

6. Tier 2: Sub-Subsystems Requirements:

1. Control Unit Requirements

1. Functional Requirements

Id	Requirement
1	The system shall be able to turn geothermal heat system on/off
2	The system shall be able to turn geothermal cooling system on/off
3	The system shall be able to store temperature sensor data from all the apartments in the database
4	The system shall be able to store proximity sensor data from all the apartments in the database
5	The system shall be able to interpret instructions from the MCU

2. Interface Requirements

Id	Requirement
1	The system shall provide a RS-485 interface with the Geothermal system
2	The system shall provide a RS-485 interface with the photovoltaic system
3	The system shall provide a virtual interface over the internet with the MCU
4	The system shall provide a RS-485 interface with the energy storage system
5	The system shall provide a Cat 5e ethernet interface with the local router
6	The system shall provide RS-485 interfaces to all apartment radiator valve adjusters
7	The system shall provide RS-485 interfaces to all apartment floor heating valve adjusters
8	The system shall provide RS-485 interfaces to all apartment heating ventilation valve adjusters
9	The system shall provide RS-485 interfaces to all apartment cooling ventilation valve adjusters
10	The system shall provide RS-485 interface to temperature sensors attached to apartment ventilation
11	The system shall receive AC electricity with maximum 16A at 250V
12	The system shall receive data instructions using Cat 5e ethernet
13	The system shall provide RS-485 interface to the energy storage system cooling valve adjuster
14	The system shall provide RS-485 interface to the photovoltaic system cooling valve adjuster
15	The system shall access the database system using a C++ connector
16	The system shall provide a heat exchanger interface with the geothermal cooling system
17	The system shall provide RS-485 interface to temperature sensors attached to domestic hot water system
18	The system shall provide RS-485 interface to temperature sensors inside apartments
19	The system shall provide RS-485 interface to proximity sensors inside apartments
20	The system shall use end to end encryption for communication with the server

3. Temporal Performance Requirements

Id	Requirement
1	The system shall execute instruction within $\leq 10\text{ms}$ of receiving them
2	The MTTF of the system shall be > 5 year

3	The MTTR of the system shall be < 12 hours
4	The system shall produce an error if the instruction fails to execute within the time limit

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall use maximum 5GB random access memory
2	The system shall cost no more than 50k NOK

2. Main Communication Requirements

1. Functional Requirements

Id	Requirement
1	The system shall provide a data structure: updateQueue
2	The system shall put received real-time instructions in the updateQueue
3	The system shall be able to interpret instructions in the updateQueue
4	The system shall be able to interpret instructions from the database

2. Interface Requirements

Id	Requirement
1	The system shall access the database system using a C++ connector
2	The system shall provide an interface to the web-application / smart-phone application

3. Temporal Performance Requirements

Id	Requirement
1	The system shall empty and send instructions from the updateQueue within an interval of maximum 10 seconds.
2	The system shall pass on scheduled instructions with a maximum delay of 60 seconds
3	The MTTF of the system shall be > 5 year
4	The MTTR of the system shall be < 1 day

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall use maximum 1GB random access memory
2	The system shall cost 0 NOK

3. Database Requirements

1. Functional Requirements

Id	Requirement
1	The system shall provide CRUD operations
2	The system shall anonymize personal data

2. Interface Requirements

Id	Requirement
1	The system shall provide a C++ connector interface

3. Temporal Performance Requirements

Id	Requirement
1	The CRUD time in the MongoDB shall not be larger than 0.01 seconds per 10000 documents
2	The CRUD time in the MySQL DB shall not be larger than 0.01 seconds per 1000 rows
3	The MTTF of the system shall be > 5 year
4	The MTTR of the system shall be < 1 day

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall be able to horizontally scale when reaching 80% of maximum RAM capacity
2	The system shall be able to vertically scale to maintain <1 ms read time
3	The system shall be able to vertically scale to maintain <10 ms write time
4	The system shall cost 0 NOK

4. Data-Gathering Software Requirements

1. Functional Requirements

Id	Requirement
1	The system shall gather continuous weather-data
2	The system shall gather continuous power-prices

2. Interface Requirements

Id	Requirement
1	The system shall access the database system using a C++ connector
2	The system shall provide a virtual interface with a weather forecasting service over the internet
3	The system shall provide a virtual interface with a power price database over the internet

3. Temporal Performance Requirements

Id	Requirement
1	The system shall gather weather forecasts for the next 24 hours every day between 23:50 and 23:59
2	The system shall gather power-prices for the previous day, every day between 00:00 and 00:10.
3	The MTTF of the system shall be > 1 year
4	The MTTR of the system shall be < 2 days

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall use maximum 100MB random access memory
2	The system shall cost 0 NOK

5. Machine Learning Software Requirements

1. Functional Requirements

Id	Requirement
1	The system shall make decisions for temperature settings, allocation of energy,
2	The system shall predict solar power production
3	The system shall predict power prices

2. Interface Requirements

Id	Requirement
1	The system shall access the database system using a C++ connector

3. Temporal Performance Requirements

Id	Requirement
1	The MTTF of the system shall be > 1 year
2	The MTTR of the system shall be < 2 days

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall be able to predict the hourly solar power production for the next day with an error margin of 2.3 kW
2	The system shall be able to predict hourly power prices for the next day with an error margin of 33.6 NOK/MWh
3	The system shall cost 0 NOK

6. Application/Website Requirements

1. Functional Requirements

Id	Requirement
1	The system shall let the user specify wanted temperature in every room of the apartment
2	The system shall let the user turn vehicle-to-building on or off
3	The system shall let the user specify the estimated time until electric vehicle is needed.
4	The system shall provide the user with statistics for power consumption, current temperature, vehicle battery status
5	The system shall let the user specify desired state of charge for their electric vehicle at any set time

2. Interface Requirements

Id	Requirement
1	The web-application shall work in the following browsers: Google Chrome, Mozilla Firefox, Apple Safari, Internet Edge
2	The system shall work on both Android and iOS.
3	The system shall access the database system using a C++ connector
4	The system shall provide a user interface
5	The system shall use end to end encryption for communication with the server

3. Temporal Performance Requirements

Id	Requirement
1	The system shall have a MTTL \leq 5 minutes
2	The MTTF of the system shall be $>$ 1 year
3	The MTTR of the system shall be $<$ 2 days

4. Non-temporal Performance Requirements

Id	Requirement
1	The application shall use maximum 500MB random access memory
2	The website shall use maximum 10MB random access memory per request
3	The system shall cost 0 NOK

7. Developer Tools Requirements

1. Functional Requirements

Id	Requirement
1	The system shall present the user with statistics for machine learning performance
2	The system shall let the user run diagnostics on the system
3	The system shall let the user handle support tickets

2. Interface Requirements

Id	Requirement
1	The system shall work on Windows versions \geq 10
2	The system shall work on Debian based Linux distributions with kernels $>$ 5.0
3	The system shall access the database system using a C++ connector
4	The system shall provide a user interface
5	The system shall use end to end encryption for communication with the server

3. Temporal Performance Requirements

Id	Requirement
1	The system shall deploy machine learning algorithm changes within 24 hours
2	The MTTF of the system shall be $>$ 1 year
3	The MTTR of the system shall be $<$ 2 days

4. Non-temporal Performance Requirements

Id	Requirement
1	The system shall use maximum 1GB random access memory
2	The system shall cost 0 NOK