systems (either physical or virtual) must be connected on the same LAN and network connectivity between the servers should be gigabit Ethernet. The web server must support a maximum of 50 concurrent web sessions. Actual internet access can be restricted to only a few ports (e.g. 80, 21) and this can be controlled by site specific firewall rules. The database server itself is not generally accessible via the internet except in the case of remote administration. All other database access is via the web server, through the iWIDGET API. The FTP client obtains meter readings from the utilities periodically and inserts this data into the database. This process could run on the web server hardware.

Table 1 iWIDGET Central System Sizing for Case Study implementation

<table>
<thead>
<tr>
<th>Database System</th>
<th>Visualisation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux – version to be agreed</td>
<td>Linux – version to be agreed</td>
</tr>
<tr>
<td>4 cores</td>
<td>4 cores</td>
</tr>
<tr>
<td>Min 4GB RAM</td>
<td>Min 4GB RAM</td>
</tr>
<tr>
<td>Min 100GB free storage (after software</td>
<td>Min 50GB free storage (after software install)</td>
</tr>
<tr>
<td>install)</td>
<td></td>
</tr>
<tr>
<td>DB2-Express-C (licence free)</td>
<td>Apache Tomcat 6</td>
</tr>
<tr>
<td></td>
<td>Open Portal (portlet container)</td>
</tr>
<tr>
<td></td>
<td>FTP client software (curl)</td>
</tr>
<tr>
<td>Java 7</td>
<td>Java 7</td>
</tr>
<tr>
<td>ssh server</td>
<td>ssh server</td>
</tr>
<tr>
<td>Internet access</td>
<td>Internet access</td>
</tr>
<tr>
<td>Internet addressable static IP/DNS host</td>
<td>Internet addressable static IP/DNS host name</td>
</tr>
<tr>
<td>name</td>
<td>name</td>
</tr>
</tbody>
</table>

2.7. System Log-in

At this stage, the widgets of the supplier side are hosted by IBM. The IBM website can be accessed by the following links:

http://iriwdg01.emerald-cloud.net:10039/wps/myportal

or

http://195.212.132.10:10039/wps/myportal
After using either link with a browser, the following screenshot appears (Figure 2):

**Figure 2 Access to the iWidget website**

In order to login, the following data can be used:
Username: iWidget
Password: Pergegetri

After accessing the iWidget website, the screenshot reported in Figure 3 appears, whence all the widgets can be accessed.

### 2.8. The WiDGETs

Each “widget” is a separate software module, which is useful for a specific task of interest for customers or water utilities. The widgets are split in two groups: (1) Customer domain (for individual customers) and (2) water utility domain (which also contains aggregated data from the customer domain widgets).

The water utility domain widgets, which are the subject of the present report, are aimed at addressing the following main issues:

1. obtain water consumption and related energy consumption data;
2. understand water consumption;
3. understand energy associated with water consumption;
4. get support to increasing operational efficiency;
5. get support to increasing the quality of service;
6. get support to influence consumers to modify their behaviour;
get support for system planning and design

Figure 3 Screenshot after accessing the IBM website

In particular, each of the widgets was developed in order to solve a detailed aspect of the main issues listed above. The list of iWidget is reported in Table 2.

Table 2 Widgets available on the water utility domain

<table>
<thead>
<tr>
<th></th>
<th>Obtain water consumption and related energy consumption data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Obtain inflow (and associated energy consumption) and total water consumption per network sector using real-time data</td>
</tr>
<tr>
<td>1.2</td>
<td>Obtain water consumption data per category of consumer using real-time data</td>
</tr>
<tr>
<td>2</td>
<td>Understand water consumption</td>
</tr>
<tr>
<td>2.1</td>
<td>Obtain real-time water balance data</td>
</tr>
<tr>
<td>2.2</td>
<td>Benchmark water losses against reference values</td>
</tr>
<tr>
<td>2.3</td>
<td>Obtain information on consumption profiling</td>
</tr>
<tr>
<td>2.4</td>
<td>Obtain detailed information on operational inefficiency</td>
</tr>
<tr>
<td>3</td>
<td>Understand energy associated with water consumption</td>
</tr>
<tr>
<td>3.1</td>
<td>Obtain information on energy consumption associated with pumping</td>
</tr>
<tr>
<td>4</td>
<td>Get support to increasing operational efficiency</td>
</tr>
<tr>
<td>4.1</td>
<td>Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network</td>
</tr>
<tr>
<td>4.2</td>
<td>Receive warnings about the status and sizing adequacy of water meters</td>
</tr>
<tr>
<td>4.3</td>
<td>Obtain information on the effect of pressure</td>
</tr>
</tbody>
</table>
In the following section a description of the water utility domain widgets is yielded. For each widget, firstly the objective is pointed out, followed by some information on how it can be accessed by the Water Utility. The description ends with the illustration of the application use.

3. The description of the Widgets

1. Obtain water consumption and related energy consumption data

1.1 Obtain inflow and total water consumption per network sector using real-time data

Application objective

This application enables the Water Utility to assess inflows and outflows from each DMA. To this end, it makes use of the data monitored in real time and concerning to inflows and outflows from each DMA and household consumptions. Prior to analysing data within each DMA, it allows accessing to flow meter data to check if the meter is working properly or to detect, through visual observation, some abnormal events.
Parameters
The parameters which can be set are:
- Temporal resolution

Input data
The inputs that the modeller can set using the widget’s interface are:
- Meter or DMA selection
- Start and end time instants

Output:
The model results are:
- Time series for the flow measured at each meter selected
- Total volumes measured at each meter selected
- Time series for the inflow and consumption at the DMA(s) selected
- Inflow and consumption data for each DMA selected

Application access
This widget is accessed by selecting the SAP widgets in the screenshot in Figure 3. Then, Consumption overview (red frame in Figure 4) can be selected.

Application Use
If the Water Utility wants to analyse the consumption of some meters, the Meter Overview option at the bottom of the screenshot has to be selected (see black frame in Figure 4).
The position in the screenshot where the parameters and inputs can be selected is indicated with a blue frame in Figure 4. The possible choices for the temporal resolution are: daily, hourly, weekly and monthly. In this case, the daily temporal resolution was chosen. As to the meter selection, the "all meters" option was set. The other options are MC6, MC9, MC8 and MC10, each of which is relative to a meter installed in the network. The time interval to be visualized was set between "25-02-2009 00:00:00" and "27-03-2009 23:59:00". After all selections have been made, the user can click on the "calculate" button.
The results are then visualized by means of two graphs. In the graph above (see in Figure 4) the bar relative to the consumption of each meter in m³ is reported with reference to the selected time interval. In the graph below, the time series relative to the consumption of each meter is plotted in m³/h.

After analysing the meter consumption, the Water Utility may want to analyse what happens in a DMA or in a group of DMAs. To this end, the DMA Inflow/Consumption option has to be selected at the bottom of the screen (see black frame in Figure 5). Then the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 5): sector to be visualized, time resolution, start and end time instant. As an example, the "all DMAS" option was selected, as well as the "daily resolution" and the time interval between "17-03-2009 00:00:00" and "27-03-2009 23:59:00". The network sectors are: DMA 1, DMA 2, and DMA 3.

**Figure 4 First screenshot of widget 1.1**
After clicking on the "calculate" button, the widget reports the results on two graphs. The graph above reports, for each DMA, a bar with the inflow and consumption in m³ relative to the selected time interval. In particular, inflow indicates the water volume which enters the generic DMA minus the water which leaves the DMA. The outflow refers to DMA users' consumption. The graph below shows, for the group of DMAs selected, the time series relative to the inflow and the consumption in m³/h.

Figure 5 Second screenshot of widget 1.1
1.2 Obtain water consumption data per category of consumer using real-time data

**Application objective**

This application allows accessing water consumption per category of consumption, i.e. domestic, business, schools, public organizations, other and unknown. The category is derived from the category of the DMA generic customer.

**Parameters**

The parameters which can be set are:
- Temporal resolution

**Input data**

The inputs that the modeller can set using the widget's interface are:
- DMA selection
- Start and end time instants

**Output:**

The model results are:
- Time series for the various categories of consumption for the DMA(s) selected
- Volume of each category of consumption for all the DMA selected

**Application access**

As widget 1.1, this widget is accessed by selecting the SAP widgets in Figure 3.

**Application use**

In order to analyse how the consumption of a DMA or of a group of DMAs can be subdivided into categories, firstly, the Consumption Categories (see black frame in Figure 6) option has to be selected. Then, the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 6): sector to be visualized, time resolution, start and end time instant. As an example, the "all DMAs" option was selected, as well as the "daily resolution" and the time interval between "22-01-2009 00:00:00" and "06-02-2009 23:59:00". As an alternative to the "all the DMAs" option, network sectors can be chosen individually: DMA 1, DMA 2, and DMA 3. After clicking on the "calculate" button, the widget reports the results on two graphs (see Figure 6). The graph above reports, for each DMA, various bars each of which indicates the consumption in m³ relative to the selected time interval and to one of the consumption categories. The graph below shows, for the group of DMAs selected the time series relative to each of the category of consumption in m³/h.
2. Understand water consumption

2.1 Obtain real-time water balance data

Application objective

This application makes it possible to assess the components of water balance by applying the well-established IWA algorithms to the flow data available in a DMA or in a group of DMAs. In particular, the net input can be decomposed into authorised (billed or unbilled) consumption and (real and apparent) water losses. The billed consumption, which can be further decomposed into metered and unmetered billed consumption, represents the Revenue Water. The unbilled consumption, also decomposed into metered and unmetered, the apparent losses, subdivided into
unauthorised consumption and meter inaccuracies, and the real losses, i.e. leakage in transmission and distribution mains, leakage and overflows in storage tanks and leakage on service connections, represent the Non-Revenue Water.

The parameters which can be set are:
- Temporal resolution

Input data
The inputs that the modeller can set using the widget’s interface are:
- DMA selection
- Annual Billed Unmetered Consumption
- Annual Unbilled Unmetered Consumption
- Start and end time instants

Output:
The model results are:
- Time series for the various components of the water balance for the DMA(s) selected
- Volume of each component of the water balance for each of the DMA(s) selected

Application access
This widget is accessed by selecting the SAP widgets in the screenshot in Figure 3. Then, the Water Balance in the upper part of the screen (see red frame in Figure 7) and on the Water Balance in the lower part of the screen (see black frame in Figure 7) have to be selected.

Application use
In order to obtain the water balance of a DMA or of a group of DMAs, firstly, the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 7): sector to be visualized, time resolution, start and end time instant. As an example, the “all DMAs” option was selected, as well as the “yearly resolution”, the annual billed unmetered consumption equal to 0 m$^3$, the annual unbilled unmetered consumption equal to 0 m$^3$, and the time interval between "01-03-2009 00:00:00" and "31-03-2009 23:59:00". After clicking on the "calculate" button, the widget reports the results on a graph, showing various bars each of which indicates the consumption in m$^3$ relative to the various components of the water balance for one of the DMA in the selected time interval.
Figure 7 First screenshot of widget 2.1

Another example of widget application is shown in Figure 8, where the daily temporal resolution is selected instead of the yearly temporal resolution. After clicking on the calculate button, the widget yields a bar graph similar to the previous one in the upper part of the screen. In the lower part of the screen, instead, it yields a different graph, which reports the time series of the various components of the water balance in the selected time interval.
2.2 Benchmark water losses against reference values

This application gives the opportunity to the Water Utility to visualise specific performance indicators in a selected time frame and temporal resolution. The performance indicators provided are: Op27-Real losses per connection, Op23-Water losses per connection, Fi47-Non-revenue water by cost, Fi46-Non-revenue water per volume, Op39-Unmetered water, Op26-Apparent losses per input volume, Wr1-Inefficiency of use of water resources. Displaying output for all the network sectors (all DMAs) or only for specific network sectors is also possible (DMA 1, DMA2, DMA 3).

The parameters which can be set are:
- Temporal resolution
- Reference value for selected performance indicator (optional)
Input data
The inputs that the modeller can set using the widget’s interface are:
- DMA selection
- Annual Billed Unmetered Consumption
- Annual Unbilled Unmetered Consumption
- Performance indicator selection
- Start and end time instants

Output:
The model results are:
- The performance indicator per DMA compared with the given reference value
- Time series of the selected performance indicator compared with the given reference value

Application access
As widget 2.1, this widget is accessed by selecting the SAP widgets in the screenshot in Figure 3. Then, the Water Balance in the upper part of the screen (see red frame in Figure 9) and on the Water Loss Benchmarking in the lower part of the screen (see black frame in Figure 9) have to be selected.

Application use
In order to obtain the consumption profiling for a group of DMAs and for a group of customer, firstly, the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 9): DMA selection, temporal resolution, Annual Billed Unmetered Consumption, Annual Unbilled Unmetered Consumption, performance indicator selection, reference value (optional), Start and end time instants. As an example, the "all DMAs" option was selected. Alternatively, network sectors (DMA 1, DMA 2, and DMA 3) can be displayed separately. The default values of the Annual Billed Unmetered Consumption and Annual Unbilled Unmetered Consumption are zero. The default reference values are extracted from the “referencevalues.properties” file in the project file system. As start and end time instants, "01-04-2009 00:00:00" and "15-04-2009 23:59:00" were selected. After clicking on the "calculate" button, the widget reports the results on two graphs (see Figure 9). The graph above reports the selected performance indicator (in %) compared with the given reference value. In the lower part of the screen the graph reports the time series of the selected performance indicator of the water balance in the selected time interval for the given temporal resolution.
2.3 Obtain information on consumption profiling

This application enables the Water Utility to derive the consumption profiling for both DMAs and customers.

The parameters which can be set are:
- Kind of Time Series

Input data
The inputs that the modeller can set using the widget’s interface are:
- DMA selection
- Meter Nominal Diameter
- Consumer ID
- Consumption Category
- Weekday Scenario
- Co-variables
- Start and end time instants

Output:
The model results are:
- Time series of the consumption pattern for each of the DMA(s) selected
- Time series of the P95, P50 (median), P25 quantiles of the consumption for each of the customer(s) selected

**Application access**

As widgets 2.1 and 2.2, this widget is accessed by selecting the SAP widgets in the screenshot in Figure 3. Then, the Water Balance in the upper part of the screen (see red frame in Figure 10) and on the Consumption Profiling in the lower part of the screen (see black frame in Figure 10) have to be selected.

**Application use**

In order to obtain the consumption profiling for a group of DMAs and for a group of customer, firstly, the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 10): DMA selection, Meter Nominal Diameter, Consumer ID, Consumption Category, Weekday Scenario, Co-variables such as the Economic Mobility, Start and end time instants. As an example, the “all DMAs” option was selected. Alternatively, network sectors (DMA 1, DMA 2, and DMA 3) can be displayed separately. The Meter Nominal Diameter was set to “all Diameters”, including the DN15, DN20, DN25 and DN30 meter types. As to Consumer ID and Consumption Category, the “all Consumers” option and the “Domestic Category” were selected respectively. As to the Weekday Scenario, the “Weekdays” option was selected; the other possible choice could be “Weekends” or “All days”. As start and end time instants, “22-01-2009 00:00:00” and “22-01-2009 23:59:00” were selected.

After clicking on the “calculate” button, the widget reports the results on two graphs (Figure 10). The graph above reports the daily consumption pattern for each DMA selected in dimensionless form, i.e. as Consumption/Daily Average Consumption. The graph below reports the time series of the P95, P50 (median) and P25 quantiles of the consumption for each of the customer selected.
2.4 Obtain detailed information on operational inefficiency

This application enables the Water Utility to derive the operational inefficiency for background leakage, leaks and pipe bursts and apparent losses.

The parameters which can be set are:

*Time Series* (background leakage, leaks and pipe bursts or apparent losses)

**Input data**

The inputs that the modeller can set using the widget’s interface are:

- DMA selection
- Weekday Scenario
- Start and end time instants

**Output data**
The model results are:
For the "Background leakage" time series:
- Percentiles P5, P25 and P95 of the background leakage per DMA
- Time series of the initial and final estimates of the Background Leakage

For the "Leaks and pipe bursts" time series:
-Leaks and pipe bursts per DMA of the selected time interval and weekday scenario
-Water Loss without Background Leakage time series, median value and possible pipe burst events

For the "Apparent losses" time series:
- Apparent losses time series per DMA
-Total apparent losses compared with the total consumption time series

Application access
As widgets 2.1, 2.2 and 2.3, this widget is accessed by selecting the SAP widgets in the screenshot in Figure 3. Then, the Water Balance in the upper part of the screen (see red frame in Figure 11) and on the Operational Inefficiency in the lower part of the screen (see black frame in Figure 11) have to be selected.

Application use
In order to obtain the operational inefficiency of the background leakage, firstly, the parameters and the inputs of the widget have to be selected (see the blue frame in Figure 11): DMA selection, Weekday Scenario, Start and end time instants. As an example, the "all DMAs" option was selected. Alternatively, network sectors (DMA 1, DMA 2, and DMA 3) can be displayed individually. As to the Weekday Scenario, the option "All days" was selected; the other possible choice could be "Weekends" or "Weekdays". As start and end time instants, "10-06-2009 00:00:00" and "18-06-2009 23:59:00" were selected.

For the "Background Leakage" time series, after clicking on the "calculate" button, the widget reports the results on two graphs (Figure 11). The graph above reports the percentiles P5, P25 and P95 of the background leakage per DMA. The lower graph compares the time series of the initial and final estimates of the Background Leakage.

If the "Leaks and pipe bursts" time series is selected, after clicking on the "calculate" button, two graphs are shown (Figure 12). The upper graph displays the leaks and pipe bursts per DMA of the selected time interval and weekday scenario. The lower chart reports the Water Loss without Background Leakage time series along with the median value and shows the possible pipe burst events.

Lastly, if the time series is set to "Apparent losses", again two charts are displayed (Figure 13). The above chart shows the apparent losses time series per DMA and the
lower chart shows the total apparent losses compared with the total consumption time series.

Figure 11 First screenshot of widget 2.4
Figure 12 Second screenshot of widget 2.4
3. Understand energy associated with water consumption

3.1 Obtain information on energy consumption associated with pumping

This widget makes it possible to evaluate the energy consumption and cost associated with the operation of the pumps which feed a district metering area, on the basis of a prefixed operation schedule and of time-based energy tariffs.

Input data

The hydraulic model is set up by accessing the EPANET network description file of the specified network, which is stored in the database; this file can then be used to obtain the data needed for the analysis. The inputs that the modeller can set using the widget’s interface are:

- Day of simulation
- DMA selection
- Energy Price
- Pump scheduling

Output data
- Total daily cost
- Total daily consumption
- Time series concerning tank water level variations

Application access
This widget is accessed by selecting the IBM widgets in the screenshot in Figure 3. Then, widget 3.1 (Pump Energy Use) has to be selected.

Application use
In order to calculate the daily energy cost and consumption associated with pump operation, the day of the simulation and the reference DMA have to be selected (see upper blue frame in the screenshot in Figure 14). In this case 02-March-2009 and DMA1 are selected. Immediately, a window opens showing the EPANET file to which the selected DMA refers. Then, the energy unit cost has to be inserted (either a single daily value or values in 6 hour long time slots). In this case, a constant value of 0.1 euro/KWh is used. Then the pump switch on has to be set in the time slots (see lower blue frame in the screenshot in Figure 14).
In this case, the only present pump is set on at 0:00 and at 18:00 in order to be operating at night time.
Then, by pushing “the submit new query” button at the bottom of the previous screenshot, a new query is generated. The query is summarized in a text message at the bottom of which the queryID is reported (see upper blue frame in the screenshot in Figure 15). By inserting this ID in the Results section (see lower blue frame in the screenshot in Figure 15) and by pushing the Refresh list button, a short summary of the case study appears as well as the results, in terms of daily energy and cost and of variations of the level of the tank present in the DMA.
Figure 14 First screenshot of widget 3.1
Figure 15 Second screenshot of widget 3.1 (Note the minimum tank level is 0 meters and the maximum is 20 meters)
4. Get support to increasing operational efficiency

4.1 Receive warnings about faults (leakages, bursts) and unusual water consumptions in the network

Application objective

This application allows network operation staff to receive warnings related to faults (leakages, bursts) and unusual water consumptions in the network. More specifically, WU staff may consult the system after a consumer presents a complaint, in order to check for any unusual water consumptions that may indicate a fault in the network. They can check the regular and the night flow for a specific water meter and compare it against the maximum values of both categories for the selected number of days. If the calculated flow range indicates unusual water consumption (i.e. at some point the flow exceeds the thresholds we compare it against), the system generates a warning and stores it in the database for further use.

Parameters:
Temporal resolution
Input data
- Meter selection
- Number of last days for which max flow and max night flow values are calculated
- Start and end time instants

Output
- Time series for regular and night flow for the selected water meter
- Max flow and night flow values for the last number of days specified

Application access

This widget is accessed by accessing to the SAP widgets in the screenshot presented in Figure 3. Then by selecting the “Performance” tab (black frame in Figure 16), we can see the flow range deviation for the selected water meter in the upper chart of the screen.

Application use

In order to run the widget, firstly, the parameters and the inputs of the widgets have to be selected (blue frame in Figure 16): temporal resolution, meter selection, number of last days for which max flow and max night flow values are calculated and the time interval. As an example, we selected “Daily resolution”, “MC6” as water meter, flow range of the last 30 days and the time interval was between “01-06-2009 00:00:00” and “07-06-2009 23:59:00”.

After clicking on the “calculate” button, the widget reports the result on the upper graph (red frame in Figure 16).
4.2 Receive warnings about the status and sizing adequacy of water meters

Application objective

This application allows network operation staff to receive warnings related to the status and sizing adequacy of water meters. Similarly to UC4.1, WU staff may consult the system after a consumer presents a complaint, but here the objective is to assess the sizing adequacy of water meters regarding consumption profiles (e.g., if meter is working outside of optimal range). They can check the flow range deviation for a specific consumer ID and compare it against the maximum and minimum values as indicated by the selected meter type. Each household meter has an intended flow range (min/max flow rate), and outside that range it is not accurate. Therefore, if the calculated flow range deviation indicates that the meter is operating outside its intended range, the system generates a warning automatically and stores it in the database for further use.

Parameters:
- Temporal resolution
Input data
- Consumer ID
- Meter Type
- Start and end time instants

Output
- Flow range deviation for a specific consumer ID, compared to the maximum and minimum flow rates as indicated by the selected Meter Type.

Application access
This widget is accessed by accessing to the SAP widgets in the screenshot presented in Figure 3. Then by selecting the “Performance” tab (see black frame in the screenshot in Figure 17), we can see the flow range deviation for the selected consumer ID in the bottom chart of the screen.

Application use
In order to run the widget, firstly, the parameters and the inputs of the widgets have to be selected: temporal resolution, consumer ID, meter type and the time interval (see blue frame in Figure 17). As an example, we selected “Daily resolution”, “84239” as consumer ID, “Gladiator EU” as the meter type and the time interval was between “01-06-2009 00:00:00” and “15-06-2009 23:59:00”.
After clicking on the “calculate” button, the widget reports the result on the bottom graph (see red frame in Figure 17). There we can see the consumption values related to the specified consumer ID, compared against the minimum and maximum values as indicated by the selected meter type.
4.3 Obtain information on the effect of pressure control on leakage components and consumption

The objective of this widget is to analyse the effect of network pressure on water consumption and leakage components. This is done through three methods: i) comparing variations in consumption or leakage components and pressure values for a given DMA and time frame ("Pressure Control" tab); ii) analysing the variation in pressure within a given DMA and time frame ("DMA Analysis" tab); and iii) analysing the effect in consumption or leakage components of a known variation in pressure within a given DMA and time frame ("Campaigns" tab).

The widget is split into three independent tabs – Pressure Control, DMA Analysis and Campaigns. Each of them needs the same common input data and parameters:

Parameters:
- Network Sector (DMA 1, DMA 2, DMA3 or all DMAs)
- Time Period (Hourly or Daily)
- Time Interval

Input data:
- Data time-series (Inflow, Leakage, Pipe-Burst, Real Loss or Billed Metered Consumption)

**Application access**

This widget is accessed by selecting the LNEC widgets in the screenshot in Figure 3. Then, one of the available tabs must be selected, depending on the feature the user wishes to explore (see red frame in figure below).

**Application use**

In order to analyse the effect of pressure variation on consumption and leakage components the user must first choose which data he wishes to visualize and select the appropriate tab:
- “Pressure Control” tab (Figure 18): shows input data time-series and pressure time-series;
- “DMA Analysis” tab (Figure 18): shows input data average value and pressure distribution;
- “Campaigns” tab (Figure 18): shows results of pressure variation campaigns.

**Pressure Control**

**Output data:**
- Time-series for selected input data
- Time-series for pressure

The user must specify values for all the shown parameters (blue frame in Figure 18): input data time-series, network sector, time-period resolution and time interval. Afterwards, simply clicking the “calculate” button (black frame) will display both the input data and the pressure time-series for the selected DMA and time interval.
Figure 18 Screenshot of widget 4.3 – Pressure Control tab

DMA Analysis

Output data:
- Input data average values within given time-frame
- Pressure variation distribution within given time-frame

Again, the user must specify the same input parameters and then click the "calculate" button. Two charts are generated (Figure 19), displaying the average value for selected data in the chosen time interval (see red frame) and the box plot for the pressure distribution during the same interval (see blue frame).
Campaigns

Output data:
- Input data distribution within selected time-frame, for each campaign
- Average pressure value during the campaign

This tab allows the user to analyse the effects of a controlled pressure-variation campaign on hydraulic data, e.g. on leakage components. The first step is again to define input parameters: input data time-series, network sector and time period. Rather than a “Time Interval”, the user must specify the start and end dates for the campaign scenarios he wishes to visualize (currently, two scenarios must be specified; see blue frame in Figure 20). Campaign start and end dates must be specified in the default format “yyyy-mm-dd HH:mm:ss”, e.g., “2009-01-05 01:00:00”. Then, clicking the “calculate” button generates a box plot of the selected input data for both campaigns. It also displays a data point showing the calculated average pressure during the campaign time interval (see red frame in Figure 20).
Available data

For all tabs, when choosing the parameters, the user must select from the range of available data in the database, otherwise no results will be displayed. Since these widget uses some data generated in other use cases, and thus not available for all time ranges, it might be useful to have a sample of currently available data ranges. Available data varies as a function of all parameters. Table 3 shows a list of some of the currently available data ranges.

In the case of campaigns, although any time interval can be selected, significant results will be obtained only if these are chosen to match periods when an effective pressure variation took place. Table 4 provides a set of campaign scenarios which can be used for reference.
Table 3 Widget 4.3 – Ranges of available data relative to leakage, pipe bursts and inflow in the database

<table>
<thead>
<tr>
<th>DMA</th>
<th>Leakage</th>
<th>Pipe-Burst</th>
<th>Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hourly</td>
<td>Daily</td>
<td>Hourly</td>
</tr>
<tr>
<td>DMA 1</td>
<td>2009-01-04, 00:00:00</td>
<td>2009-04-12, 00:00:00</td>
<td>2009-01-01, 00:00:00</td>
</tr>
<tr>
<td></td>
<td>2010-02-27, 23:00:00</td>
<td>2010-01-01, 00:00:00</td>
<td>2010-10-31, 00:00:00</td>
</tr>
</tbody>
</table>

Table 4 Widget 4.3 – Ranges of available data for the campaigns

<table>
<thead>
<tr>
<th>Scenario</th>
<th>DMA</th>
<th>Start date</th>
<th>End date</th>
<th>Avg Pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>DMA 2</td>
<td>5-1-2009</td>
<td>18-1-2009</td>
<td>5.7</td>
</tr>
<tr>
<td>A2</td>
<td>DMA 2</td>
<td>19-1-2009</td>
<td>1-2-2009</td>
<td>6.2</td>
</tr>
<tr>
<td>A3</td>
<td>DMA 2</td>
<td>2-2-2009</td>
<td>15-2-2009</td>
<td>6.7</td>
</tr>
<tr>
<td>A4</td>
<td>DMA 2</td>
<td>16-2-2009</td>
<td>1-3-2009</td>
<td>7.2</td>
</tr>
<tr>
<td>A5</td>
<td>DMA 2</td>
<td>2-3-2009</td>
<td>15-3-2009</td>
<td>6.7</td>
</tr>
<tr>
<td>A6</td>
<td>DMA 2</td>
<td>16-3-2009</td>
<td>29-3-2009</td>
<td>6.2</td>
</tr>
<tr>
<td>A7</td>
<td>DMA 2</td>
<td>30-3-2009</td>
<td>12-4-2009</td>
<td>5.7</td>
</tr>
<tr>
<td>A8</td>
<td>DMA 2</td>
<td>13-4-2009</td>
<td>26-4-2009</td>
<td>4.7</td>
</tr>
</tbody>
</table>

4.5 Receive customized suggestions about pumping scheduling

This widget makes it possible to optimize the scheduling of the pumps which feed a district of the water distribution network.

Input data
The inputs that the modeller can set using the widget’s interface are:
- Day of simulation
- DMA selection
- Energy Price

Output data
- tank levels and pumping scheduling
Application access

This widget is accessed by selecting the IBM widgets in the screenshot in Figure 3. Then, widget 4.5 (Pump Scheduling) has to be selected.

Application use

In order to optimize the scheduling of the pumps, the following inputs have to be inserted (blue frame in Figure 21): day of simulation, energy price (unique daily price or daily tariffs), district to which the widget has to be applied. In this case the day 02-March-2009, a single daily price equal to 0.1 kilowatt/hour and DMA1 are selected respectively. Then, the “Submit Query” button has to be clicked on and a summary then appears in a lower window.

Among the various information, the window also reports the QueryID number (196 in this case). By inserting this datum into the Results Section (blue frame Figure 22), the widget yields graphs for the tank level temporal variation and for the pump scheduling. Additional information reported in a table are the total pumped volume and the total pumping energy and cost.
Figure 21 First screenshot of widget 4.5
Figure 22 Second screenshot of widget 4.5

5 Get support for increasing the quality of service

5.1 Receive information to make billing more accurate and flexible

This widget makes it possible to get information about the consumption data measured by a smart metering device and calculates the total costs and the costs associated with the various time slots.
Parameters
The parameters that the modeller can set using the widget's interface are:
- Display method

Input data
The inputs that the modeller can set using the widget's interface are:
- Device
- Water price
- Period of analysis

Output data
- Consumption representation

Application access
This widget is accessed by selecting the IBM widgets in the screenshot in Figure 3. Then, widget 5.1 (Tariff evaluation) has to be selected.

Application use
In order to run the widget, the inputs which have to be inserted are the number of the device to be analysed, the water unit price (which can take on a single daily value or otherwise can be expressed in slot time tariffs) and the period of analysis (made up of the start and end dates) (blue frame in Figure 23). In this case, device number 00056868 is selected. After the selection, a window opens in the widget showing the associated user type and number. A single daily price equal to 0.1 euro/m$^3$ is then inserted. The start and end dates of the analysis are then set at 02-march-2009 and 03-march-2009 respectively. The parameter display method has then to be fixed, considering the following possibilities, which lead to different representations of the consumption data.
If the “volume time series” is chosen as display method, the graph and table shown in Figure 24 are yielded by the widgets. In particular, the graph shows the cumulative consumption volume plotted against time. The table below the graph, instead, shows the volume values in correspondence to the start and end dates of the analysis. As a difference between the latter and the former, the widget table also reports the total consumption volume in the analysed period and the total cost of the water.
If the “flow time series” is chosen as display method, the graph and table reported in Figure 25 are yielded by the widgets. In particular, the graph shows the consumption rate plotted against time. Besides the data which appear in the previous display mode, the table below the graph also shows the costs subdivided into the various time slots.

Figure 24 Second screenshot of widget 5.1
If the "pie chart volume" is chosen as display method, the graph and table reported in Figure 26 are yielded by the widgets.

In particular, the graph shows the costs associated with the various time slots as a pie chart. The lower table is the same as the previous display mode.

If the “Summary Table” display mode is chosen, only the table is yielded (Figure 27).
Figure 26 Fourth screenshot of widget 5.1
5.2 Receive information to improve the management of complaints

Application objective

This application is aimed at using detailed consumption data to improve the quality of service provided to consumers, by enabling faster and more effective answers to complaints. This is achieved through the analysis of currently active warnings concerning possible technical or billing issues, as determined by widgets WU_UC04.1 and WU_UC04.2.

Parameters:
- Client ID
- Current date

Input data
- Information from warnings generated in widgets WU_UC04.1 and WU_UC04.2, for all metering devices in the network.

Output
- Information about currently active warnings for selected Client ID

Application access
This widget is accessed by accessing to the LNEC widgets in the screenshot presented in Figure 3. Then, tab “WU_UC05.2 – Complaints” must be selected (see red frame in Figure 28).

Application use
In order to run the widget, the user starts by specifying appropriate values for the input parameters – which client is to be analysed (Client ID) and when (Date). Upon pressing the “calculate” button, the application displays information about active warnings on the specified date for the specified client ID (see blue frame in Figure 28), indicating whether it is a “Fault” warning (generated in WU_UC04.1) or a “Size” warning (generated in WU_UC04.2). If no warnings are available, the widget tells the utility staff that no “fault” or “sizing” problem has occurred and that the complaint should be further examined.

Figure 28 Screenshot of widget 5.2

5.3 Receive information to provide warnings to consumers

Application objective
The purpose of this widget is to enable the water utility to improve the quality of service by detecting and sending early warnings to consumers about possible leaks.
This is done by analysing deviations to the minimum standard consumption pattern through an extended period of time.

Parameters:
- Network sector
- Tolerance
- Time period

Input data:
- Water consumption data throughout selected time period

Output:
- List of possible leaking devices in the selected network sector and time period

Application access
This widget is accessed by accessing to the LNEC widgets in the screenshot presented in Figure 3. Then, tab “WU_UC05.3 – Warnings” must be selected (see red frame in Figure 29).

Application use
The user starts by selecting appropriate parameter values – network sector, tolerance and time interval. The tolerance parameter (green frame in Figure 29) determines the minimum value above which a value is considered to be non-zero. After selecting these parameters and upon pressing the calculate button, the widget displays a list of possibly leaking devices (see blue frame in Figure 29). This list includes the device ID, an estimation of the likely leaking period, the minimum leaking value registered throughout the specified time period and an indication of the severity of the leak.
6. Get support to influence consumers to modify their behaviour

6.1 Receive customized suggestions about adaptive pricing schemes

Application objective

This use case provides water utility staff with specific pricing schemes according to consumption categories (residential, non-residential) and the geography (district metered area) to promote changes in the consumers’ behaviour. Three different pricing schemes are offered to the user, namely, Time-of-Use (TOU), Peak-Time-Rebate (PTR), and Seasonal Use (SU).

Time-of-use pricing divides the day into distinct time periods and provides a schedule of rates for each period. A peak period and an off-peak period are thus defined where the suggested rates are respectively higher and lower. The TOU analytic uses the characteristics of the aggregated demand time series of the selected group of customers to produce a suggested pricing schedule.

Peak-Time Rebate enables consumers to earn a rebate by reducing water use during peak demand hours. Under the PTR pricing option, the use case first calculates the peak usage periods and then suggests a discount to be offered to the customer based on the reduction of their volume of consumption.

Seasonal Use considers that water usage varies throughout the year and determines the peak and off-peak seasons. A higher rate is suggested to charge the users during the peak season depending upon the demand increase with respect to the off-peak season.
Parameters:

- Water consumption category
- Billing program among three options:
  - Time of use
  - Peak-time rebate
  - Seasonal use
- Time period by defining start and end dates
- List of smart meter devices organized by DMA
- Current unit price of water for weekdays and weekends
- Input parameters in a single query

Input data

Water consumption data throughout the selected consumption period.

Output

Suggested pricing schedule according to the pricing program selected

Application access

This widget is accessed by accessing to the HRW widgets in the screenshot presented in Figure 3. Then, tab “Adaptive pricing” must be selected (see red frame in Figure 30).

![Figure 30 First screenshot of widget 6.1](image)

Application Use

The user interface illustrated in Figure 31 enables the user to select the input parameters including a consumption category, a billing program, a time period, a list of smart meter devices, and the current unit price of water for weekdays and weekends.
Figure 31 Second screenshot of widget 6.1

After selecting and entering the input parameters, the user can click on the “Submit query” button. The application will process the inputs and return the results which will be listed under the query explorer. The user may then select the new query and the user interface will render the results into charts and tables (Figure 32, Figure 33, Figure 34). Depending upon the type of pricing program selected, the application will process the data and present results in different manners. If TOU is selected, the application will calculate, as is shown in Figure 32, hourly demand averages for weekdays and weekends. It will also create a chart showing the proposed pricing schedule for weekdays and weekends. In addition, the application will compute and display more detailed information in a summary table.

The pricing schedule and the information table are suggesting a modified sequence of prices for weekdays and weekends. The calculations are based on the average demands and suggest periods of higher pricing and periods of lower pricing. If applied as suggested, the changes in price will approximately not affect the total amount of the customer’s bill because the intent of the application is to shift the peak consumption periods. However, the user may, for instance, increase the prices as suggested during peak-consumption periods and maintain the original unit price for the off-peak consumption hours.
Figure 32 Third screenshot of widget 6.1
If PTR is selected as pricing method, the application will present, as is shown in Figure 33, a chart of monthly consumption including the demand during peak times, the total demand, and the forecasts for the incoming month. In addition, a rebate information table will be created showing the suggested rebate on the price of water, the peak-consumption periods for weekdays and weekends, the monthly average consumption during peak times and total, and the forecasted consumption.

![Monthly Consumption Chart](image)

**Rebate and Consumption Information**

<table>
<thead>
<tr>
<th>Period</th>
<th>Weekdays</th>
<th>Weekends</th>
<th>Average Consumption (m³)</th>
<th>Forecast Consumption (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17:32:3</td>
<td>8:56:08</td>
<td>50.039</td>
<td>70.673</td>
</tr>
</tbody>
</table>

Figure 33 Fourth screenshot of widget 6.1

For SU it is advisable to select a time period of at least six months to properly identify seasonal changes in water consumption. The application will present,
as is shown in Figure 34, a seasonal demand chart and a seasonal pricing table containing the suggested unit prices for water.

![Seasonal demand average chart](image)

**Figure 34 Fifth screenshot of widget 6.1**

6.2: Receive customized suggestions about awareness campaigns

**Application objective**

This application enables the Water Utility to understand the extent to which the application of awareness campaigns will affect the householders’ opinion towards water conservation and, subsequently, towards reducing their water consumption.

This widget focuses on the urban population that resides in a specific area. The model does not include geographic information of the area and has a monthly time step. Household-agents are used for simulating the households’ monthly decisions regarding water conservation attitude (positive (+1) / negative (-1)). These decisions are related to the social impact that is exerted to the household-agents by their social network (other household-agents) and by water policies. Following the decision of a positive or negative attitude towards water conservation each household-agent “decides” its water demand by choosing between the mean water demand of the population and a water demand reduced by a conservation rate selected by the modeller. This choice is non deterministic which means that agents with positive opinion regarding water conservation may eventually choose...
not to conserve water. In order to accommodate the increase in water demand due to the increasing quality of life conditions, the population’s mean monthly water demand is affected by an annual increase rate.

Parameters: the modeller is able to parameterise the model by selecting values from the sliders in the model’s interface.

Input data
The parameters that the modeller can set using the widget’s interface are:
- The number of total months that the modeller wants to run the simulation
- The initial household population
- The increase rate and the step of the population increase
- Water policies parameters (when, how long and type of water policies)

Output:
The model results are:
- The evolution of water conservation opinions in percentage of households with positive opinions towards water conservation
- The evolution of domestic water demand in litres per person per day

Application access
This widget is accessed by accessing to the NTUA widget in the screenshot presented in Figure 3. Then, the user is redirected to the following view in Figure 35 with the model for assessing policy effects.

Application Use
Setup of the model’s parameters
Selection of total simulation time in months
1. Select from the slider "total-time-of-simulation" the maximum simulation steps [0 - 120]

This slider marked with the red frame in Figure 36 allows the modeller to choose the number of months that the model will run and produce results for. The maximum allowed number of months is 120 corresponding to a period of 10 years.

![Figure 36 Second screenshot of widget 6.2](image)

Setup of household population increase rate

It is possible for the modeller to set the population’s increase rate and the time step (in terms of months) with which such an increase takes place (see red frame in Figure 37). These parameters are included in the model so as to incorporate phenomena of population’s increase. It is possible that these parameters are out of scope for some cases and hence they can be set to zero.

1. Select from the slider “population-increase-step” the step, in months, of population’s increase [0 - 12] in months (if this parameter is not relevant select 0)

2. Select from the slider “%_population_increase” the population increase rate [0 - 1] in fraction (if this parameter is not relevant select 0)

If one of the above parameters is set to 0, population increase will not be applied.
Setup of household population and distribution of one household demographic characteristic

1. Select from the slider “population” the number of the household-agents that will create the model’s population [1 - 1000].

   In this slider, the modeller is able to choose the number of the agents that will be used so as to simulate the behaviour of the under investigation households. Due to computation limitations, the maximum number of household agents is set to 1000. The modeller may use aggregates such as 1 household agent per 3, 10 or 100 households, depending on the population that needs to be simulated.

2. Select from the sliders “%_middle_demographic_class” and “%_highest_demographic_class” the participation percentage of this type of demographic class to the total population. Example: if 60% of the population is characterised as middle class and 10% of the population is characterised as rich, set slider “%_middle_demographic_class” to 0.6 and slider “%_highest_demographic_class” to 0.1. The model will calculate the percentage of the lowest demographic class (i.e. poor).

   For the purposes of this widget a demographic class can be the income, age or education level of the population. The modeller will need the distribution of the characteristic so as to input the percentages in the model’s interface. The modeller may choose freely which socio-demographic characteristic will use depending on data availability.
Setup of the Initial number of households positive to water conservation
1. Select from the slider "%+water_conservation" (see red frame in Figure 39) the initial fraction of households which are positive towards water conservation [0 - 1]. As an example, setting this parameter to 0.5 means that 50% of the initial households have a positive attitude towards conservation.

Setup of Awareness Campaign
1. Select from the slider "onset-envcampaign" (red frame in Figure 40) when (number of months since the beginning of the simulation) an awareness campaign will begin [0-120]

2. Select from the slider "end-envcampaign" (red frame in Figure 40) when (number of months since the beginning of the simulation) an awareness campaign will end [0-120]

3. Select from the slider "Intensity_of_awareness_policy" (red frame in Figure 40) the intensity of the awareness campaign under investigation [no policy – low - medium - high]. A low intensity awareness campaign may include only messages of water conservation in the water bills, a medium intensity awareness campaign may also include posters in central points of the community under investigation, and high intensity awareness campaigns may also include door-to-door briefing for water conservation. If no awareness campaign is applied it is possible to set the slider of "Intensity_of_awareness_policy" to "no policy".
Figure 39 Fifth screenshot of widget 6.2

Figure 40 Sixth screenshot of widget 6.2
Setup of Pricing Policy

1. Select from the slider “onset-pricingpolicy” when (number of months since the beginning of the simulation) the information regarding a pending price change will reach the population [0 - 120]. The onset of the pricing policy is set either the month when the change will occur or even a couple of months earlier (taking into consideration that the community will be informed earlier regarding this change). The end of the pricing policy is calculated by the model at 6 months after its onset.

2. Select from the slider “Pricing_Policy” (red frame in Figure 41) whether prices will increase or decrease. If no pricing policy is applied it is possible to set the slider of “Pricing_Policy” to "no policy".

Setup of water demand variables

1. Select from the slider “mean-water-demand” (red frame in Figure 42) the mean monthly water demand in litres per person per day of the population under investigation (if such information is not available make an assumption based on the RBD’s reported mean values or country’s reported values).

2. Select from the slider “water-demand-increase-rate” (red frame in Figure 42) an annual increase rate for the mean monthly water demand that is relevant to the population based on expert knowledge.
3. Select from the slider “conservation-rate” (red frame in Figure 42) the fraction of decrease in the mean monthly water demand. Assign different values of conservation rate and compare the results of the different experiments.

Figure 42 Eighth screenshot of widget 6.2

Setup procedure
The setup procedure, which can be activated by pushing the setup button (red frame in Figure 43) is aimed at preparing the model for the simulation. In particular, time $t$ is set to 0 and the household-agents are assigned the setup characteristics selected in the previous steps.

Simulation procedure
Simulation starts when the “go button” is pushed (red frame in Figure 44). During the simulation procedure water policies and the social network exert pressure to the household-agents. On the other hand, the household-agents decide based on this pressure their attitude towards water conservation and select their water demand.
Results

The results of the model (Figure 45) are presented in the plots “% of positive opinions towards conservation” and “mean monthly water demand in litres per person per day”.

Figure 43 Ninth screenshot of widget 6.2

Figure 44 Tenth screenshot of widget 6.2
By right-clicking the plots, it is possible either to copy the image of the plot (right click the plot / click on COPY IMAGE) or to copy the data of the plot by creating a .csv file named as the plot (right click the plot / click on EXPORT).

Figure 45 Eleventh screenshot of widget 6.2

The results are also exported in the Output window (red frame in Figure 46). By right clicking the window it is possible to copy the results and paste them, for further analysis, in a spreadsheet.

Figure 46 Twelfth screenshot of widget 6.2
7. Get support for system planning and design

7.1 Obtain water consumption trends regarding “what-if” scenarios

This widget was implemented in a unified way with widget 6.2.

7.2 Get support to decision-making on water network expansions

Application objective

This application is meant to provide support to decision making on water network expansions. This is done by calculating the values for three performance indexes for the network (minimum pressure, maximum pressure and minimum velocity) based on a series of consumption scenarios, which are estimated based the current network model and consumption pattern estimations derived from other use cases.

Parameters:
- Value / range of values for water demand deviations from current network model
- Reference values for network performance indexes

Input data
- Network model file (EPANET format .inp)
- Consumption pattern file (.pat) (optional)

Output
- Performance index charts for each measure and specified consumption scenario

Application access

This widget is accessed by accessing to the LNEC widgets in the screenshot presented in Figure 3. Then, tab “WU_UC05.7 – Network Expansions” must be selected (see red frame in Figure 47).

Application use

In order to run the widget, the user starts by uploading the network topology file (in EPANET .inp format) containing information of the standard network model (see blue frame in Figure 47). Next, consumption scenarios to be analysed must be specified – either a range of scenarios or a single scenario, which are selected by ticking or leaving unticked the “Analyze range of demands” box. The user must specify the change in the base demand for each scenario, which will create the different scenarios to be analysed (see green frame in Figure 47).

The user may then select to upload a pattern file (.pat), which specifies the daily consumption pattern to be considered in the scenario, and which should take into
account the insights obtained from previous use cases (pink frame in Figure 47). After that, pressing the calculate button will generate charts for all three performance index metrics, depending on the default or specified reference values (see red frame in Figure 47), where 0 indicates minimum quality and 3 indicates maximum quality. The reference values for the metrics can be slided either way, and the charts will reflect these changes in real-time.

Figure 47 Screenshot of widget 7.2

7.3 Obtain information to support optimal equipment replacement scheduling

Application objective

This widget provides water utility staff with important information on equipment deterioration during operation. Such deterioration may be due to multiple factors, e.g., installation conditions, aging of the equipment, consumption profiles, chemical composition of the water, etc.

The types of equipment supported are smart meters and pumps. Regarding water meters, the use case suggests a replacement time based on a balance between the value of unmeasured water due to metering inaccuracies and the cost of metering. Regarding pumps, the replacement time is calculated by comparing the total cost of purchasing the new equipment and the expenses derived from the deterioration which is mostly influenced by the increase in energy consumption of aging pumps.

Parameters:
- the ID of an individual smart meter device;
- the age of the device;
- a deterioration function;
- the unit cost of non-revenue water;
- the annual growth rate of the marginal cost of non-revenue water;
- the interest rate associated with the capital cost of replacement;
- the cost of the investment.

Input data:
- a date of reference for the calculations of energy consumption;
- a district metered area in the network;
- the energy price for four periods in the day;
- the on/off status of the pump in the time periods;
- a pump deterioration curve;
- the annual percent rise of the electricity cost;
- the capital cost of a new pump.

Output:
The model results produced by the application are:
- suggested time of replacement in years;
- chart showing the NPV of investing in a meter replacement.

Application access
This widget is accessed by selecting the IBM widgets in the screenshot in Figure 3. Then, widget 7.3 (Pipe replacement) has to be selected.

Application Use
The first step in the use of the widget concerns the insertion of the parameter and input values, as is shown in the screenshots shown in Figure 48 and Figure 49. In order to meet its objectives, the application for meter replacement enables the user to:
- select an individual smart meter device;
- input the age of the device;
- choose a deterioration function;
- input the unit cost of non-revenue water;
- input the annual growth rate of the marginal cost of non-revenue water;
- input the interest rate associated with the capital cost of replacement;
- input the cost of the investment;
- visualize the suggested replacement time;
- visualize a chart displaying the evolution of the net present value of the investment.

**Figure 48 First screenshot of widget 7.3**
The application for pump replacement enables the user to:
- select a date of reference for the calculations of energy consumption;
- choose a district metered area in the network;
- input the energy price for four periods in the day;
- set the on/off status of the pump in the time periods;
- select a pump deterioration curve;
- input the annual percent rise of the electricity cost;
- input the capital cost of a new pump;
- visualize the suggested time of replacement.

After using the widget, graphs such as that in Figure 50 are produced which highlight the optimal replacement periods for water meters and pumps.
7.4 Determine optimal placement of valves and flow meters on pipes in the network

This widget finds the optimal location and pressure setting of new pressure reducing valves on the water distribution network. The optimization is carried out to minimize the sum of nodal pressures subject to a minimum pressure specified by the user. The objective of minimizing the pressure is a surrogate for minimizing pressure driven leakage in the system as leakage parameters are not always available.

The user may choose between a deterministic and robust optimization analysis. In the deterministic case, water demands for the optimization are based on measured demands at the chosen date and time. For a robust analysis, demand scenarios representing high and low demand are generated from the measured demand and a confidence level chosen by the user.

Results presented here include the location and setting for new pressure reducing valves. A plot of nodal pressures against node elevations is also shown to illustrate the new distribution of pressures in the system.

Parameters
- Analytics Method
Input data
The inputs that the modeller can set using the widget’s interface are:
- Day of simulation
- DMA selection
- Number of valves installed
- Time slot for demand forecast
- Minimum pressure acceptable in the network

Output data
- Pressure at network nodes

Application access
This widget is accessed by selecting the IBM widgets in the screenshot in Figure 3. Then, widget 7.4 (Valve Placement) has to be selected.

Application use
These inputs (see blue frame in Figure 51) to be inserted are the day for the optimization, the time slot, the minimum pressure that has to be guaranteed in the network following the installation of control valves, the total number of control valves and the reference district. In this case, the day 2-March-2009, the time slot from 0:00 to 1:00, the minimum pressure equal to 20 m, a total number of valves equal to 2 and DMA 1 are selected respectively. As a parameter, the analytics method (deterministic or robust) can be chosen. In this case, the deterministic was opted in for.
After inserting all the inputs, the submit new query button has to be clicked on with the mouse. After clicking, a window appears summarizing all the features of the query and reporting the number of the query itself (in this case 182). By selecting query 182 in the results section, the results appear (see screenshot in Figure 52). In the solution window, besides a summary of the salient data of the optimization, the pipes where the valves are positioned are highlighted and the trend of the pressure at network nodes is shown. The layout of the network is also reported.
4. Summary

In this report all the widgets developed by the partners of the iWIDGET project for the water utility’s side have been described. Along with the widgets developed for the consumer’s side (see parental report M32_b), they represent an effective tool useful for improving the knowledge, understanding and control of urban water demand. These widgets are tested first against the historical data recorded made available by AGS (MS33) and then against the data collected in real time in three case studies (MS34).

Figure 52 Second screenshot of widget 7.4
5. Appendix A – Smart meters used in the UK case study

ADM Product Overview

Introducing ADM Automated Meter Reading solution from Smart Metering Systems plc.

We work hard to maintain a reputation for delivering the high quality of service that our clients demand.

Alan Foy, CEO, Smart Metering Systems plc

Overview

The ADM is an automated meter reader (AMR) solution which can be connected directly to the pulse output of any utility meter: gas, propane, water, electricity and oil. The single passive commissioning process which is simple to install makes the ADM an AMR of choice by numerous international utility companies. The ADM is certainly innovative in terms of its passive commissioning process which takes less than 30 seconds, simple to install, is ergonomically designed and utilizes the latest technologies.

- Costs are less than regular manual meter read service.
- Passive commissioning completed in under 30 seconds by non-technical staff.
- ADM provides 1/2 hourly reads, single monthly reads and web analytics with consumption alerts.
- ADM uses existing GPRS networks.
- The ADM is atmospherically certified to ATEX Zone 0, equivalent to the U.S. Class I, Division 1 (gas/oil) certification, and IP68 certified.
- Battery design life of 10+ years.
- Guaranteed in perpetuity.
- Access to data on ADM Data Management System via secure web portal.
- External unit less expensive and also reduces disruptions opposed to an integral AMR within new meters.
- Installing an ADM to existing and new pulse meters is less disruptive and less expensive than deploying smart meters with integral AMR technologies.

Other SMS Services Include:

- Installation, disconnection and relocation of gas infrastructure.
- Installation of domestic, commercial or industrial gas metering equipment.
- Prepayment meter solutions.
- Purchase of existing meter portfolios.
- Smart metering solutions.
- Comprehensive gas use analysis through a dedicated web interface.
Benefits of the ADM AMR system:

- Eliminates manual meter reads.
- Uses existing GSM networks via SIM cards so no need to invest in and fabricate RF infrastructures.
- Simple to deploy: Single stage passive commissioning takes less than 30 seconds and can be undertaken by non-technical personnel or by the customer; no need for a PC or other technology to deploy or commission.
- Direct cost savings:
  - Annual costs typically less than annual physical meter reading costs.
  - Reduction in unapproved debtor days caused by bill queries.
  - Reduced field costs through reduction in field van / truck roll.
  - Costs are significantly lower for companies to add an ADM unit to existing or new pulse meters when compared to the deployment of smart meters with integrated AMR technology. An ADM solution also enables utility companies to avoid undertaking unnecessary meter replacement projects thus securing continued value from installed meters therefore avoiding unnecessary costs.
- Contribution to environmental targets through reduction in van / truck roll.
- Improved customer satisfaction:
  - Customers know their actual usage.
  - Reduction in customer attrition.
- Designed specifically to meet the AMR requirements of a $230B gas supply company.
- Designed to provide 48 data reads per day which are uploaded daily as standard. Option to deliver 4 x in-day reads, i.e. every 6 hours.
- 10+ year battery life.
- Designed to collect pulses from volt free pulse outputs.
- SIM paired to target meter for security.
- Rolling 30 day data memory. This ensures data integrity and continuity in the event that the GPS signal is unavailable for any reason.
- Zero failures to date.
- Preferred solution by customers over meters with integral AMR technology. Failure of units with integral AMR technology results in whole meter replacements and associated costs. Additionally, current meters with integral AMR technologies are more costly than base meters with external AMR units.
- Single channel unit – accepts data from a single source.
- IP68 certified.
- Base case temperature tested from -40C to +60C.
- The ADM is environmentally tested to ATEX Zone 0, the highest certification, which certifies the ADM unit to operate in explosive gas laden atmospheres. ATEX Zone 0 is equivalent to the U.S. Class 1, Division 1 (gasless) certification.
- Configurable to enable multi-level, hierarchical customer access to Data Management System via web portal.
- Customer configurable exception alerts.
- Data is available in various file formats such as CSV. Contact SMS for a list of available file formats that can be supplied for free, ideal for importing data directly into billing systems.
- Ideal for natural gas, propane gas, water and electricity meters.

Universal drawbacks of other AMR devices and services:

- Prices of other AMR units are generally more than the ADM unit.
- Specialist (trained) workforce required to deploy and commission.
- User access limitations.
- Power hungry – regular battery replacements.
- Expensive and excessive hardware.
- Major investment required to achieve full implementation such as LAN, HAN, radio, etc.
- Expensive installations caused by complex commissioning processes.
- Data from GPRS AMR solutions proven to be more secure than Radio Frequency (RF) AMR solutions.

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**Smart Metering Systems plc**

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**ADM**

The intelligent metering solution from Smart Metering Systems plc
ADM Overview
The ADM is an automated meter reader (AMR) solution which can be connected directly to the pulse output of any utility meter: gas, propane, water, electricity and oil. The single passive commissioning process which is simple to install makes the ADM an AMR of choice by numerous international utility companies.

Pulse data is recorded within the ADM, transmitted and uploaded into our data management system. This data is available via a web portal through an easy-to-use web interface. The data can also be exported in any standard file format as required by the customer.

The ADM solution, complete with the ADM Data Management System, is a full data logging solution. The profile data is transmitted via GPRS from the ADM unit to the ADM Data Management System. High and low flow rates and daily consumption alarms are supported within the Data Management System which is accessed via a secure web portal. The ADM is housed in an IP68 and ATEX Zone 0 rated enclosure and is powered by a long-life battery pack. The simple and innovative passive activation process requires no preliminary or on-site programming and takes less than 30 seconds. This significantly reduces the overall cost and time of installation.

ADM Version 3
The ADM version 3 is a GPRS solution that retains the simplicity of installation and commissioning with a battery life of 10+ years, is certified for use in ATEX Zone 0, equivalent to the U.S. Class 1, Division 1 (gasses) certification, and is IP68 certified. The ADM delivers 48 data reads per day as standard at day +1. In-day data transfers can be configured if required. The data is uploaded daily to the SMS Data Management System. The total system is designed to be robust, easy to deploy and above all scalable.

Certifications
The ADM is IP 68 certified and also ATEX Zone 0 certified, the most stringent certification, which means the ADM can safely operate in explosive gas laden atmospheres. ATEX Zone 0 is equivalent to the U.S. Class 1, Division 1 (gasses) certification.

Pulse Input
The ADM unit is connected via a simple cable connection to a 2 meter flying lead or provided with a RJ11 connector.

Network Survey
Network survey on install: the unit will search the available networks, individual cells and all the transmission strengths to find a suitable connection.

Communications
The ADM is designed to operate over GSM Quad Band frequencies: 850MHz, 900MHz, 1800MHz & 1900MHz. A one-size-fits-all SIM is used that automatically reaps to make the most robust connection as easy as possible.

Commands
The device sets up a two way session with the server that enables the device and server to transfer data and instructions in a seamless and efficient manner.

Updates can be issued to the devices over the air. Configuration parameters can be uploaded which are automatically collected by the units when they log in. These messages can be defined by unit or by groupings of units. For instance, every install for a customer may be required to change its reporting time, rather than do this for every unit individually, the systems allows for one change to be replicated across multiple units automatically. When managing large deployments this is vital.
Automatic Logging - Automatic server logging from manufacture through to deployment.
Each unit that connects to the server has its own unique identification code that is automatically logged by the server and goes on to be the identifier for the rest of its life. This means that from the production line to install, every action is logged and recorded against that unit.

Communication Filters - Automatic spam filtering and source authorisation.
The system checks messages against approved number lists and deletes them if they are unapproved.

Clock Synchronisation - Automatic real time clock synchronisation.
This device can synchronise with a server based time function to ensure it is always on time.

Reporting
Command driven reporting periods based on day of the week and hour of the day. User configurable reporting times based on days or weeks, using any or all days in the week. Voltage reporting as standard. The system automatically monitors the condition of all the units in the field and reports on any that need attention.

Data Collection
Configurable logging periods from one minute to twelve hours. Counts are aggregated into logging periods known as 'buckets'. Bucket sizes are configurable to give better resolution of the meter readings.

Alarms
User configurable threshold alarms for count periods or buckets. Users can pick a consumption level at which alarms are generated for a given time period. The server can then forward these alarms to any point of contact over email.

Antenna
Integrated antenna. A bespoke Quad Band tuned antenna is built into the device to give maximum performance.

Installation
Plug and play. Simply connect ADM to the meter and activate with the fob provided. The device will go through its automated configuration procedure. A simple traffic light system lets the installer know that the install was successful. If the install location is unsuitable, the unit alerts the installer and remains with a red light on until successfully re-commissioned.

Construction
The assembly is contained within a highly resistant ASA plastic.

Quality
The device is designed and manufactured in the UK under a stringent quality control environment in line with ISO 9001 and audited under Quality Assurance Notification issued by Basesa.
ADM is fully tested and configured within the factory removing technical on-site commissioning requirements.
6. Appendix B – Smart meters used in the Portuguese case study

AMI AS230
Single Phase Smart Meter

Features
- EN 62053-21; Accuracy Class 1 or Class 2
- EC Directive 2004/22/EC (MDI): Class A or B
- kwh, kvarh and kW/h Energy Measurement
- Import/Export
- Modular WAN/LAN Capability
- Home Automation Network allowing access to:
  - Gas, Water, Other Meter Data, Customer Display
  - Comprehensive Tariff Structure
  - Maximum Demand Registration
  - Load Limiting
  - Load Profiling Recording (4 channels)
  - Instrumentation Profile Recording (8 channels)
  - Extensive Security Features
  - Storage for External Register Values
  - Product Design: Life 20 Years
  - Optical Communications Port
  - Internal Clock with Battery Back-up
  - Compact Design
  - IP53 in accordance with IEC 60529:1989

The AMI domestic Smart Meter offers multi-tier metering and flexible modular communications to interface directly to the utility via a Wide Area Network (WAN) or Local Area Network (LAN) and to connect to a consumer’s Home Automation Network (HAN).

The module provides the platform for many different forms of communications including G3/Wireless, PLC and Lower Power Radio for WAN/LAN communications. The modular and optical port can be used to read data from other meters meter connected to the HAN.

The meter measures a combination of import and export active energy, four-quadrant reactive energy and apparent energy. Extensive security features protect the meter and module from fraud or tampering.

Instrumentation values are available to aid meter commissioning. The meter records up to 120 days of load and instrumentation profile data in shared storage.

Power Master Unit software provides a Windows™ graphical interface for programming the meter and reading meter data.

Meters can be supplied to meet EC Directive 2004/22/EC (MDI): accuracy Class A, or Class B.

The meter has an ingress protection rating of IP53 to IEC 60529:1989.
Display

Programmable Display sequence with English display descriptions or OASIS identifiers.

Communications

Local
- Optical bidirectional (IEC 62056-2) port
- HAN interface will be available to match market requirements

Remote
- WAN communications port allowing remote meter reading and programming of meter data.
- Modules will be available for: GSM/GPRS, PLC, Low Power Radio

Tariff Structure

- 8 Time-of-Use Registers
- 1 Maximum Demand Register
- 12 Seasons
- 24 Change of Season Dates
- 48 Switching Times
- 32 Exclusion Dates
- 13 End of Billing Dates
- 10 Daily Billing Registers
- Daylight Savings
- Deferred Tariff

Typical Load/Instrumentation Profiling

<table>
<thead>
<tr>
<th>Load Profile</th>
<th>Instrumentation Profile</th>
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</tr>
<tr>
<td>1000kW, 400V</td>
<td>10000, 10000, 10000</td>
</tr>
</tbody>
</table>

System

The HAN allows any remote meter to be read directly by the Utility or to be viewed on the Home Display.

Contactor Disconnect

The main 100A contactor can be disconnected locally or remotely by the Utility. This can be driven directly or driven by the meter at load limiting thresholds.

Technical Data

| Current Range  | 5-100A (BS 5-65A DIN) |
| Voltage Range  | 220-240V              |
| Frequency      | 50Hz                   |
| Impulse Withstand | 12V Impulse from 40 Ohm source |
|                | 65V Impulse from 2 Ohm source |
| Display Character | 9.5 x 3.5 |
|                | High contrast, wide angle |
| Baud Rate      | Optical - 300 to 9600 baud |
|                | WAN - 9600 baud |
| Design Life    | 20 years               |
| Temperature    | -25° C to +65° C (operational range) |
|                | -23° C to +85° C (storage) |
| Humidity       | Annual mean 75% (non-condensing) |
| Test Indicator output | 2000 pulses/48h (warm) |
| Dimensions *   | 170 H x 122 W x 65 (Deep) |
| Specification  | EC Directive 2004/22/EC (MI) |
| Accuracy       | EC Class A or Class B |
|                | IEC Class 2 or IEC 62053-23 |
| Case           | IP53 to IEC 60529:1989 |

* With shunt terminal. A full cover version of the meter is also available.

Our policy is one of continuous product development and the right is reserved to modify the specification contained herein without notice.

Elster Metering Systems
Tolgates Business Park
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Beaconsfield, SL9 3DF
United Kingdom
Tel: 44(0)870 2253200
Web: www.elstermetering.com

AMI Brochure ID 12010

D331-Appendix 1
iWIDGET Grant / Project No. 318272
7. **Appendix C – Smart meters used in the Greek case study**

V200 and V210 Kent range of domestic volumetric cold water meters

The meters that give you more

www.elster.com
V200 and V210 Volumetric cold water meters

Manufacturing water meters for utility, commercial and domestic applications, Elster Metering Limited is the world’s leading manufacturer of integrated metering, offering solutions for revenue metering, cost allocation, network monitoring, distribution and industrial applications. V200 and V210 volumetric meters are designed to maximise revenue collection and both are available in a range of sizes covering a wide range of flow rates.

Key features
- Simple to link with Emeris radio technology
- Performance exceeds ISO 4064 Class C standard
- Detection of extremely low flows
- Precision calibrated assembly method
- Maximised revenue collection by innovative design
- Volumetric design permits optimum performance in horizontal, vertical or inclined pipelines
- Proven grooved piston for excellent durability and reduced blockages
- Hermetically sealed copper can register with glass lens, providing conformity to IP68

Innovative communication
As the demand for remote metering increases the V200/V210 offers a range of communication options for every utility company. Incorporating an inductive pulse target which can be read by a tamper-proof, bi-directional inductive pulse transmitter, the V200/V210 is easily integrated into a remote reading system by simply adding the relevant module. The bi-directional inductive pulser monitors the flow of water and is self-powered for years of reliable use.

The V200/V210 can also be fitted with the revolutionary new iVISION register module to provide an encoded output. iVISION works by using Optical Character Recognition (OCR) technology to “read” the numbers on the wheels of the register; the many benefits of which include:
- Absolute reading
- Zero contact, zero friction, virtually 100% accuracy
- Easy retrofitting

Outstanding accuracy and long-term performance
V200 and V210 meters are designed to give long, trouble-free working life, with excellent features such as the proven grooved piston design. The action of this piston creates flow eddies in the grooves which hold solids in suspension until flushed out, reducing the possibility of meter stoppages. The V200/V210 meters offer the lowest headloss when compared to competitors’ meters reducing network leakage operational costs. Its volumetric design permits optimum performance in horizontal, vertical or inclined pipelines.

Register and shroud
The easy-to-read, hermetically sealed copper can register has a 10-year proven track record. Tamper-proof registers are sealed to eliminate condensation and waterproofing, and offer conformity to IP68.
V210 meter manifold connection

1. Pre-equipped with inductive pulse target allowing integration into remote reading systems
2. Grooved piston design gives long working life and reduces blockages
3. Filter design improves flow and reduces headloss
4. Compact, easy-to-handle and robust body
5. Pressure plate with ‘O’ ring seal to ensure no unmeasured bypass
6. Tamper-proof snap fit shroud
7. Hermetically sealed copper can register with glass lens, providing conformity to IP68

V200 meter in-line connection
About Elster Group

A world leader in advanced metering infrastructure, integrated metering, and utilization solutions to the gas, electricity and water industries, Elster’s systems and solutions reflect over 170 years of knowledge and experience in measuring precious resources and energy. Elster provides solutions and advanced technologies to help utilities more easily, efficiently and reliably obtain and use advanced metering intelligence to improve customer service, enhance operational efficiency, and increase customer benefits. Elster’s AMI solutions enable utilities to cost-effectively deliver, manage, and conserve the life essential resources of gas, electricity, and water. Elster has over 7,500 staff and operations in 38 countries in North and South America, Europe, and Asia.

For additional information, visit www.elster.com
### Specifications Class D to BS5728 and ISO4064

#### Class D

<table>
<thead>
<tr>
<th>Meter Code</th>
<th>V200</th>
<th>V200</th>
<th>V210</th>
<th>V210</th>
<th>V210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter thread size</td>
<td>G2&quot;A</td>
<td>G1&quot;A</td>
<td>G1/2&quot;A</td>
<td>G1/2&quot;A</td>
<td>G2&quot;A</td>
</tr>
<tr>
<td>Overload flow rate</td>
<td>(\text{q}_{\text{m}} \pm 2%)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Permanent flow rate</td>
<td>(\text{q}_{\text{p}} \pm 5%)</td>
<td>1.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Transitional flow rate</td>
<td>(\text{q}_{\text{t}} \pm 2%)</td>
<td>11.5</td>
<td>28.75</td>
<td>28.75</td>
<td>28.75</td>
</tr>
<tr>
<td>Minimum flow rate</td>
<td>(\text{q}_{\text{m}} \text{min} \pm 5%)</td>
<td>7.5</td>
<td>18.75</td>
<td>18.75</td>
<td>18.75</td>
</tr>
<tr>
<td>Starting flow (approximately)</td>
<td>l/h</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

All models: Headloss at \(q_{m}\) less than 1 bar. Headloss at \(q_{p}\) less than 0.25 bar. Maximum water temperature 50°C. Maximum working pressure 16 bar. Maximum registration 99,999.99litres.

### Specifications Class C to BS5728 and ISO4064

#### Class C

<table>
<thead>
<tr>
<th>Meter Code</th>
<th>V200</th>
<th>V200</th>
<th>V210</th>
<th>V210</th>
<th>V210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter thread size</td>
<td>G2&quot;A</td>
<td>G1&quot;A</td>
<td>G1/2&quot;A</td>
<td>G1/2&quot;A</td>
<td>G2&quot;A</td>
</tr>
<tr>
<td>Overload flow rate</td>
<td>(\text{q}_{\text{m}} \pm 2%)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Permanent flow rate</td>
<td>(\text{q}_{\text{p}} \pm 5%)</td>
<td>1.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Transitional flow rate</td>
<td>(\text{q}_{\text{t}} \pm 2%)</td>
<td>22.5</td>
<td>37.5</td>
<td>37.5</td>
<td>37.5</td>
</tr>
<tr>
<td>Minimum flow rate</td>
<td>(\text{q}_{\text{m}} \text{min} \pm 5%)</td>
<td>15</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Starting flow (approximately)</td>
<td>l/h</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

All models: Headloss at \(q_{m}\) less than 1 bar. Headloss at \(q_{p}\) less than 0.25 bar. Maximum water temperature 50°C. Maximum working pressure 16 bar. Maximum registration 99,999.99litres.

### Meter Description

<table>
<thead>
<tr>
<th>Meter Description</th>
<th>V200 Qp1.0 &amp; 1.5</th>
<th>V200 Qp2.5</th>
<th>V210 Qp1.0 &amp; 1.5</th>
<th>V210 Qp2.5</th>
<th>V210 Qp3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter diameter (A)</td>
<td>mm</td>
<td>94</td>
<td>94</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Height of meter (B)</td>
<td>mm</td>
<td>113</td>
<td>113</td>
<td>126</td>
<td>156</td>
</tr>
<tr>
<td>Height of meter – Be open (C)</td>
<td>mm</td>
<td>180</td>
<td>177</td>
<td>193</td>
<td>203</td>
</tr>
<tr>
<td>Meter lengths (D)</td>
<td>mm</td>
<td>130, 115, 154, 163</td>
<td>165, 190</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Height of meter with Encoder (mm)</td>
<td>mm</td>
<td>127</td>
<td>125</td>
<td>140</td>
<td>150</td>
</tr>
<tr>
<td>Length over connections (E)</td>
<td>mm</td>
<td>N/A, 200, 228, 250</td>
<td>263, 288</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Weight (approximately)</td>
<td>kg</td>
<td>0.95</td>
<td>1.2</td>
<td>1.26</td>
<td>0.92</td>
</tr>
<tr>
<td>Height with bi-directional pulser = B + 10mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Register Options

<table>
<thead>
<tr>
<th>Meter Description</th>
<th>Inductive</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>V200 (N1, N1.5, N2.5)</td>
<td>1 Pulse/litre</td>
<td>Full reading in m³</td>
</tr>
<tr>
<td>V200 (N1, N1.5, N2.5)</td>
<td>1 Pulse/litre</td>
<td>Full reading in m³</td>
</tr>
<tr>
<td>V210 (N1.5, N2.5)</td>
<td>1 Pulse/litre</td>
<td>Full reading in m³</td>
</tr>
</tbody>
</table>

Accuracy Curve shown overleaf.
V200 and V210 Volumetric cold water meters Product Specification

Typical Accuracy Curve

Pressure equipment directive 97/23/EC:
This product is applicable to networks for the supply, distribution and discharge of water and associated equipment and is therefore exempt.

Copyright Blastr Maturing Limited 2008.

Note: Specifications are subject to change without notice.
Cube 300 kWh & kW Meter

- DIN 96x96 Standard Format
- Installation Aids – ‘Right First Time’ kW Display
  Configuration Display (CT, VT & Pulse setting)
- Accuracy better than Class 1
- Isolated Pulse Output plus Dual Tariff Option
- MODBUS® RTU Communications Option
- IP54 Protection Category
- Designed & Made in the UK with a 5 year Warranty
- Large Clear Display
Cube 300 — a DIN 96x96 panel mounting Electronic kWh Meter

Easy to install and convenient to use. Equally suitable for both 3 wire and 4 wire 3x unbalanced loads (optionally for single phase or balanced 3 phase systems). These Meters have been designed to measure accurately irrespective of the type of load — ideal for a motor or heater, or for a modern electronically controlled load.

Safe to Use

With fully isolated current inputs, installation is assured. Current input isolation allows these meters to be directly connected under certain conditions and provides versatility of connection. Installation in conjunction with other instrumentation can be carried out safely, without affecting accuracy.

Easy to Install

The Cube 300 is fitted with large Rising Cause terminals — allowing connection to a wide range of cables from 0.25mm² to 4mm².

Easy to Configure

Cube 300 Meters are configured from the front panel to suit installations using Current and/or Voltage Transformers, with decimal point and legend being automatically set to provide optimum resolution.

Easy to Commission — Right First Time

Configuration: CT, VT & Pulse configuration can be displayed at the touch of a button. Links at the rear of the meter can be removed to disable Configuration.

Wiring: With VL displayed at the push of a button, installations can be quickly and simply tested — connections confirmed & the load measured. To remove the possibility of reading errors, the display returns to kWh after 60 seconds.

Pulse Output: With a Pulse Test facility, pulses can be generated — without any load present — to test all downstream equipment.

Easy to Use

The Cube 300 can be read from any angle. The bold LCD display overcomes small character size, poor visibility and short life associated with electrolyctic and mechanical counters and provides the necessary legends (Wh, kWh, MWh) to simplify reading. The programmable isolated pulse output provides an interface to a remote data collection system or BEMS.

Fully Supported

Comprehensive operating instructions supplied with every Cube 300 - include full information on installation. These include connection schematics and configuration details for virtually all CT ratios. Full technical support is readily available from your Local Distributor or from Technical Sales at ND Measuring Solutions.

Universality of Connections

For maximum convenience all Cube 300 Meters can be powered from the measurement voltage. Where supplies may be subject to unusually wide variations, the Meters may be powered from a separate auxiliary supply. Standard Meters are suitable for both 3 wire and 4 wire 3x unbalanced loads, and can be used on single phase.

Accurate Real World Measurement

A precision measurement system maintains full accuracy in the presence of harmonics and randomly and/or periodically interrupted waveforms - as commonly found on modern electronically controlled loads.

Dual Tariff Option

The Cube 300 is optionally available with 2 registers for Dual Tariff applications. Tariff changeover is effected by an external signal.

Communications Options

A high speed internal RS485 MODBUS ® communications option allows all readings to be read remotely. Communications option is factory fitted.

---

**OUTLINE SPECIFICATION**

**INPUTS**

<table>
<thead>
<tr>
<th>System</th>
<th>3 Phase 3 or 4 Wire Unbalanced Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>400/230V, 3 Phase 3 or 4 Wire</td>
</tr>
<tr>
<td>Current</td>
<td>110/63V, 20/120V optional. Others to order</td>
</tr>
<tr>
<td>Measurement</td>
<td>5A, from external CTs. IA optional. Fully isolated</td>
</tr>
<tr>
<td>Range</td>
<td>Voltage 50% to 120%</td>
</tr>
<tr>
<td>Frequency</td>
<td>Fundamental 45 to 65Hz</td>
</tr>
<tr>
<td>Range</td>
<td>Harmonics Up to 20th harmonic</td>
</tr>
<tr>
<td>Burden</td>
<td>Voltage &lt;0.1VA per phase</td>
</tr>
<tr>
<td>Current</td>
<td>&lt;0.1VA per phase</td>
</tr>
<tr>
<td>Overload</td>
<td>Voltage 10x for 1 hour</td>
</tr>
<tr>
<td>Current</td>
<td>x10 for 0.5 second max</td>
</tr>
</tbody>
</table>

**DISPLAY**

- Type: Custom, Supervised, LCD
- Data Retention: 10 years max. Stores kWh & Meter set-up
- Format: 8 x 6.0mm high digit with Dij & 5:2mm legends
- Scaling: Direct reading. User programmable CT & VT
- CT Primary programmable from 1(1)A to 250kA
- VT primary programmable from 115V to 550V
- Wh, kWh, MWh, etc. depending on user settings

**AUXILIARY SUPPLY**

<table>
<thead>
<tr>
<th>Standard</th>
<th>240V 50/60Hz ±1.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options</td>
<td>110V 50/60Hz ±1.5%</td>
</tr>
<tr>
<td>Load</td>
<td>3VA max</td>
</tr>
<tr>
<td>Overload</td>
<td>x1.2 continuous</td>
</tr>
</tbody>
</table>

**ACCURACY**

- kWh Better from Class 1 per EN 61036 & EN 62053-21
- Better from Class 1 per BS 8431
- Better than ±1% reading. Class 1 BS 8431

**PULSE OUTPUT**

- Function: 1 Pulse per unit of energy
- Scaling: Suitable between 1 A and 10,000 counts/kWh register
- Pulse Period: 0.1 sec. default, Settable between 0.1 and 20 sec
- Rise & Fall Time: <2.0ms
- Type: N/O Volt free contact. Optically isolated IEC61010
- Contacts: 100mA, ac/cd max. 1.000 ac max
- Isolation: 2.5kV 50/60Hz 1 minute

**MODBUS® Serial Comms**

<table>
<thead>
<tr>
<th>Bus Type</th>
<th>RS485 2 wire + Gv. 1/4 Duplex, 1/4 unit load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>MODBUS® RTU with 9-bit CRC</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>4800, 9600 or 19200 User settable</td>
</tr>
<tr>
<td>Address</td>
<td>1 - 247 User settable</td>
</tr>
<tr>
<td>Latency</td>
<td>Reply within 25ms max.</td>
</tr>
<tr>
<td>Command Rate</td>
<td>New command within 5ms of previous one</td>
</tr>
</tbody>
</table>

**GENERAL**

- Tariff Change Normal
- Signal: 24V ac or dc
- Alternating 60V < V < 300V ac or dc
- Isolated at 250V ac from all other inputs & outputs
- Temperature: Operating -10°C to +60°C
- Storage : -20°C to +70°C
- Humidity: < 75% non-condensing
- Environment: IP54 standard, IP65 optional

**MECHANICAL**

- Terminals: Rising Cause 4mm² (12 AWG) cable max.
- Enclosure: DIN-EN60715 96 x 96
- Material: Moulded, with fire protection to UL94-V-O. Self extinguishing
- Dimensions: 96 x 96 mm x 83.5 mm (72 mm behind panel)
- Weight: ~250g

**SAFETY**

Conforms to EN 61010-1 Installation Category III

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**Typical Connection Drawing**

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