# E2District

## Deliverable 1.2
## Use-cases specification

Dissemination Level: PU

This project is partially funded by the European Commission under the H2020 Framework Programme - Grant Agreement no. 696009

| | | |
|---|---|---|
| **Project Number** | : | 696009 |
| **Project Title** | : | Energy Efficient Optimised District Heating and Cooling – E$^2$District |
| **Deliverable Dissemination Level** | : | PU |

| | | |
|---|---|---|
| **Deliverable Number** | : | D1.2 |
| **Title of Deliverable** | : | Use-cases specification |
| **Nature of Deliverable** | : | R |
| **Internal Document Number** | : | E2D_D1.2_WP1 |
| **Contractual Delivery Date** | : | m12-30/01/2016 |
| **Actual Delivery Date** | : | 29/06/2017 |
| **Work Package** | : | WP1 |
| **Author(s)** | : | J.Fournier/T.Lecomte (VERI) |
| **Total number of pages** (including cover) | : | 20 |


# Abstract

This deliverable aims to describe the use cases considered as priority for the development of the intelligent algorithms and for the implementation of the demonstrator


# Acronyms

| | |
|---|---|
| CHP | Combined Heat and Power |
| DHCN | District Heating & Cooling Network |
| DHW | Domestic Hot Water |
| DMS | District Management System |
| DSM | Demand Side Management |
| DSP | District Simulation Platform |
| DMS | District Management System |
| ESCO | Energy Service Company |
| ESPC | Energy Savings Performance Contract |
| EU ETS | Europe Emissions Trading System |
| FIT | Feed In Tariff |
| IT | Information Technology |
| SC | Supervisory Control |
| SCADA | Supervisory Control And Data Acquisition |

| | |
|---|---|
| SHW | Sanitary Hot Water |
| PSO | Production Scheduling Optimization |
| TPA | Third Party Access |
| UC | Use case |

**Keyword list**

Use cases, demo sites, priority, replicability

# Document History

| Date | Revision | Comment | Author/Editor | Affiliation |
|---|---|---|---|---|
| 31/01/2017 | 0.01 | Draft structure | J. Fournier | VERI |
| 07/04/2017 | 0.02 | Template suggestions | K. Kouramas | UTRCI |
| 11/04/2017 | 0.03 | Generic and UC1.1 use-case description, comments, additions to section 2, | K. Kouramas | UTRCI |
| 12/04/2017 | 0.04 | Combination revisions of UTRCI (3.0), ACCIONA (comments), and VERI (Business models) | T.Lecomte | VERI |
| 14/04/2017 | 0.05 | Glossary, amendment of introduction with new tables, partly answer to 4.0 comments, priority table summary | T. Lecomte | VERI |
| 18/04/2017 | 0.06 | Release after meeting of April 18th | T. Lecomte | VERI |
| 02/05/2017 | 0.06a | Amendment related to Cork test site. | M. Klepal | CIT |
| | 0.06b | Acronyms, Additions to sections 1 and 2, Updated UC1.1, corrections. | K. Kouramas | UTRCI |
| | 0.06c | Various comments and additions | J.C. Esteban | ACCIONA |
| | 0.06d | Business model, use cases | M. Glais, G. Naves-Maschietto, T. Lecomte | VERI |
| 18/05/2017 | 0.07 | Aggregate all 6.0 releases, proposition of modifications for chapter 2 and comments for Cork Use cases | T. Lecomte | VERI |
| 21/06/2017 | 0.08 | Aggregate all 7.0 releases from partners | T. Lecomte | VERI |
| 27/07/2017 | 1.0 | Final release | T. Lecomte | VERI |

# Executive Summary

In deliverable D1.1 (D1.1: Report on requirements for district heating and cooling, 2016), based on the services needs definition, we introduced the concept of a system that formalize and address the needs of the stakeholders. It is an exhaustive and high level answer, which encompasses all features that are expected.

This document now goes down one level, by listing and detailing the use cases for which the platform will be developed and tested, for both demonstrator and virtual sites.

A use-case is a fixed evolution of one or several aspects of a DHCN ecosystem compared to the existing situation. These aspects are operating mode, technical configuration and context.

The different use cases defined in this deliverable have been built and validated by all partners to either answer to the stakeholder's requirements or tackle replicability problematic, and will be used directly into the different Work Packages for the development.

So after listing all possible evolutions on the three aspects, use cases are defined for each site (Cork and Varna), with a specific formalization.

Finally, a replicability section is presented, which purpose is to make sure that the developments are applicable to other contexts than the ones related to the sites studied during the project.

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# 1 Introduction

In deliverable D1.1[1] (D1.1: Report on requirements for district heating and cooling, 2016), based on the services needs definition, we introduced the concept of a system that formalize and address the needs of the stakeholders. As a reminder, the global view of the proposed system, divided in four work areas is presented below. For all work areas, scope, tasks and targets have been defined.

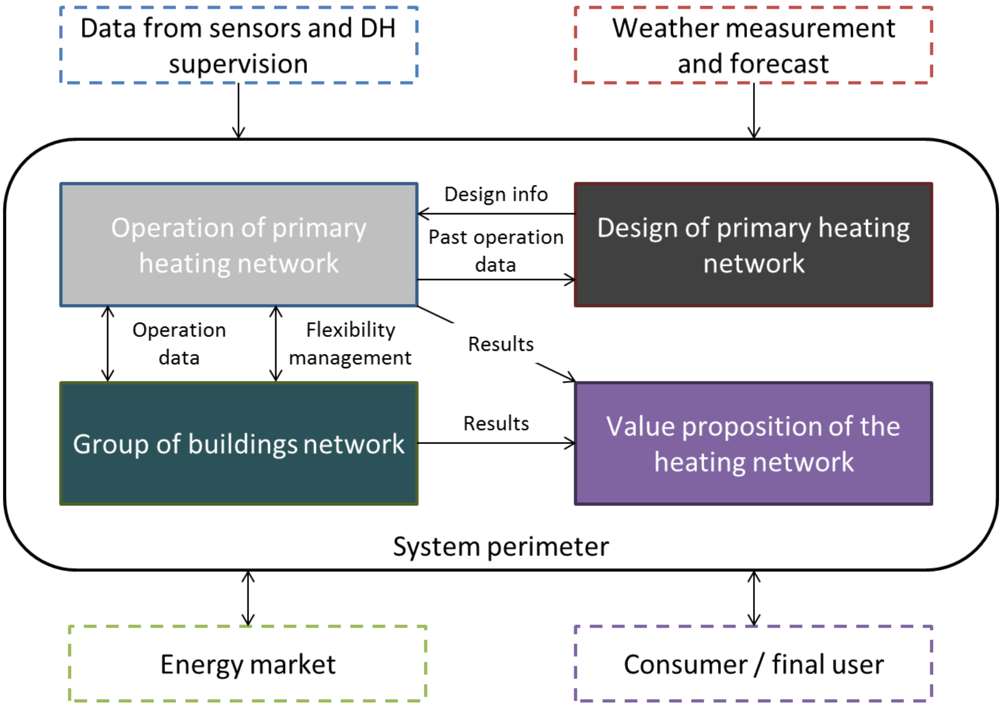


*Figure 1 E²District Work Areas defined in deliverable D1.1*

It is an exhaustive and high level answer, which encompasses all features that are expected. Practically, in terms of development strategy, it is now necessary to go down one level and precise the configurations for which the platform will be developed and tested, from demonstrator and virtual sites cases.

Then, the purpose of this document is to list the use-cases that address a part of the work areas defined above. Regarding each task and target defined in Deliverable D1.1, the tables thereafter describe what use cases precise.

| Design of primary heating network | |
|---|---|
| **Task or target defined in Deliverable 1.1** | **For each one, what does Deliverable 1.2 fully or partially answer?** |
| Models the whole DHCN and alternative scenarios in terms of assets | What sites?<br>What are alternative scenarios? |
| Optimizes network design taking into account all kind of flexibilities | Which site (demonstrator/virtual) for each kind of flexibility |
| Makes calculations off-line, at the scale of one (or several) representative year(s) | Out of scope 1.2 |
| Provides results with changes in demand trends (on several horizons of time) from one year to several years | Which is the demand trend? Which is the time horizon? |
| Reports on local economic impact (jobs/direct activity, indirect activity …) | Out of scope 1.2 |

| | |
|---|---|
| Assesses different options for project and long term operation risks, taking into account district planning | What are the options? |
| Provides KPIs related to relevant energy, economic (esp. maintenance contracts), H&S and environmental aspects | Out of scope 1.2 |
| Provide a single interface with all necessary information | Out of scope 1.2 |
| Be modular | What are the combination of modules developed and tested and for which site? |
| Interface with external components such as tools, database, operators | Out of scope 1.2 |
| Adapt/comply to different regulation contexts | What are the different regulation contexts |

*Table 1 - Value of use cases definition for Design work area*

| Operation of primary heating network | |
|---|---|
| **Task or target defined in Deliverable 1.1** | **For each one, what does Deliverable 1.2 fully or partially answer?** |
| Computes different network operation optimization (as production dispatching, production scheduling and supply temperature) taking into account the different degrees of flexibility, end-users heat demand, asset reliability, Health & Safety, environment | What are the different kinds of optimization and for which site?<br>What are the degrees of flexibility?<br>What are the different end-users heat demand profiles?<br>Are asset reliability and H&S taken into account? |
| Provides all necessary information to operate the network in a single interface, as real-time dashboarding, operation KPIs, … | Which site? |
| Detects and diagnoses anomalous performance | Which site? |
| Reports on process variables relevant to maintenance contracts, regulation and Health & Safety | Which site? |
| Provide a single interface with all necessary information | Which site? |
| Provide a simple/intuitive end user interface (user experience) | Which site?<br>What functionalities should the interface provide to end users, DHO and DHM? |
| Adapt / comply to different regulation contexts | What are the different regulation contexts |
| Be modular | What are the combination of modules developed and tested and for which site? |
| Be well integrated with current tools : Interfaces with external components such as tools, database but also with operators | Out of scope 1.2 |
| Be able to make "Quick" data treatment (this target will be precised during WP1.2 and WP3, regarding temporal aspects of the operation decision process) | Out of scope 1.2 |

*Table 2 - Value of use cases definition for Design work area*

| Group of building network | |
|---|---|
| **Task or target defined in Deliverable 1.1** | **For each one, what does Deliverable 1.2 fully or partially answer?** |
| Sends reports/recommendations (?) to the subscriber and the end-user to give them the opportunity to have higher control to decrease their own bill / their own consumption / their environmental impact. Models the subscriber behaviour including its sensitivity to different stimuli such as economical, environmental, … | Which site? |
| Analyzes feedbacks from the subscriber and the end-users | Which site? |
| Creates and provides new business models taking into account flexibility of the prosumers. Supports intelligible/understandable tariff structures & | Which site? |

| | |
|---|---|
| bills | |
| Provides personalized tariff structures, taking into account different subscriber segments | Which site? What structures? What segments of clients? |
| Provides abstracted real-time information to "first-line support“ | Which site? |
| Be modular | What are the combination of modules developed and tested and for which site? |

*Table 3 - Value of use cases definition for Design work area*

| Value proposition of the heating network | |
|---|---|
| **Task or target defined in Deliverable 1.1** | **For each one, what does Deliverable 1.2 fully or partially answer?** |
| Sends reports/recommendations (?) to the subscriber and the end-user to give them the opportunity to have higher control to decrease their own bill / their own consumption / their environmental impact. Models the subscriber behaviour including its sensitivity to different stimuli such as economical, environmental, … | Which site? |
| Analyzes feedbacks from the subscriber and the end-users | Which site? |
| Creates and provides new business models taking into account flexibility of the prosumers. Supports intelligible/understandable tariff structures & bills | Which site? |
| Provides personalized tariff structures, taking into account different subscriber segments | Which site? What structures? What segments of clients? |
| Provides abstracted real-time information to "first-line support“ | Which site? |
| Be modular | What are the combination of modules developed and tested and for which site? |

*Table 4 - Value of use cases definition for Design work area*

# 2 Meaning and perimeter of Use Cases in E2District

## 2.1 General description of a Use Case in E2District

In this deliverable, a **use-case** is a **fixed evolution** of one or several **aspects** of a DHCN system including:

***The operating mode (procedures and operating rules)***

This is both the way to operate the DHCN and the associated equipment (SCADA, decision-making tools, monitoring equipment and control equipment) that allows the operator to control the assets, in order to ensure the service (comfort) for customers, while trying as much as possible to be energy efficient.

***The technical configuration***

The technical assets are the components that constitute the DHCN, more especially the components of production, distribution and buildings. IT means are not part of the technical configuration. If IT means evolves, it is part of operating mode evolution.

***The context***

The context of a DHCN is the environment in which the DHCN is working, but cannot be influenced by the operator or manager. The environment is:

- Regulatory (possibly influenced by local authority or national authority)
- Economic (possibly influenced by markets)

- Contractual terms (possibly influenced by suscribers or owners)
- Heat demand (possibly influenced by end-users/suscribers, i.e. by refurbishing buildings)

The evolution of this aspect represents a part of replicability assessment and can be representative of the foreseen trends of a DHCN.

The deliverable builds on the analysis of the existing situation and the feedback from operational team of the Cork and Veolia sites, combined to the requirements expressed in deliverable 1.1.

**The reference case is constituted by the current (existing) configuration of each one.**

The use cases represent evolutions of the reference case. The two reference cases are Cork and Varna. These evolutions have been defined based on the feedback from operational teams on the different sites, completed by each partner's expertise and experience feedback. As it gathered some needs and requirements expressed by different stakeholders, deliverable D1.1 was also a source of inspiration.

These evolutions are described on a general way that represents a first reading grid to understand the way we choose in E2District in order to address the objectives of each work area expressed in deliverable D1.1.

After this general description of the possible evolutions, specific Use Cases are defined for Cork Heating Network (section 3.2) and Varna heating network (section 3.3). Each new use case is a use case that presents a fixed evolution on each aspect.

Finally, a replicability section is presented, which purpose is to make sure that the developments are applicable to other contexts than the ones related to the sites studied during the project.

## 2.2 List of the possible evolutions

The work in Task 1.2 and this deliverable has focused to exhaustively cover all possible generic evolutions in the operation, design, business models and attractiveness of energy efficient systems. These evolutions are presented in detail in the sections below. Although these evolutions are exhaustive and representative for DHCN, due to the specific focus of the E2District project to the operational and ICT technologies for energy efficient districts and due to time and demonstration limitation (a full exploration of all use-cases will require more than the three years of the project as well as a bigger number of different and diverse demo-sites), E2District will focus only in a set of representative use-cases, needed to demonstrate the feasibility and replicability of the technologies developed.

Therefore, the following tags have been defined which will be used to highlight for each evolution the priority in this project, the demo-site that this evolution will be demonstrated and the work area that the evolution is related to (see deliverable D1.1):

**[Priority]** This tag gives information about evolution priority, and. Values are either "High" or "Low". "High" means that this evolution has to be tackled during the project.

**[Site]** This tag means that the specified site has expressed a need, in line with the evolution.

**[Work Area]** This tag indicates the associated work area as defined in the document "report on requirements for DHCN" (D1.1).

### 2.2.1 Evolution of the operating mode

The primary objective of this project is to establish a new way of operating the DHCN through the development of innovative control methods, decision-making tools and flexibility management tools. Several orientations can be investigated, as described below.

a. **[High]** **[Cork; Veolia Site]** **[Operation]** **Optimization of DHCN plant-system real-time operation**. The main focus of the operating mode of a DHCN is to expand and replace the existing operating system-level (supervisory) control strategies, which mainly consist of fixed set-point and predefined scheduling of the heating and cooling system based on operator or contractor empirical expertise, with novel supervisory control strategies that can provide **optimized dynamic set-point adaptation** to load and heat distribution variations (such as pressure changes, weather variations). The objective of the new supervisory control strategies is to account for the efficiency and/or cost maximization of the overall plant performance. It is directly related to the use-case defined in deliverable D2.1 (*§3.2.1 SC using DSP as a testbed).*
b. **[High]** **[Cork; Veolia Site]** **[Operation]** **Optimization of production scheduling** (start-up and shut-down and operating load at each time step). This provides to the operator a dynamic decision-making tool to define the schedule of all the production (boilers, CHP, storage), a few days or few hours ahead, taking into account all dynamic behaviour of the DHCN (load, weather, electricity market, etc.). In order to take the best decision, the optimisation core takes into account both production and distribution efficiency. It replaces the existing tools that are generally self-made and elaborated from expertise by determining fixed set points. Because of this, these tools cannot integrate too much dynamic behaviour of the needed inputs without impacting the robustness. Moreover, they don't take into account the impact on distribution costs. It is directly related to the use-case defined in deliverable D2.1 (*§3.2.2 PSO using DSP as a thermal hub load forecast engine)*
c. **[High]** **[Cork; Veolia Site]** **[Operation]** **Optimization of both plant-system operation and production scheduling** is the combination of the two previous points.
d. **[High]** **[Cork, Veolia site]** **[Operation]** **[Building]** Use of **building flexibility** and **behavioural flexibility** (**demand-side management**) in order to adjust heat demand profile while ensuring a good quality of service for end-users. It can be seen as a module that proposes an additional and innovative flexibility compared to the one proposed by heat storage. It is necessarily linked with optimization of production scheduling. Those flexibilities may require investments in new devices, user interfaces, controllers, regulators, etc. as well as shift in the business model of the network towards a more interactive relationship with end-users. Some actions can be implemented with no or low level of investment, such as a more precise scheduling & forecasting of buildings occupancy, a real-time data display of energy consumption to end-users …
e. **[Low]****[Cork; Veolia Site]** **[Operation]** Provide the operator with **elements of risk management**, such as probability of occurrence, range of uncertainty, what-if scenarios as well as online fault detection and diagnosis.
f. **[High]** **[Veolia Site]** **[Design]** **Optimization of electricity selling contracts**. In the first place, this can be done under the **existing electricity framework** with current market conditions (prices, volumes, engagements and penalties). The **electric selling scheme** in itself can also be **optimized**, when it comes to determine the best balance between several markets conditions. In all cases, the optimization will make use of available flexibilities on the production side (heat storage, heat dissipation, adjustable heat recovery on the CHPs) that makes it possible to uncouple, for a given period of time, electrical and heat production. If available, flexibilities on the demand side can also be taken into account.

### 2.2.2 Evolution of the technical configuration (with investments)

Another key objective of E2District is to develop district simulation tools that can be used for the design and evaluation of different technical configurations of a DHCN system. These simulation tools will form the E2District district simulation platform (DSP) that will be used as an asset portfolio decision support tool to optimize asset configuration and utilization. In this context, the evolutions for technical configuration are the following:

a. **[High]** **[Cork; Veolia Site]** **[Design]** Investment in a **new thermal storage** or **adjustment** of the **size** of an existing **thermal storage**
b. **[Low]** **[Cork; Veolia Site]** **[Design]** Investment in **new production units**, that can be motivated by the need to cope with an increase of heat demand, the replacement of old units close to their end-of-life, to seize new opportunities on the electrical market or in order to optimize the fleet
c. **[Low]** **[Cork; Veolia Site]** **[Design]** Increasing of the **renewable energy share** and decreasing of CO2 emissions. This could be done by using biogas instead of natural gas for CHPs and/or boilers, by installing a new biomass boiler, or other renewable energy sources or waste heat recovery (MSW Incinerator, waste heat from industry or data-centers, heat pump on sewage water network …). If CHPs are fuelled by renewable energy, Feed-in-Tariffs could be accessible
d. **[Low]** **[Cork; Veolia Site]** **[Design]** **Evolution of heat demand** from the point of view of the annual consumption and of the heat demand pattern. This evolution would come from the **connection** of new buildings, from the supply of new services (Domestic Hot Water, white goods), from the behaviour demand response introducing the behaviour flexibility into the system, etc. In this case, the evolution of heat demand can be assessed, associated to the two previous points
e. **[Low]** [Cork] **[Design]** similarly, the impact of the **evolution of the electricity demand**, as a result of the supply of new clients or of new uses, can be studied.

### 2.2.3 Evolution of the context

In Deliverable 1.1, one important target defined for “Design of primary heating network” and “Operation of primary heating network” is the possibility of our tools to adapt/comply to different regulation contexts.

The context means the environment in which the DHCN is, i.e. regulatory, markets, contracts with the customer with related heat demand. By definition, the operator/manager/owner cannot act on this context. These evolutions can present either opportunities or risks. Evaluating the opportunities can prove the high-value of the tools that we are developing for future trends. Taking into account the new constraints will help the DHCN to minimize the risks, and ensure the replicability and robustness.

a. **[High]** **[Cork, Veolia Site]** **[Design]** evolution of the opportunities and constraints with the trends of the electricity framework[1] : new mechanism, evolution of the tariff, participation to a capacity market
b. **[High]** **[Veolia Site]** **[Operation]** long-term evolution of the heat demand : the heat demand of DHCN is continuously changing over the years. This evolution can be an increase (new connections, add DHW services) or a decrease (refurbishment,

[1] One or several markets (long-term market, day-ahead market and free market) for the selling of electricity, with given volumes and selling prices (annual or dynamic)

disconnections). While demand increase can be answered by new production equipment, demand decrease generally makes the production oversized. Then, whatever the case, the algorithms have to be flexible enough to be sure that the operation is all the time optimised.

**c.** [Low] [Veolia site] [Operation] [Design] Evolution of CO2 market constraints: **Higher pressure on CO2 emissions**, through the EU ETS (decrease on annual cap on CO2 emissions and/or increase in CO2 prices) or additional regulations (carbon tax). For example, some actual "recommendations" can become mandatory if regulation changes.

### 2.2.4 Operating modes / specific aspect of business models

Associated with evolution of operating modes, a new business model can be an extra answer to enhance the efficiency of our solution and/or propose a new value proposition, in a period when the attractiveness of the network is challenged and when volumes sold tend to decrease. Business models are treated in WP6.

a. **[High] [Cork; Veolia Site] [Attractivity]** Provide **Digital services.** The benefits would be an improved image of the district heating and the service would be a key element for a more interactive relationship between the operator of the network and end-users. Innovative methodologies based on the implementation of new Digital Services, mainly looking forward the "engagement of users" in the energy management (in a reasonable approaches), and also based in conclusions coming from the "behavioural analytics". For example, it could be interactive information screens to engage occupants of buildings and district in active participation in sustainable energy management. These digital services should integrate with existing information systems and processes reaching out to wide spectrum of occupants to maximise the effectiveness.

b. **[Low] [Veolia Site] [Operation]** Include **dynamic variations** in the variable price of heat. Practically, variable part could be updated each season, or for each period of the day, or on an hourly basis … in order to reflect period when heat is expensive to produce (peak load) or, on the contrary, cheaper (mid-season, summer).

c. **[Low] [Veolia Site] [Operation]** Include **progressive billing**, which consists of charging the consumption depending on several levels: from a level of "first needs" (with low prices) to a level of "comfort" (with high prices).

d. **[Low][Veolia Site] [Attractivity]** Proposition of an **energy savings performance contract** to the Public Service Delegate of the network, which would set targets in terms of energy efficiency among others.

e. **[Low][Veolia Site] [Attractivity]** Provide "**bundled services**", i.e. additional services to the **end-users**, which can be energy-related services (generalization of supply of DHW, energy efficiency services (ESCO), direct connection of white goods, cooling, electricity selling, gas selling), or not (water, home management, telecom, facility management …). The advantage for the client and the end-user would be a reduced bill and a single point of contact for all those services.

f. **[Low][Veolia Site] [Attractivity]** Include a **fix part** (€/MW) in the heat price, to account for fix costs. This would mechanically provide clients with less variable prices.

Other aspects of an innovative Business Model can be mentioned:

g. **[High][Cork; Veolia Site] [Attractivity] [Operation]** Develop a **demand-side management** approach, to address flexibility needs, which would lead to a more active implication of the end-user in the operation of the heating network. Energy monitoring, information campaigns, financial incentives (price signal), energy monitoring, and two-way communication with end-users are among the ways to implement demand-side management. It is linked with dynamic variations of heat price (first point of this section), which could integrate flexibility needs as a variable.

h. **[Low][Cork; Veolia Site] [Attractivity] Eco-labelled** heating network (target in terms of %REN)
i. **[Low][Veolia Site] [Attractivity]** Support to the development of the concept of **prosumers** and to the obligation of **Third Party Access**.

### 2.2.5 Replicability

Beyond evolution of the context that represents part of replicability assessment for the same DHCN over the time, ensuring replicability means also taking into account in the developments different kinds of DHCN. This variability is listed through the following points:

a. **[High]** Other **climatic zones** (symbolized by different values of Heating Degree Days)
b. **[High]** Different **sizes** (in terms of length, number of buildings, annual heat production) which are often linked). It can be considered that Cork and Veolia sites already cover the range small-and-medium-size heating network (< 100 GWh).
c. **[High]** Different **heat demand pattern**. As stated before, heat demand pattern is mainly linked to the type of buildings (residential, tertiary …), the type of service (heat only or heat and heat + Domestic Hot Water). Particularly, the demand during summer, that is quite more stable than winter has to be tackled.
d. **[Low] Type of contract** with clients, which is "not applicable" for Cork (no real clients from a contractual point of view) but representative of classic contract between an operator and its end-users for Veolia sites. For replicability purpose, different types of contractual agreements (prosumers, TPA, energy savings performance contracts, ) should be considered.
e. **[Low]** DHCN **Ownership** and type of **management** (Public Management, Public-Private management and Private Ownership)
f. **[Low] Network architecture** (double primary network departure, meshed network, …)
g. **[Low]** Other type of **production units**. For the case studies considered, only gas boilers and gas engines were part of the production units in the existing situation. Other type of fuels for heat-only boilers (biomass, biogas, fuel oil), other types of CHPs (steam turbine, ORC), heat pumps, solar thermal panels should be considered.

During the project, some of the mentioned points above, especially the points considered as priority will be addressed through the differences between the sites involved in the project (Cork and Veolia site). These differences are presented below:

| | Cork | Varna |
|---|---|---|
| Climatic zone | Temperate oceanic | Continental |
| Size | Length : ~2km<br>Installed heat power : 4,1 MWth | Length : ~30km<br>Installed heat power : >30 MWth |
| Heat demand pattern | Office pattern<br>Only heating | Residential pattern<br>Heating + SHW |
| Type of contract | No contract | Classic contract<br>No prosumers, no TPA, no ESPC |
| Ownership | Public management | Private ownership |
| Network architecture | Mono primary departure<br>Not meshed<br>Distribution of buildings: 3-Way | Double primary departure<br>Not meshed<br>Distribution of buildings: |

| | | |
|---|---|---|
| | valves | substations |
| Kind of production units | Gas boiler, CHP, heat storage | Gas boiler, CHP |

*Table 5 – Replicability answer through Cork and Veolia site*

Finally the replicability will be addressed with different ways, either the representativeness of the demonstrator and virtual sites or through use cases with a specific evolution. It is presented in the following table.

| | Strategy to address replicability |
|---|---|
| Electrical market | Representativeness of the demonstrator sites, use cases |
| Climatic zone | Representativeness of the demonstrator sites |
| Size | Representativeness of the demonstrator sites |
| Heat demand pattern | Representativeness of the demonstrator sites |
| Type of contract | Representativeness of the demonstrator sites |
| Ownership | Representativeness of the demonstrator sites |
| Network architecture | Representativeness of the demonstrator sites |
| Kind of production units | Design use-cases |

*Table 6 – Strategy for replicability*

### 2.2.6 Priority summary

The following table list all evolutions that have been detailed above, and associates priority for each one.

"High level" means that this evolution has to be tackled during the project.

"Low level" means that assessing the impact of this evolution is interesting to answer the needs defined in the deliverable D1.1 but considered as no possible to address during the project duration.

| Category of the evolution | Evolution | Priority |
|---|---|---|
| Evolution of the operating mode | Optimization of DHCN plant-system operation | High |
| | Optimization of production scheduling | High |
| | Optimization of both production scheduling, electricity selling and distribution parameters | High |
| | Use of building flexibility and behavioural flexibility (demand-side management) | High |
| | elements of risk management | Low |
| | Optimization of electricity selling contracts | High |
| Evolution of the technical configuration (with investments) | Investment in a new thermal storage or adjustment of the size of an existing thermal storage | High |
| | Investment in new production units | Low |
| | Renewable energy share | Low |

| | | |
|---|---|---|
| | Evolution of heat demand | Low |
| | Evolution of the electricity demand | Low |
| Evolution of the context | Evolution of the opportunities and constraints with the trends of the electricity framework | High |
| | Evolution of heat demand | High |
| | Evolution of CO2 market constraints | Low |
| Operating modes / specific aspect of business models | Provide Digital services | High |
| | Dynamic variations in the variable price of heat | Low |
| | Include progressive billing | Low |
| | energy savings performance contract | Low |
| | Provide “bundled services” | Low |
| | Include a fix part (€/MW) in the heat price | Low |
| | Develop a demand-side management approach | Low |
| | Eco-labelled heating network | Low |
| | Concept of prosumers | Low |
| Replicability | Other climatic zones | High |
| | Different sizes | High |
| | Different heat demand pattern | High |
| | Type of contract | Low |
| | DHCN Ownership and type of management | Low |
| | Network architecture | Low |
| | Other type of production units | Low |

*Table 7 - Evolution priority summary*

# 3 List of use cases

## 3.1 Use case framework

A use case is detailed by the following points:

| | |
|---|---|
| **Brief description** | Clear description in one sentence |
| **Work(s) area(s)** | Involved "work area" among the four ones defined in the deliverable 1.1. |
| **Actors Involved** | List of all entities external to platform (composed by DOS, SC, PSO, DSP) interacting with the platform and necessary to involve to perform the use case. They can be stakeholders as defined in Deliverable 1.1, or IT entity. |
| **Related KPIs** | List of related indicators among those defined in the deliverable D1.3[2]. |
| **Service Concept** | Explanation of the use case |
| **Context Replicability** | Definition of derivative use cases with only evolution of context; Allows to assess the replicability of the algorithms and technical solutions in different kind of contexts |
| **Concept Schematic** | Scheme showing the interactions between the different actors |

## 3.2 Cork Use Cases

Among all possible evolutions listed in chapter 2, some of them have been identified as relevant to be tackled for the site of Cork, because directly deducted from the expressed needs.

All the KPIs are potentially applicable with the right sensing and monitoring capabilities in the demo-sites. In this deliverable we down-select the KPIs that are of interest for each use case. During the activities in WP5, the E2D Consortium will prepare a demonstration plan and will verify which down-selected KPIs can be directly applied and which down-selected KPIs should be estimated.

### 3.2.1 UC1.1 Optimization of DHCN plant system operation

| | |
|---|---|
| **Brief description** | This use-case describes the role of the Supervisory Controller in the DHCN thermal generation system |
| **Work(s) area(s)** | Operation of primary heating network |
| **Actors Involved** | DHCN operator; District Management System (DMS); DHCN manager |
| **Related KPIs** | Technical KPIs : all<br>Environmental KPIs : $KPI_{\_RRE}$ and $KPI_{\_FPR}$<br>Economic KPIs : $KPI_{\_ENC}$<br>Quality of Service KPIs: $KPI_{\_FLEX}$ and $KPI_{\_INT}$<br>Social KPIs : none |
| **Service Concept** | The main objective of the supervisory control (SC) is the optimal operation and coordination of district heating/cooling plant equipment (such as CHPs, heat-pumps, chillers, boilers), |

demand (heat exchanger load) and energy storage. The operation of the supervisory controller is shown in detail in Figure 2 below. By DMS, we define the district system energy management platform, which can range for a simple BMS, such as in the E2District demo-site, to a SCADA. The E2District platform is connected to the DMS system. First, weather measurements and forecasts, metering and sensing values from the thermal plant/generation system (including energy consumption, production and distribution supply temperatures, differential pressures, mass-flow rates), load measurements and historical data are gathered. This information is then used to generate key physical variables (supply/return production/distribution temperature, pressure, flowrate) and thermal load (energy and power) estimations or forecasts, while a monitoring module is used for the pre-processing (data cleaning and filtering, missing data estimation etc.) of current and historical data. The pre-processed measurements and estimates are then used as inputs to the SC, which uses the preselected KPIs to obtain the optimal thermal plant equipment set-points. The optimal set-points are sent to the DMS and then to the thermal plant equipment to adapt the operation of the thermal generation. The SC is applied on-line in a closed-loop fashion i.e. by repeating the operation continuously and in regular time intervals to maintain a constant monitoring of the demand and system variable variations and adapting the thermal generation equipment and storage to these system variations. Finally, the operator receives on-line data, reports or fault alarms via the DMS or with other dashboard functions that could be provided as front-end to the DMS or the district operation system (DOS) (which is not part of this work).

**Context Replicability** None

**Concept Schematic**

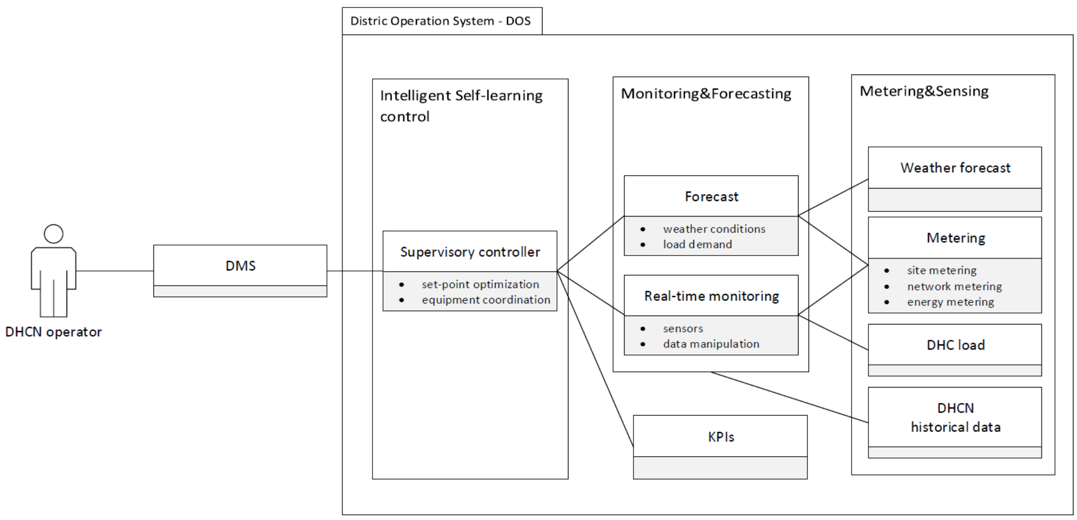


*Figure 2 UC1.1 - Optimization of DHCN plant system operation*

### 3.2.2 UC1.2 Optimization of production scheduling

| | |
|---|---|
| **Brief description** | Optimisation of production scheduling of Cork site, with current context and current technical configuration. |
| **Work(s) area(s)** | Operation of primary heating network |
| **Actors Involved** | DHCN Operator, DHCN manager, DMS, weather forecast, electricity price forecast (UC1.2b) |
| **Related KPIs** | Technical KPIs : all<br>Environmental KPIs : all except $KPI_{\_CO2B}$<br>Economic KPIs : all except $KPI_{\_SAM}$ and $KPI_{\_GRM}$<br>Quality of Service KPIs: all<br>Social KPIs : none |
| **Service Concept** | The tool gives once a day making-decision information about the way to operate the different production units for the next days (boilers, CHP and heat storage). By taking into account load forecast that is calculated from weather forecast through a dedicated service, the optimisation process that uses both DSP and PSO proposes optimal set points for next days. To do this, the tool take into account all possibilities of controlling production and distribution and proposes, satisfying economic and environmental goals regarding KPIs defined in D1.3, what solutions suit well. It is a proposition given to the operator or manager. The operator checks and chooses the best proposition, launches the calculation with different parameters if needed, and enters new related set-points in SCADA. If not validated, the production works as usual. |
| **Context Replicability** | UC1.2b Evolution of electrical contract and market: possibility to sell electricity produced by CHP on electricity market. Prices conditions are different from current situation. Currently, electricity is exclusively self-consumed because selling price on free market is lower than electricity purchase price from national grid. A situation where the spread between electricity purchase price and CHP's electricity selling price is reduced or even inversed will be studied. |

**Concept Schematic**

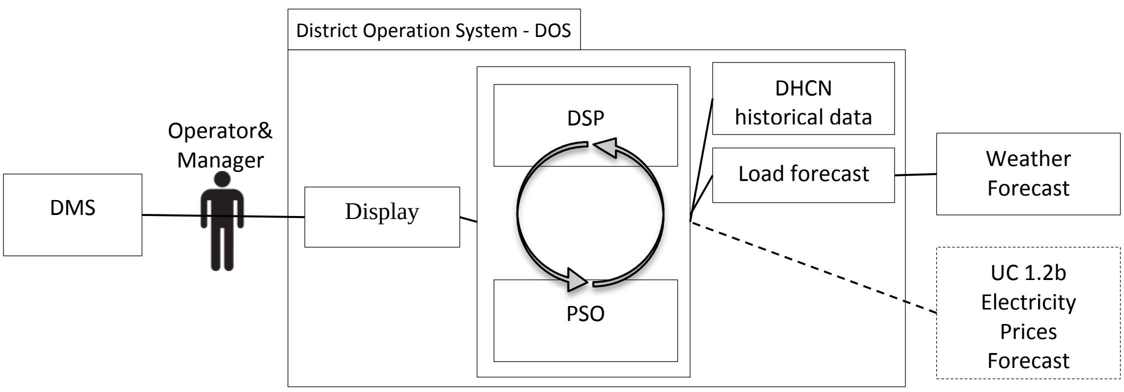

*Figure 3 UC1.2 and 1.2b – Optimization of production scheduling*

### 3.2.3 UC1.3 Optimization of production scheduling with behavioural flexibility (demand-side management)

**Brief description** Optimisation of production scheduling of Cork site, with current context and current technical configuration, taking into account a new flexibility means. It is a derived case from UC1.2 or 1.2b.

**Work(s) area(s)** Operation of primary heating network

**Key stakeholders** DHCN Operator & Manager, Subscriber, end user, DMS, weather forecast, electricity price forecast (UC1.2b)

**Related KPIs** Technical KPIs: all

Environmental KPIs: all

Economic KPIs: all except $KPI_{\_SAM}$ and $KPI\_{}_{GRM}$

Quality of Service KPIs: all

Social KPIs : all

**Service Concept** It is the same service as UC1.2, with additional developments of DSM tools as behavioural and building flexibility that is an objective of the project to make the DHCN more flexible. Cork will be the reference site for behavioural flexibility development.

Evolution related to introduction of the occupants behaviour flexibility. Engaging with Cork district occupants in the Behaviour Demand Response will allow the production scheduler to take into account the behaviour flexibility through the expected BDR impact estimated by the BDR module of the E2District system.

**Context Replicability** None

**Concept Schematic**

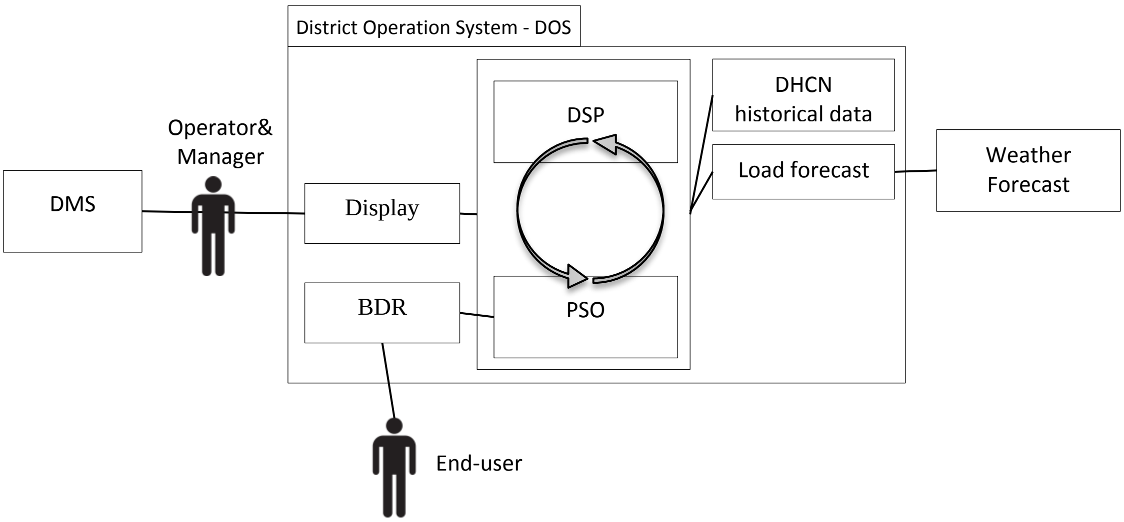


Figure 5 UC1.3 – Optimization of production scheduling with behavioural flexibility

### 3.2.4 UC1.4 Optimization of heat storage capacity

| | |
|---|---|
| **Brief description** | Optimal design of heat storage of the site of CORK, taking into account the optimization algorithms developed during the project |
| **Work(s) area(s)** | Design of primary heating network |
| **Actors involved** | General contractor & Designer, DHCN owner, Investors/Project backers |
| **Related KPIs** | Technical KPIs : all<br>Environmental KPIs : all except $KPI\_{CO2B}$<br>Economic KPIs : all except $KPI\_{SAM}$ and $KPI\_{GRM}$<br>Quality of Service KPIs: none (considered as constraint)<br>Social KPIs : none |
| **Service Concept** | It is the service that allows testing different heat storage capacities with the DHCN of CORK in order to enhance the performance. The designer can set up the capacity of the heat storage and evaluate the interest of each one regarding the investment. The system calculates the economical KPIs and the designer can choose the best one. Then the solutions and associated KPIs will be high-value justification to make easier the decision by the DHCN owners and/or investors. |
| **Context Replicability** | None |
| **Concept Schematic** | |

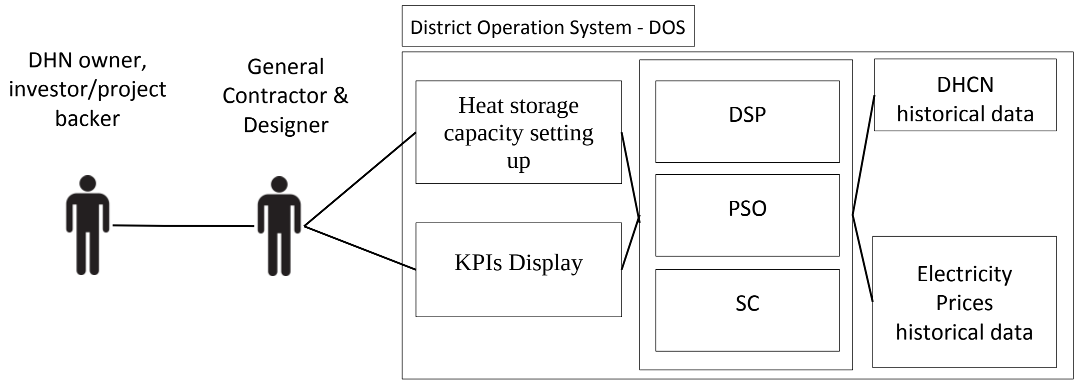


Figure 6 UC1.4 – Optimization of heat storage capacity

## 3.3 Varna Use Cases (public version)

Varna use cases are defined to address replicability issues.

### 3.3.1 UC2.1 Optimization of production scheduling

| | |
|---|---|
| **Brief description** | Decision-making function for maximisation of short term electricity selling |

| | |
|---|---|
| **Work(s) area(s)** | Operation of primary heating network |
| **Actors Involved** | DHCN Operator, DHCN manager, weather forecast, electricity price forecast |
| **Related KPIs** | Technical KPIs : all<br>Environmental KPIs : all except $KPI_{\_CO2B}$<br>Economic KPIs : all<br>Quality of Service KPIs: all<br>Social KPIs : none |
| **Service Concept** | The tool gives once a day updated making-decision information about the way to operate the different production for the two next days. This includes set-points (on/off, load) for each electrical production asset participating for electrical market and the boiler. In this decision, long-term engagement and penalties are taken into account. Distribution flexibility is implicit in optimisation scheme. |
| **Replicability** | **2.1b** this release is based on an evolution of electricity market terms in the next years, that makes the way to operate more complex than currently. |

### 3.3.2 UC2.2 Evaluation of new renewable production

| | |
|---|---|
| **Brief description** | Evaluation of additional production means (geothermal/solar/biomass) that allow to increase flexibility of the site regarding the different markets and decrease the carbon footprint |
| **Work(s) area(s)** | Design of primary heating network |
| **Actors Involved** | General contractor & Designer, DHCN owner, Investors/Project backers |
| **Related KPIs** | Technical KPIs : $KPI_{\_GTE}$, $KPI_{\_PTE}$, $KPI_{\_PWR}$, $KPI_{\_COE}$<br>Environmental KPIs : all<br>Economic KPIs : $KPI_{\_ENC}$, $KPI_{\_GRM}$, $KPI_{\_SAM}$<br>Quality of Service KPIs: none (considered as constraints)<br>Social KPIs : none |
| **Service Concept** | It is the service that allows evaluating the interest of additional production units. It gives to the designer the performance of each scenario (heat and electrical efficiency, environmental and economic). He can set up the design parameters of the new production units (at less capacity), and compare all these scenarios. Then the solutions and associated KPIs will be high-value justification to make easier the decision by the DHCN owners and/or investors. |
| **Replicability** | None |

## 3.4 Strategy development of each use case in E2District

For each use-case, information is given about the strategy to address each use-case.

| | N° | Name | Validation procedure | Comments |
|---|---|---|---|---|
| Cork Use cases | UC1.1 | Optimization of DHCN plant system operation | Validated by on-site demonstration | |
| | UC1.2 | Optimization of production scheduling | Validated by on-site demonstration | |
| | UC1.2b | Optimization of production scheduling with evolution of electrical selling context | Validated by simulation | Electrical selling context will be derived from existing Irish context |
| | UC1.3 | Optimization of production scheduling with building flexibility and behavioural flexibility (demand-side management) | BDR aspects validated by demonstration | To accompany the technical assessment, additional business model aspects will be treated in the specific work package (WP6) |
| | UC1.4 | Optimization of heat storage capacity | Validated by simulation | Design UC |
| Varna | UC2.1 | Optimization of production scheduling | Validated by simulation | |
| | UC2.1b | Optimization of production scheduling with electricity terms evolution | Validated by simulation | |
| | UC2.2 | Evaluation of new renewable production | Validated by simulation | Design UC |

*Table 8 – Use cases strategy development in E2District*

# 4 Conclusion

After listing the evolutions that could represent part of an answer to the stakeholders needs (operating mode, technical configuration) and context evolutions that are important to address for replicability issues, different use cases have been described for each site, precise enough to fix the perimeter for which the developments will be made.

These use cases are used directly in WP2 (modelling perimeter), WP3 (intelligence development), WP4 (dashboards) and WP5 (demonstrator).

# 5 Bibliography

[1] (2016). *D1.1: Report on requirements for district heating and cooling.* E2District.

[2] (2016). *D1.3: Report on KPIs and monitoring strategy for district heatin and cooling*. E2District