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1.Description of the use case

1.1 Name of use case

Name of the use case:
Automated Implicit Demand Response

Area Domain(s)/ Zone(s):
Energy Systems / Customer Premises / Operation

1.2 Version management

Version No.	Date	Name of author(s)	Changes	Approval status
0.1	18/04/2025 09:56	Cécile Rabrait		Draft
0.2	01/07/2025 13:03	Cécile Rabrait	Continue drafting the UC	
0.3	04/07/2025 09:39	Cécile Rabrait	Corrections after first review	

1.3 Scope and objectives of use case

Scope:

Optimization of a building's energy consumption through automated Implicit Demand Response (DR). The communication between the building's Customer Energy Manager System (CEMS) and the Building Automation System (BAS) can control the building's energy consumption based on market spot prices.

Objective(s):

The overall objectives of this use case are to: - O1 : Reduce energy costs by engaging consumers and building resources in automated Implicit Demand Response in an operational environment, - O2 : Implement CEMS as the main control point for the building's energy management : the CEMS will receive price signals and control the BAS in order to adjust and optimise energy consumption.

Related business case(s):

1.4 Narrative of use case

Short description:

Implicit DR is triggered by making real time prices and/or dynamic pricing available to consumers who may adapt their consumption behaviour accordingly and consequently save money on their bill. In this use case, the Building Owner (BO) has a spot-price contract for electricity and will therefore benefit from being able to shift the building's energy consumption (automatically) based on the actual spot price per hour. The CEMS in the building is able to receive electricity price signals and to control the flexible assets in the building in order to optimise consumption and to reduce the consumer’s electricity costs. In this use case, implicit DR will focus on the building’s hybrid heating system that is responsible for domestic hot water heating. The hybrid heating system is supplied by an exhaust air heat pump and district heating (DH). DH has seasonal prices with a peak load component that needs to be taken into account in the implicit DR optimisation. The building included in the use case is a residential building with self-contained flats.

Complete description:

The Building Owner (BO) has a spot price-based contract with the Retailer. This contract makes it attractive for the BO to adapt the building electricity consumption in order to save on energy expenses. In the first phase, the main resource for the implicit DR optimisation is the buildings heating system that consist of an exhaust air heat pump and district heating. The Building Owner is interested to obtain cost-savings from optimal operation of the hybrid heating system. This requires cross-sector optimisation across electricity (heat pump) and district heating. The Building Owner already has a BAS (and a Smart Meter) installed, as well as a CEMS installed. This system will allow for the optimisation of the building’s hybrid heating system by 1) shifting consumption in response to price signals received by the CEMS, and selecting which source (DH or heat pump) is used for generating the energy for heating at any time. The CEMS is able to control the BAS and thereby the electricity and district heating consumption in the building based on a predetermined set of parameters or boundaries related to minimum thermal temperature determined by the Facility Manager who is responsible for managing the heating system in the building. The CEMS will take these boundaries, the thermal inertia of the building (learned by the CEMS), heating system dynamics (learned by the CEMS), weather forecast, and time (impacts occupancy, ventilation schedules, etc that also need to be learned by the CEMS) into account when optimising the heating system control. The Facility Manager has chosen a CEMS to manage the heating system in the building automatically based on predetermined settings related to comfort and/or price settings. The comfort parameter is conditioned by a contract between the Building Owner and the residents guaranteeing residents a minimum thermal temperature. If necessary, the Facility Manager will be able to override the automatic settings.

1.5 Key performance indicators (KPI)

ID	Name	Description	Reference to mentioned use case objectives
RESONANCE_KPI2b	Increased accuracy of flexible asset models	The results obtained with the innovative AutoML-based hybrid models are compared to state-of-the-art ML models and the percentage decrease of forecasting error is calculated.	Objective 1 (O1)
RESONANCE_KPI2c	Coverage of flexibility potential in homes / buildings	The ratio is calculated by comparing the total amount of flexible capacity with the capacity covered by the asset types supported in the project.	Objective 1 (O1)
RESONANCE_KPI3a	The number of CEM solutions tailor-made for customers	The number of full-scale CEM solutions (integrated with RM solutions) that are tailor-made for customers (consumers/prosumers) and demonstrated in the pilots.	Objective 2 (O2)

ID	Name	Description	Reference to mentioned use case objectives
RESONANCE_KPI4b	Return on Investment for consumers/prosumers	A full-fledged discounted cash flow analysis of the customers that engage in demand response activities will be performed, based on pilot-driven assumptions about costs for equipment and services, as well as benefits from increased self-consumption and flexibility services.	Objective 1 (O1)
RESONANCE_KPI5b	TRL of the RESONANCE Framework	The smart appliances, CEMs and aggregation solutions developed on top of the RESONANCE Framework have been demonstrated in an operational environment.	Objective 2 (O2)
RESONANCE_KPI5e	The number of energy consumers/prosumers in the pilots	The numbers of consumers/prosumers (individual people) either living in the pilot buildings or otherwise interacting with the pilots	Objective 1 (O1)
RESONANCE_KPI5f	Increased participation of energy consumers in DSFM	The KPI indicates the increase in customer flexibility available for RES balancing. The increase ratio is calculated by comparing the mean available flexibility per consumer in the pilots with a reference value obtained from the literature and past DR projects.	Objective 1 (O1)

1.6 Use case conditions

Assumptions

• The Building Energy Management System (BEMS) is capable of receiving and processing real-time price signals. • The hybrid heating system (exhaust air heat pump and district heating) is fully integrated with the CEMS. • Occupants of the residential building are informed about the potential fluctuations in heating due to DR activities. • The exhaust air heat pump and district heating systems are functioning correctly and have regular maintenance.

Prerequisites

• All components of the hybrid heating system are tested for compatibility with the CEMS. • CEMS can receive real-time price signals • Historical and real-time data on electricity spot prices and district heating costs are available and integrated into the CEMS. • Data on the building’s energy consumption patterns and flexible assets are available and updated in the CEMS. • The building owner has entered into a spot-price contract for electricity

1.7 Further information to the use case for classification/mapping

Relation to other use cases

RESONANCE UC2 - Finnish pilot : Automated Explicit Demand Response

Level of depth:

Moderate to Advanced level of depth

Prioritisation:

High Priority: Focus on reducing electricity costs through real-time price adaptations and automated system optimizations.

Generic, regional or national relation:

Regional and national relevance: this UC is specific to the Finnish pilot of the RESONANCE project, but the concept could be generalized to Finland.

Nature of the use case:

Commercial & Technical: involves sophisticated control systems and cross-sector optimization

Further keywords for classification:

Implicit DR, Real-time pricing, Dynamic pricing, Hybrid heating system, Exhaust air heat pump, District heating, Spot price contract, Cost savings, Building Automation System (BAS), Smart meter, Customer Energy Management (CEM), Thermal inertia

1.8 General remarks

Remarks:

None

2.Diagrams of use case

2.1 Diagrams of use case

Diagram name	Diagram image
RESONANCE UC1 - Finnish pilot : Automated Implicit Demand Response	

3. Technical details

3.1 Actors

Actor name	Actor type	Actor description
Building Automation System (BAS)	System	A Building automation systems (BAS), also known as building management system (BMS) or building energy management system (BEMS), is the automatic centralized control of a building's HVAC (heating, ventilation and air conditioning), electrical, lighting, shading, access control, security systems, and other interrelated systems.
Customer Energy Manager (CEM)	Application	The CEM is a logical function optimizing energy consumption and or production based on signals received from the grid, consumer‟s settings and contracts, and devices minimum performance standards. The Customer Energy Manager collects messages sent to and received from connected devices; especially the inhome/building sector has to be mentioned. It can handle general or dedicated load and generation management commands and then forwards these to the connected devices. It provides vice versa information towards the “grid / market”. Note that multiple loads/generation resources can be combined in the CEM to be mutually controlled. When the CEM is integrated with communication functionalities it is called a Customer Energy Management System or CEMS.
Retailer	Role	Entity selling electrical energy to consumers - could also be a grid user who has a grid connection and access contract with the TSO or DSO. In addition, multiple combinations of different grid user groups (e.g. those grid users that do both consume and produce electricity) exist. In the remainder of this document, the terms customer/consumer and grid user are used interchangeably where appropriate.
District Heating Utility	Business Actor	District heating supplier, which also provides district heating prices coming from power exchange.
District Heating	System	District heating is a system for distributing heat generated in a centralized location through a system of insulated pipes for residential and commercial heating requirements such as space heating and water heating.
Heat pump	System	A heat pump extracts heat from the cold outside air and transfers it inside buildings. To this end, a compressor inside the device uses electricity to increase the temperature of the heat extracted from the outside air. The heat pump can also provide cooling by transferring warm indoor air to the outside.
Resident	Business Actor	Resident of the building
Building Owner	Business Actor	Owner of the building
Facility Manager	Operator	Party that manages a building

3.2 References

No.	References type	Reference	Status	Impact on use case	Originator/organisation	Link

4. Step by step analysis of use case

4.1 Implicit demand response in an apartment building

No.

A

Scenario description

CEMS optimizes apartment heating based on resident preferences (minimum temperature in the apartment), energy prices (DH, electricity), thermal inertia and weather forecasts.

Primary actor

CEMS

Triggering event

Energy price signal

Pre-condition

Building indoor temperature measurements and electricity prices are fetched, building temperature model is available.

Postcondition

Optimized heating plan for building automation system

4.1 Steps of Implicit demand response in an apartment building

Step No.	Event	Name of process/activity	Description of process/activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
1	Transmits electricity price	Price Signal Transmission	CEMS receives real-time electricity price signals from the energy market.	Report	Retailer	CEMS	Inf.1	R-2.3
2	Transmits building measurements (indoor temperature, heat pump electricity consumption and district heating consumption)	Building Data Transmission	The building's sensors transmit measurements such as indoor temperature, heat pump electricity consumption, and district heating consumption to the CEMS.	Report	Building Automation System	CEMS	Inf.2	R-1.17, R-2.5, R-3.9
3	Transmits district heating price	District Heating Price Transmission	The CEMS receives real-time district heating price signals.	Report	District Heating Utility	CEMS	Inf.3	R-2.3

Step No.	Event	Name of process/activity	Description of process/activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
4	Optimization of the heating vector plan	Heating Vector Plan Optimization	The CEMS analyzes the received data and optimizes the heating vector plan to minimize costs while maintaining comfort levels. This includes determining the optimal usage of the heat pump and district heating based on price signals, building measurements, and other factors such as weather forecasts and occupancy schedules.	Calculate	CEMS	CEMS	x	x
5	Sending of scheduled control commands to district heating and heat pump	Execution of Optimized Heating Plan	The CEMS sends scheduled control commands to the building's heating systems (district heating and heat pump) to implement the optimized heating plan. This ensures energy consumption is adjusted in response to price signals, optimizing cost savings and efficiency.	Send	CEMS	Building Automation System	Inf.5	R-3.5, R-3.9
6	Command from building automation system to heating system	Control signal from building automation system to heating system	Building automation system sends the control command to building heating system.	Send	Building Automation System	District Heating System	Inf.6	R-3.5, R-3.9
7	Command from building automation system to heat pump	Control signal from building automation system to heat pump	Building automation system sends the control command to heat pump	Send	Building Automation System	Heat pump	Inf.7	R-3.5, R-3.9

5 Information exchanged

5.1 Information exchanged

Requirement, R-IDs	Information exchanged, ID	Name of information	Description of Information Exchanged
R-2.3	Inf.1	Electricity Price Signals	Real-time electricity price signals from the energy market to the CEMS.
R-1.17, R-2.5, R-3.9	Inf.2	Building Measurements	Measurements from the building's sensors including indoor temperature, heat pump electricity consumption, and district heating consumption.
R-2.3	Inf.3	District Heating Price Signals	Real-time district heating price signals from the district heating utility to the CEMS.
R-3.5, R-3.9	Inf.5	Control commands	Scheduled control commands from the CEMS to the building’s BA
R-3.5, R-3.9	Inf.6	Control commands	Command from building automation system to heating system
R-3.5, R-3.9	Inf.7	Control commands	Command from building automation system to heat pump

6 Requirements

6.1 Requirements regarding configuration issues

Category ID
R-1

Category name for requirements
Requirements regarding configuration issues

Category description
x

Requirement R-ID	Requirement name	Requirement description
R-1.17	Existence of legacy systems	Some legacy systems

6.2 Requirements regarding Quality of Service issues

Category ID
R-2

Category name for requirements
Requirements regarding Quality of Service issues

Category description
x

Requirement R-ID	Requirement name	Requirement description
R-2.3	Availability of information flows	Continuous availability not required but information must be available at specific times or under specific conditions
R-2.5	Accuracy of data requirements	Adequate accuracy can be assumed

6.3 Requirements regarding security issues

Category ID
R-3

Category name for requirements
Requirements regarding security issues

Category description
x

Requirement R-ID	Requirement name	Requirement description
R-3.5	Replay	Ensuring that data cannot be resent by an unauthorized source is quite important
R-3.9	Authentication and Access Control mechanisms commonly used with this data exchange	Public key encryption (e.g. SSL/TLS)

7 Common terms and definitions

7.1 Common terms and definitions

Term	Definition
BAS	Building Automation Manager
CEM	Customer Energy Manager
RM	Resource Manager
CEMS	Customer Energy Manager System (includes CEM and RM)
DR	Demand Response

8 Custom information

8.1 Refer to section

Refers to section	Value	Key

Publisher Organization

Organization name	Organization Acronym	Country
TRIALOG		
TEKNOLOGIAN TUTKIMUSKESKUS VTT		
VOLUE	VOLUE	Norway
CAVERION SUOMI OY		

Technologies for use cases:
CEM, RM

High level Use Case:
HLUC 9: Flexibility provision by Building, Districts and Industrial Processes

Related Project:
RESONANCE

Cordis Link:
https://cordis.europa.eu/project/id/101096200

9 Download

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