Project acronym	B4B
Project full name	Brains for Building's Energy Systems
Grant No	MOOI32004
Project duration	4 year (Starting date 1 May 2021)

Deliverable 2.8

Energy-flex-balance software implementation by industrial partners

Authors (in alphabetical order): Jan-Willem Dubbeldam (Kropman), David Fortini (O-Nexus), Tamas Keviczky (TUD), Bart Lelij (O-Nexus), Yun Li (TUD), Shalika Walker (Kropman), Neil Yorke-Smith (TUD), Joep van der Velden (Kropman)

Work package	WP2
Result	4
Lead beneficiary	Delft University of Technology
Due Date	1 July 2025
Deliverable Status	Final
File name	B4B WP2 D2.8 Energy-Flex-Balance Software Implementation by Industrial Partners.docx

This project received funding from Dutch Ministry of Economic Affairs and Climate Policy and Ministry of the Interior and Kingdom Relations under the MOOI program.

SUMMARY

The built environment requires energy-flexible buildings to reduce energy peak loads, to prevent exceeding the connection capacity to the electricity grid, and to maximize the use of (decentralized) renewable energy sources. The challenge is to arrive at smart control strategies that respond to the increasing variations in both the energy demand as well as the variable energy supply. This enables grid integration in existing energy networks with limited capacity, and maximizes the use of decentralized sustainable energy generation. Buildings can play a key role in the optimization of the grid capacity by applying demand-side management control and thereby shifting cooling and heating demand in time. To adjust the grid energy demand profile of a building without compromising the user requirements, the building should acquire substantial energy flexibility capacity.

The main ambition of the Brains for Buildings Work Package 2 is to **develop smart control strategies** that use the operational flexibility of non-residential buildings to minimize energy costs, reduce emissions and avoid exceeding the connection capacity to the electricity grid, without compromising comfort levels. To realize this ambition, development of the following key components is targeted within the B4B WP2: (A) open-source HVAC and electric services models, (B) energy demand prediction models and (C) flexibility management control methods. Most results related to key components (A) and (B) have been reported in Deliverable 2.1-2.2-2.3 summarizing activities performed in Task 2.1 and 2.2. The combined Deliverable 2.4-2.5 described activities within Task 2.3, regarding the developed flexibility management control methods (key component (C)) and the development/testing of supporting high-frequency energy balance prediction models within key component (B).

This report serves as the deliverable for activities carried out by industrial partners (Kropman and O-Nexus) within Task 2.4b, and covers the commercial uptake and utilization of control strategies for building energy flexibility from the project, and the validation and integration in their own proprietary software products. It describes the prototypes of the flexibility management control solutions that make use of the proof of concepts developed in Task 2.4a and integrate new functionalities developed in Tasks 2.1, 2.2 and 2.3 and in WP1 (Task 1.1.6).

In Chapter 2, Kropman describes the development of new functionalities based on the proof of concept of Task 2.4a for their InsiteSuite SCADA platform (https://insitesuite.nl/). The new functionalities have been integrated in the InsiteSuite platform in a modular form, and demonstrated via an EV smart charging implementation that is currently fully operational at one of Kropman's office buildings and one of their InsiteSuite clients.

Chapter 3 summarizes the activities carried out by O-Nexus, regarding the development, investigation, and implementation of PCM thermal-buffering as an energy management solution for SME buildings, carried out via a case study at The Green Village. This Proof-of-Concept implementation was performed through their partnership with Flamco and Comfort Partners. It will be followed by a validation of their system at the TBI training centre in Amsterdam and a larger scale demonstration in a housing project to support their business case.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background and Objectives

The built environment requires energy-flexible buildings in order to prevent energy peak load and to maximize the use of (decentralized) renewable energy sources. The challenge is to arrive at smart control strategies that respond to the increasing variations in both the energy demand as well as the variable energy supply. This enables grid integration in existing energy networks with limited capacity, as well as making maximum use of decentralized sustainable generation.

The main ambition of the B4B project is to develop smart control strategies that use the operational flexibility of non-residential buildings to minimize energy costs, reduce emissions and avoid spikes in network load, without compromising comfort levels. Furthermore, the goal is to show that flexibility of energy production/demand of smart buildings can reduce operational constraints in the current network.

To realize this ambition, development of the following key components will be targeted within the B4B project:

- Open-source HVAC and electrical services models
- As a foundation for our research, open-source models were created for heating, ventilation, and air conditioning (HVAC) systems and electrical services within non-residential buildings. These models serve as the building blocks for the development of the energy prediction models.
- Energy prediction models
- Building upon the HVAC and electrical services models, advanced energy prediction models were constructed. These predictive models are essential for forecasting energy consumption patterns, enabling proactive and efficient energy management.
- Flexibility management control methods
- To harness the inherent flexibility within non-residential buildings, innovative control methods were developed. These methods facilitate the dynamic allocation of energy resources, ensuring optimal energy utilization and minimizing wastage. The most promising control methods will be tested in living labs, first in a digital environment and later on in real buildings.

This report describes the further development and integration of prototype flexibility management control solutions carried out in Task 2.4b, by making use of the proof of concepts developed in Task 2.4a and integrating new functionalities developed in Tasks 2.1, 2.2 and 2.3 and in WP1 (Task 1.1.6).

1.2 Approach and report structure

A structured and collaborative approach has been defined to achieve the objectives of the B4B project. Before starting, the consortium partners discussed and decided about the task distribution. This ensured that a wide variety of models and methods have been developed in the B4B project, and it has also allowed partners to exchange feedback about the different models and methods, gaining a common insight on the pros and cons of each approach. The developed models and methods have been tested using real data from living labs, representative simulation models, and use cases in order to investigate the added value of their results and to demonstrate their applicability for the control of building energy flexibility.

The work on the development of the key components listed above has been carried out simultaneously. As the learning outcomes of each key component can have a positive impact on the development of the other key components, regular outcome sharing meetings have been organized and collaborations between consortium partners have been established.

This report serves as the deliverable for activities carried out by industrial partners (Kropman and O-Nexus) within Task 2.4b, and covers the commercial uptake and utilization of control strategies for building energy flexibility from the project, and the validation and integration in their own proprietary software products.

In Chapter 2, Kropman describes the development of new functionalities based on the proof of concept of Task 2.4a for their InsiteSuite SCADA platform (https://insitesuite.nl/). The new functionalities have been integrated in the InsiteSuite platform in a modular form, and demonstrated via an EV smart charging implementation that is currently fully operational at one of Kropman's office buildings and one of their InsiteSuite clients.

Chapter 3 summarizes the activities carried out by O-Nexus, regarding the development, investigation, and implementation of PCM thermal-buffering as an energy management solution for SME buildings, carried out via a case study at The Green Village. This Proof-of-Concept implementation was performed through their partnership with Flamco and Comfort Partners. It will be followed by a validation of their system at the TBI

training centre in Amsterdam and a larger scale demonstration in a housing project to support their business case.

2 INSITESUITE: CORPORATE EXPANSION

Authors: Shalika Walker, Joep van der Velden, Jan-Willem Dubbeldam (Kropman)

2.1 Development of a corporate expansion

Goal: The Dutch electricity grid is under great pressure due to grid congestion. The network is full for large-scale consumption connections, which hinders or limits companies that want to become more sustainable. As a result, companies face challenges in electrifying their operations, integrating renewable energy sources, and optimizing energy usage. Without viable solutions, organizations may experience delays in their sustainability initiatives, increased energy costs, and difficulty meeting regulatory requirements.

To address these issues, Kropman expanded the development of the **InsiteSuite** Supervisory Control and Data Acquisition (SCADA) system, offering in-house and third-party solutions designed to help large-scale organizations and commercial buildings navigate the complexities of the energy transition (see the development roadmap in Figure 2.1).

By offering advanced energy management strategies, demand response systems, and smart grid technologies, **InsiteSuite** enables businesses to reduce their CO_2 emissions, improve energy flexibility, and ensure reliable energy consumption. Through innovative solutions, the company empowers organizations to take control of their energy needs, mitigate the risks associated with grid congestion, and accelerate their sustainability goals.

All three Kropman Business Lines (BL) *Ontwerp en Techniek, Projecten, and Services* are working for customers on these subjects. Kropman wants all BLs to be supported with software tooling. Tools for commercial promotion, energy analysis and simulation of new technologies, integration of software modules in existing building management systems and of course an active control implementation. These software modules and value-added services can be provided to the customer either by on premise installation or cloud hosted.

InsiteSuite is actively partnering with other companies to increase the applications and advancing technology into the market. A perfect fit can be found in partners that can supply components, hardware, services to their customers, but do not have the access to advance energy management, software applications and BMS integration knowledge.

Pathway:

Figure 2.1 Roadmap of advancement of InsiteSuite (in terms of R&D development).

2.2 Products

The InsiteSuite SCADA system is structured into two primary categories, each serving a distinct yet complementary function: InsiteReports and InsiteView.

1. **InsiteReports** is a powerful reporting and analytics tool designed to transform raw data into meaningful insights. By aggregating data from multiple sources, it converts complex information into user-friendly formats that enhance decision-making. The platform supports user-defined flexible formats, ensuring that reports are tailored to specific needs, whether for energy management or other building-related data (Figure 2.2 shows example dashboards).

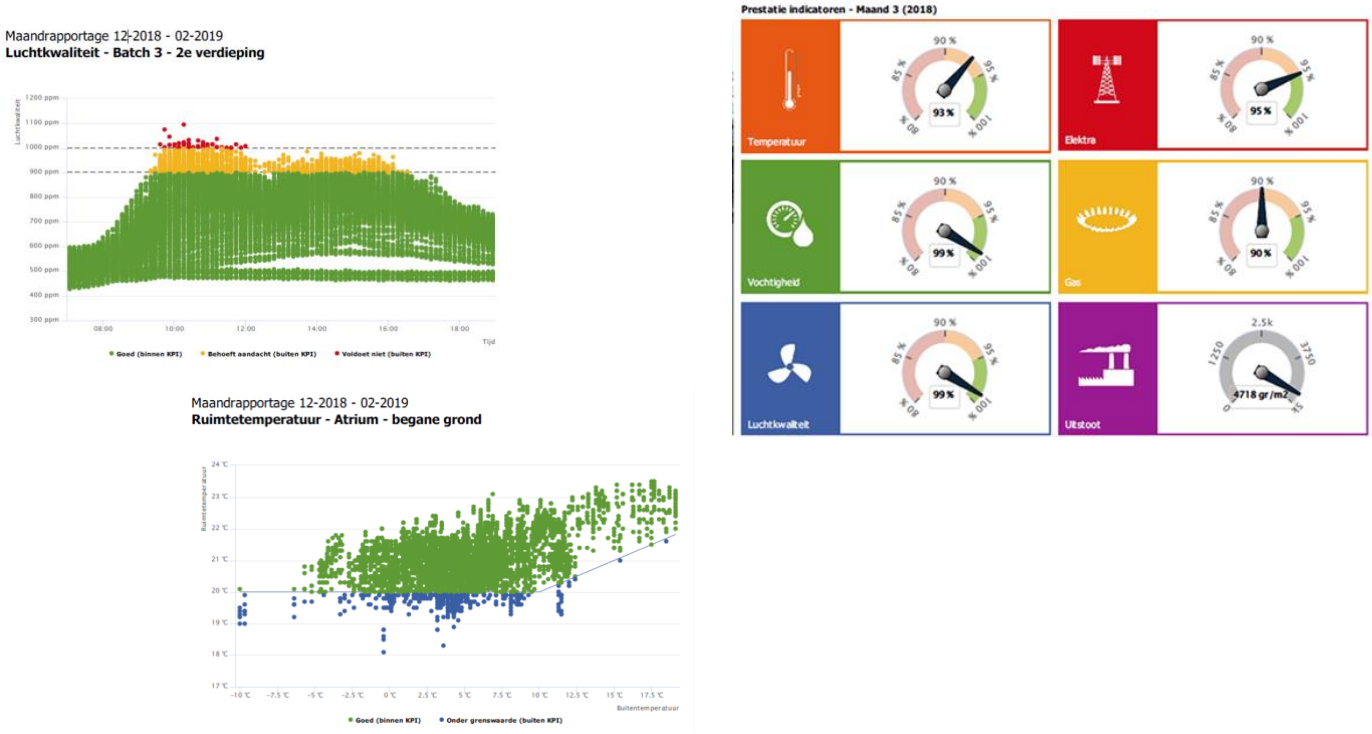


Figure 2.2 Example dashboards created at system level and sub-system level.

With an intuitive online dashboard, InsiteReports provides a seamless presentation of key metrics, allowing users to monitor performance in real time. With features like targeted information dissemination for specialized audiences and predictive analysis, this tool is well-suited for applications such as fault detection and diagnostics (FDD).

Built on modern web technologies such as HTML5, InsiteReports offers a highly accessible and programmable interface. Its user-friendly design ensures ease of use, while its flexibility allows for customization based on specific reporting requirements. Whether for facility managers, energy consultants, or building operators, InsiteReports delivers a robust solution for data-driven optimization.

Besides giving graphical insights into the performance of a building installation, InsiteReports has been expanded to play a key role in providing a prepared dataset for the purpose of predicting building behaviour with the help of **machine learning algorithms**.

2. **InsiteView** functions as the core SCADA (Supervisory Control and Data Acquisition) system. It provides advanced monitoring, visualization (see Figure 2.3), graphical programming options for automation and control solutions (see Figure 2.4), ensuring seamless integration of building management system (BMS). This allows for efficient energy management, real-time operational oversight, and enhanced decision-making capabilities.

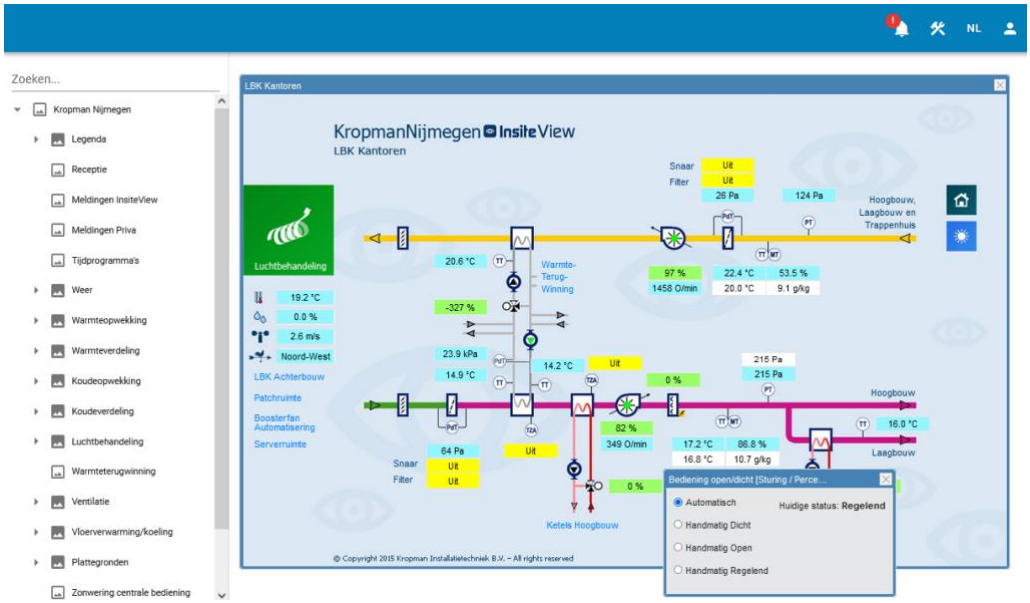


Figure 2.3 Visualization of InsiteView SCADA system.

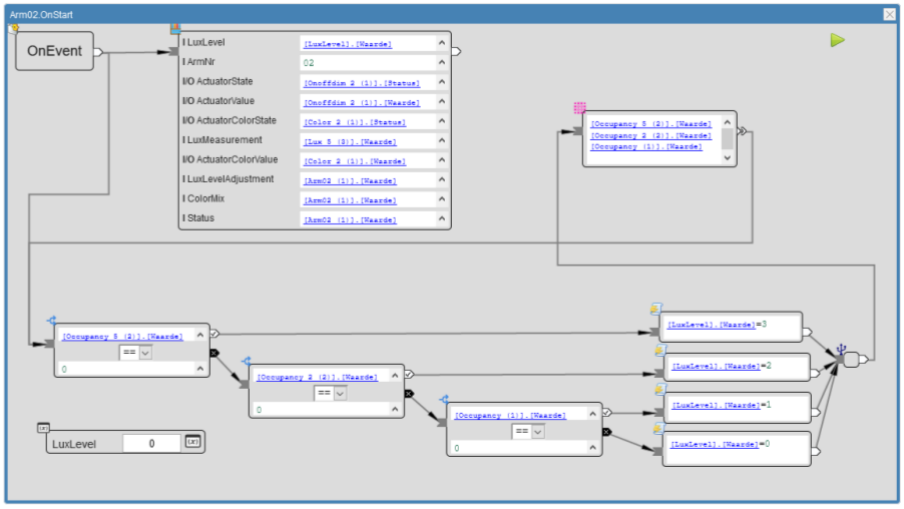


Figure 2.4 Graphical programming in InsiteView.

InsiteView has the capability of modular integration of applications such as predictive analytics and model-based controls (MPC). By leveraging optimization techniques, it enables efficient energy management and

operational improvements across various building systems. With predictive capabilities, InsiteView helps anticipate changes in energy demand and system performance, ensuring proactive adjustments.

The platform features server-based controls that integrate seamlessly with multiple building systems, allowing for centralized management and automation. Users can implement graphical programming or scripting to customize control strategies, making it adaptable to diverse operational requirements. This flexibility ensures that different systems within a facility work in harmony, maximizing efficiency and reducing operational costs. By combining predictive analytics, automation, and adaptability, InsiteView provides a **cutting-edge solution** for modern building management.

2.3 Validation, integration into products and services (tested during B4B project)

Within the B4B project, small scale and large-scale smart charging were explored and validated for the future development of the corporate expansion (Somers, 2023; Reinders, 2022; in 't Veld, 2023; Khan et al, 2023).

Smart charging – This concept focuses on optimizing the charging of electric vehicles (EVs) in a way that balances grid demand and reduces peak loads. By implementing intelligent charging schedules and leveraging real-time grid data, smart charging helps businesses and fleet operators integrate EVs without exacerbating grid congestion and move towards Paris proof buildings.

Small-scale and large-scale smart charging was successfully implemented and is now fully operational at one of Kropman's office buildings (Chamari et al, 2025) and one of Kropman's/InsiteSuite clients (see Figure 2.9, (Hermans et al, 2024)). This deployment has enabled efficient management of the charging of a significant number of electric vehicles while optimizing energy usage and minimizing strain on the grid. By using intelligent algorithms and real-time data, the system dynamically adjusts charging schedules based on electricity demand, availability of renewable energy, and grid capacity. As a result, it was able to reduce peak energy consumption, actively control energy demand, create a better net load profile (see Figure 2.6), lower operational costs, and contribute to a more sustainable and resilient energy infrastructure.

This successful implementation serves as a key milestone for InsiteSuite, demonstrating the effectiveness of its modular solutions (see Figures 2.5, 2.7) and paving the way for further large-scale adoption.

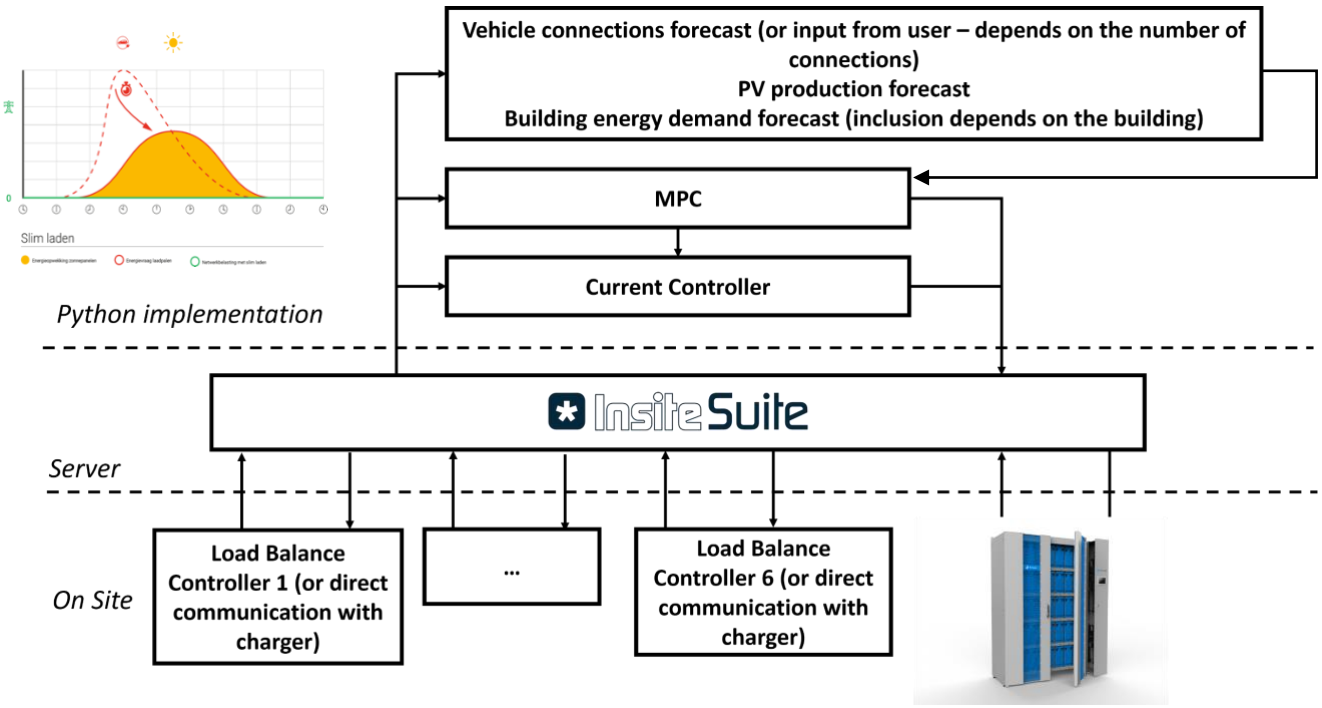


Figure 2.5 Smart charging software connectivity (depending on the building and its resources, inputs vary).

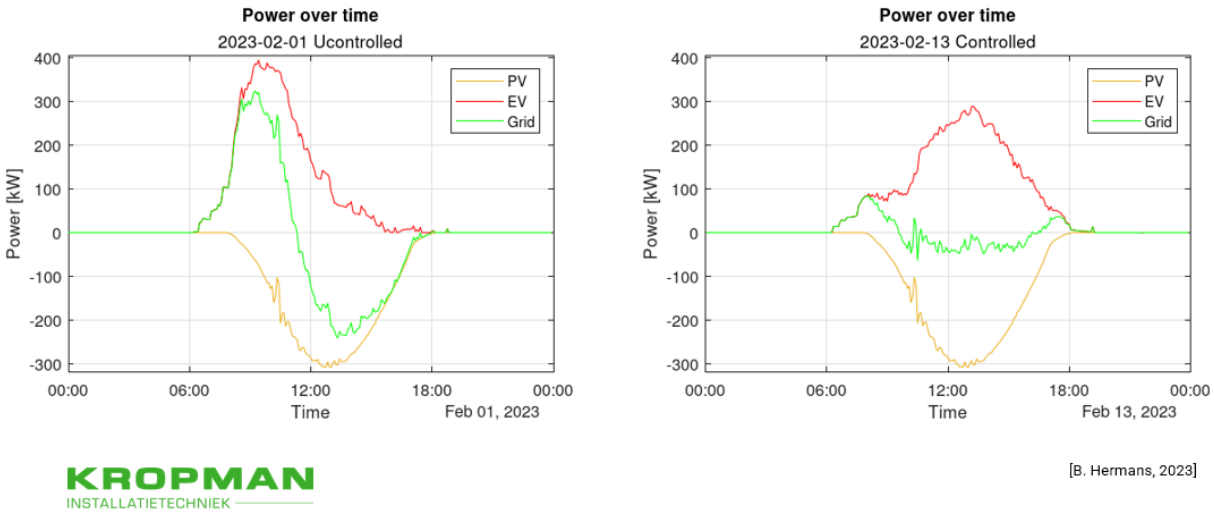


Figure 2.6 Validation results (large-scale study).

Along with the development of these concepts, significant efforts were made in software development to create digital tools that enable real-time monitoring, predictive analytics, and automated energy management. Developing near precise forecasting methods (see Figure 2.8) for various types of buildings and control systems, as well as for emerging energy loads such as EV chargers, solar power systems, and electrical grid connections, is essential for effective energy management. This forecasting service within InsiteView enables the use of not only machine learning but also other prediction mechanisms. By utilizing these capabilities and the use of more complex models (black box, white box or mixed), the platform provides more accurate predictions for load management with Model Predictive Control (MPC), fault detection and diagnostics (Kramer et al, 2025), temperature and comfort control and many more real-life applications. These software solutions are designed to facilitate seamless integration with existing energy infrastructures.

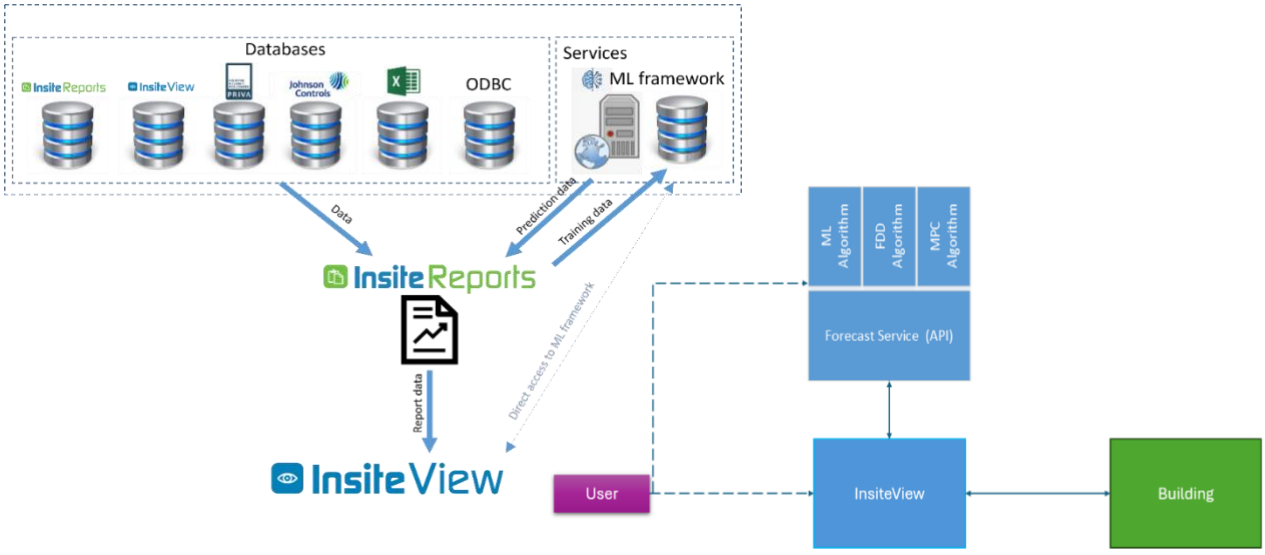


Figure 2.7 Modular attachment of different services with InsiteView.

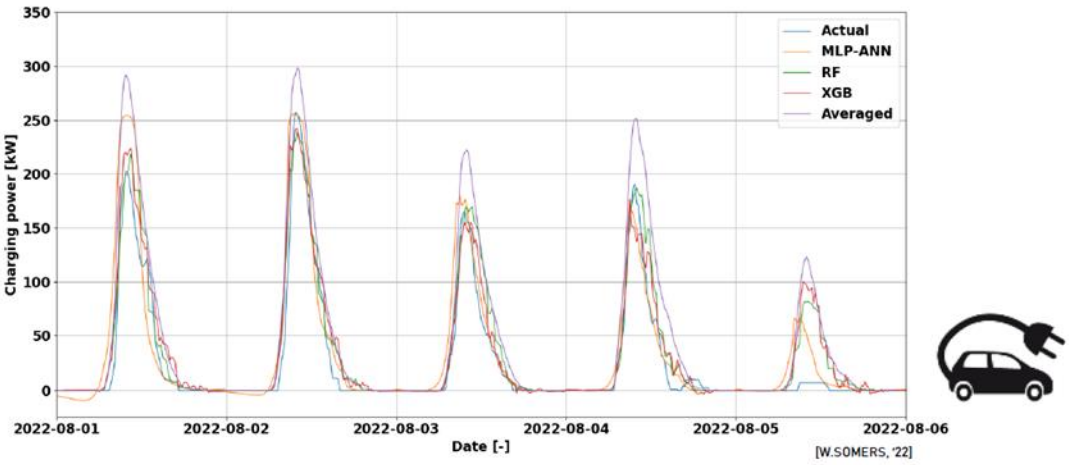


Figure 2.8 Machine Learning predictions of large-scale EV charging system (the figure shows a comparison of different ML algorithms).

Implementation of the developed MPC-methods requires also additional hardware. Therefore, enhancement of building management systems (BMS) hardware was a crucial part of the process. Existing BMS platforms were upgraded to incorporate demand-side management functionalities. This involved integrating smart sensors, IoT devices, and automation technologies to optimize energy distribution, ensure grid compliance, and improve overall operational efficiency.

Figure 2.9 Integration with SCADA system.

In addition to these developments, InsiteSuite (https://insitesuite.nl/) provides the capability of white-labelling and rebranding for third party customers. This white-labelling process allows establishing a distinct, standalone interface tailored to the specific needs of its clients. During Brains4Buildings activities white labelling was also performed to provide the software solution to other parties. This strategic adaptation not only strengthens InsiteSuite's technological foundation but also improves its ability to deliver scalable and innovative energy solutions. Thereby the expansion is scalable and does not stay only within Kropman.

The customized, white-labelled interfaces ensure seamless integration with InsiteSuite's solutions while providing clients with a user-friendly, intuitive dashboard for monitoring and controlling their energy consumption effectively. By combining these advancements, InsiteSuite is well-positioned to offer innovative, scalable solutions that support businesses in overcoming grid congestion challenges and achieving their sustainability objectives.

3 COMMERCIAL IMPLEMENTATION

Authors: David Fortini, Bart Lelij (O-Nexus)

3.1 Introduction

The ambition of O-Nexus is to reduce CO_2 emissions by 30% in SME buildings. This can be achieved by loading energy buffers at specific moments. For example, with clean and cheap PV or clean electricity from EPEX. Reduced cost for energy and compliance with CO_2 targets are incentives for implementation of thermal energy buffers with smart steering.

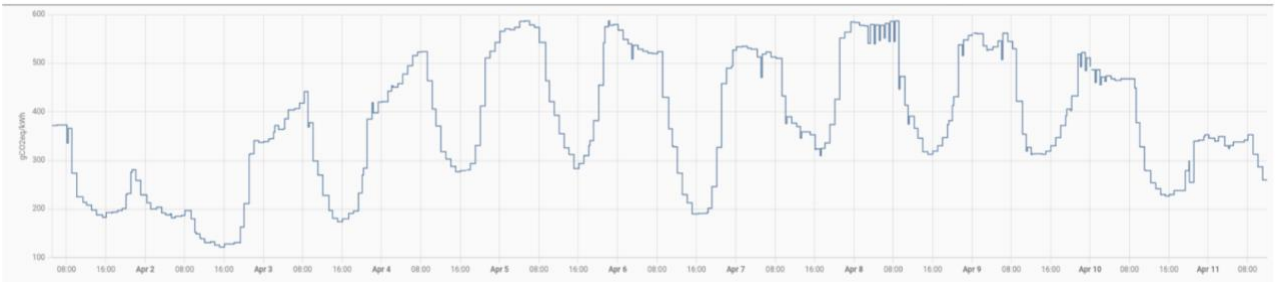


Figure 3.1 The CO2 footprint from the grid (g_CO2/kWh) varies between 100-600 g_CO2/kWh. Loading the buffer with green grid-power leads to significant improvements. Reference: CO2SIGNAL or CO2monitor (URL provided in Chapter 5).

Network congestion is leading to delays when building new facilities, and higher contractual costs for bigger network connections. Dynamic network tariffs and decreased waiting time for reduced network capacity requests can be achieved by implementing thermal buffers with smart steering algorithms.

Besides the development of the technology and steering algorithms, it is also essential that building regulation values energy storage and flex capabilities. The Dutch government stated (van Gastel, 2025) that electrical and thermal storage will be valued and integrated in NTA8800 by May 2026.

Aalberts Industries (also known as Flamco) introduced a Phase Change Material (PCM P49) buffer for industrial purposes: The Central Bank. The heat that is stored in the buffer (±60 kWh_th), is generated with a conventional heat pump with a supply temperature up to 54 °C. The O-Nexus steering algorithm takes care of efficient steering of the heat-production. In the B4B context, O-Nexus investigated the application of the Central Bank in SME buildings.

For the technical development of the steering algorithms O-Nexus also used the Flamco FlexTherm. This is a smaller thermal buffer (3-6-9-12 kWh_th) heated by a resistor. In this report we also give reference to this product.

Figure 3.2 Typical SME-size buildings that could benefit from a thermal buffer and smart steering.

3.2 The technical principle

The short, high-level explanation of the concept is as follows:

- The thermal buffer is filled when relatively cheap, clean energy is available.
- The heat source can be either a resistor (Flamco FlexTherm) or heat pump (Flamco Central Bank).

- The FlexTherm resistor can be gradually dimmed with a Solid-State Relay. This enables us to increase self-use of PV-production close to 100% when the PV-power varies between 0 and 3000W and as long as the buffer is not full.
- The Central Bank + heat pump has limited possibilities to dim the power by changing the setpoint of the supply-temperature causing a modulation of the compressor in a few steps from 800-1000-2.500-3.500 W_electric.

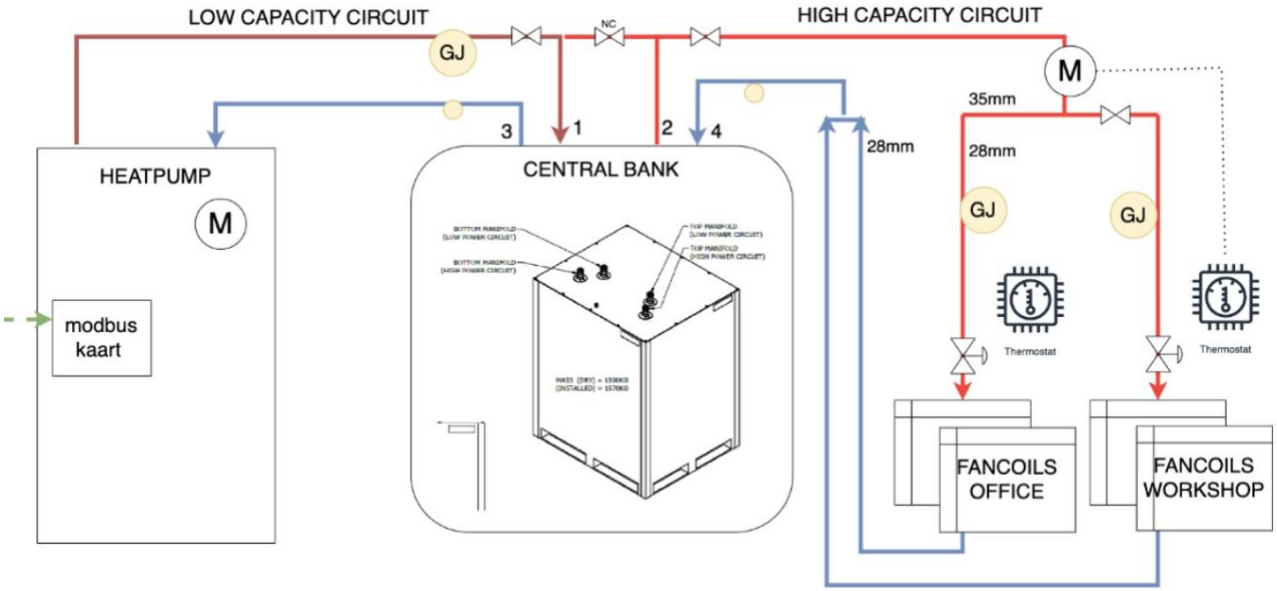


Figure 3.3 Principle of the Central Bank concept in the middle the Thermal Buffer. Left side is the production circuit: the heat pump is activated by the O-Nexus algorithm and produces heat when there is PV surplus (grid-export) or favourable grid conditions. The right side is the distribution circuit: this is physically separated from the production circuit.

Figure 3.4 Test location at The Green Village with Central Bank, fancoils for distribution and Comap thermostats.

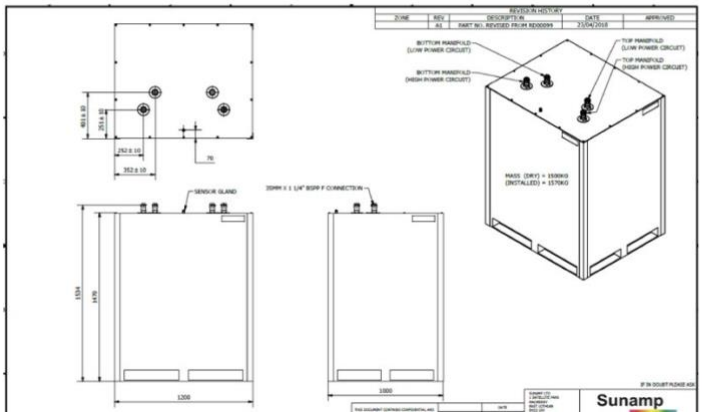
The Central Bank PCM buffer

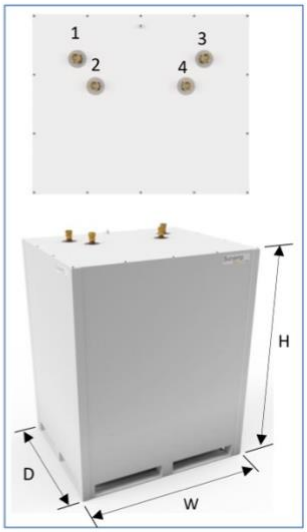
The Central Bank is designed for storing heat and for decoupling the heat source from heating demands and is supplied with PCM to suit the operating temperatures of the heat source and heat emitters/absorbers. Typical applications are:

- Replacement hot water thermal storage and buffer vessels used in buildings for buffering heat and/or for decoupling heat sources from the heating demands (e.g. heat pump & CHP based heating systems).
- Shifting the heating loads in a building to cheaper off-peak tariffs (e.g. for heat pump-based heating systems) and for demand side management.
- Reducing pre-heat time required in building, i.e. rapid warming of heat emitters leading to higher customer satisfaction.

Integration of multiple heat sources operating at different times and/or at different temperatures and for integrating solar thermal and solar PV systems with existing heating plant.

Overall dimensions (mm)	Width (W) x Depth (D) x Height (H)	1200 x 1000 x 1470mm
Connection	1. Top Manifold (HPC) 2. Top Manifold (LPC) 3. Bottom Manifold (HPC) 4. Bottom Manifold (LPC)	1-1/4" BSP Parallel Female 1-1/4" BSP Parallel Female 1-1/4" BSP Parallel Female 1-1/4" BSP Parallel Female
Pressure loss characteristics (See table 3)	Low power circuit (LPC) High power circuit (HPC) Low & High-power circuits connected in parallel	K_V - LPC = 8.0 K_V - HPC = 13.0 K_V – (Combined) = 21





		UniQ Heat 80 – SU58 Standard	UniQ Heat 80 – SU88 Special order	UniQ Heat 80 – SU118 Special order
Weight – Unit Weight – Installed [1]	kg kg	1,500 1,570	2,100 2,170	1,510 1,580
Heat source temperature ▪ Maximum flow temperature, T1 ▪ Minimum flow temperature for charging, T1 ▪ Minimum return temperature for charging, T2	°C	 80 65 65	 110 95 90	 140 125 125
Heating load temperature ▪ Maximum flow temperature – Transient, T3 ▪ Design flow temperature, T3 ▪ Maximum return temperature for discharging, T4	°C	 = T1 53 – 55 50	 = T1 80 – 82 80	 = T1 110 – 115 100
Minimum flow rates for efficient charging & discharging – Depends upon application ▪ Low power circuit (LPC) ▪ High power circuit (HPC)	L/s [m^3/h]	 0.25 [0.9] 0.35 [1.25]	 0.25 [0.9] 0.35 [1.25]	 0.25 [0.9] 0.35 [1.25]
Nominal storage capacity [2]	kWh	90	80	105
Heat loss rate [3]	W kWh/24h	127 3.0		
Maximum working pressure ▪ Low and high power circuits (LPC & HPC)	MPa [bar]	 1.6 [16]	 1.6 [16]	 1.6 [16]

Figure 3.5 Details of the Central Bank buffer.

3.3 Concepts for implementation

The implementation of the collective thermal PCM buffer required an approach of several steps:

Step #1 was the Proof of Concept (PoC) that we tested at The Green Village in Delft. This project ended in February 2025 and the main objectives were met: basic understanding of the system that combines heat production (Daikin heat pump), heat storge (Flamco Central Bank), heat distribution (Daikin fancoils), and the steering by O-Nexus triggered by forecasting of the heat demand, grid export to the grid (including 24h forecast), and dynamic tariffs (published 24h upfront).

Step #2 is moving the PoC to the TBI Training Centre in Amsterdam. The purpose of this setup is to do validation of the system and further checks for robustness of the algorithms.

Step #3 obviously follows step #2 and would be a pilot project. The results of step #2 need to be evaluated and boundary conditions need to be detailed. The concept below is discussed with various corporations and at least one (De Alliantie) stated that they would consider participation.

Below the description of the pilot-project:

Figure 3.6 Concept for all renovation from collective gas to all electric heating.

Renovation of small collective gas-fired heating system to all electric

The energy transition requires a significant change in behavior and applied technologies. The innovative application that O-Nexus is presenting here is part of the heat transition and focuses on providing a solution to the problems encountered when implementing collective heating, particularly in the renovation of a gas-based system to all-electric.

The innovation we are introducing now is a combination of two new technologies:

The first technology is a compact thermal (PCM) buffer that Flamco/Aalberts Industries recently introduced to the Dutch market. The thermal buffer, which has a capacity of 60 kWh per module, is heated by a conventional Daikin heat pump. The second innovation is the Home Energy Management System (HEMS) that O-Nexus has been offering since last year for use in homes and small SMEs (small and medium-sized enterprises).

What is the principle?

Thanks to the thermal buffer, the production and use of heat by the residents can be decoupled. This allows the HEMS to choose the optimal time for energy use and heat production. For example, when there is surplus clean, self-generated solar energy (PV) or low-cost dynamic (EPEX) energy tariffs, or when the PEF (primary energy factor, i.e., the average energy index) or the g_CO2/kWh of electricity from the grid is the lowest. The HEMS also ensures that the electric power used by the heat pump is limited if local grid congestion occurs.

What problem does your idea solve?

This system solves several problems:

- Energy costs decrease because the cheapest consumption time is chosen.
- The PEF decreases because a 24-hour forecast is used. This data and prediction are provided through a collaboration with NetAnders (part of Tennet/Gasunie). This project would serve as validation for a use case of NetAnders.
- Because O-Nexus will soon be connected with congestion services from the grid operators, potential congestion that may arise when neighborhoods switch from gas to electric heating will be counteracted. O-Nexus is involved in the innovation tables of Stedin and Liander.
- Additional benefit: the buffer helps during short-term service interruptions or other disruptions to the heat supply.

To which of our ambitions does this idea contribute?

We believe this solution contributes to several ambitions within the B4B project scope:

- Reducing energy poverty by using the lowest energy tariffs of the day.
- Reducing CO_2 and align with PEF targets. For 2023, this PEF is 1.31. With our system, the PEF for homes is expected to be significantly lower.
- Reducing or preventing grid congestion. This is a problem for the grid operators, with a societal cost. It can also delay the desired heat transition, as grid congestion may prevent timely delivery of an upgraded electrical connection.
- A reliable and robust collective (district) heating supply.

What is the desired result?

The ideal test location is a (renovation) project with district heating, where both energy costs and congestion are an issue. Additionally, the number of homes is limited to 10-20 to minimize project costs and reduce risks, including aspects such as resident communication.

Project specifications:

- A complex with district heating for 10 to 20 apartments.
- Renovation from gas to all-electric heating.
- Social housing.
- Not perfectly insulated. Label B. Due to the relatively high energy costs, the benefits of energy control are significantly larger. In other words, cheap energy is more important the more you use it.

Desired results:

- An all-electric collective heating system.
- A compact thermal storage of around 120-180 kWh (to be determined) based on the Flamco Central Bank.
- Domestic Hot Water (DHW) is produced with the compact Flamco FlexTherm.
- Residents notice nothing of the buffer or the control.
- Energy costs and PEF are significantly reduced.
- The results in reduced costs and improved energy and CO_2 performance can be demonstrated with data. The measurement period should therefore last at least two winters.
- After the trial, the installation remains in operation. Note: the lifespan of a PCM buffer is approximately 20,000-30,000 cycles.

3.4 Commercial uptake and utilization of results from B4B

The participation of O-Nexus in the B4B project enabled us to find the opportunity of PCM-buffering. When we approached Flamco and asked for possible cooperation and co-development, the test location at The Green Village and the B4B framework helped us to get started.

Today we have a partnership with Flamco and Comfort Partners. Our mutual customer, De Alliantie, is looking forward to seeing positive test results and a robust validation of the efficiency of the PoC at the TBI training center in Amsterdam.

3.5 Discussion

Some issues are still open for discussion and further development:

Future business case

The business case has three drivers: energy optimization, increased grid tariffs and availability of (new or expanded) grid connections.

- Energy optimization in this B4B context is based on Time of Use tariffs. In the near future there will probably be increased energy prices and more volatile ToU tariffs caused by influx of 'uncontrolled' renewable electricity.
- Dutch grid operators implement new contract forms in order to encourage smart use of the available grid capacity.

- In the Netherlands the net congestion is delaying projects because of waiting time for new grid-connections or upgrade of capacity for existing connections (convert from gas to electricity).

Besides that, taxes, geopolitics and regulation from EU and individual countries will change over time. There are many uncertainties that make it difficult to make an exact calculation but the general idea that prices of CO_2 and energy will rise and using buffers and flexibility will help to limit future energy cost.

Legislation

In the actual building regulations (NEN or NTA8800) there is no method to value efforts of buffering heat or energy. The benefits are described in this project: lower energy cost and CO_2, less grid-impact. Quick adoption of these aspects in NTA8800 would accelerate further innovation and implementation of flex-methods in the built environment.

License models versus project investment

Other than the bigger commercial and industrial buildings, there is no strong tradition or need to have extensive service contracts for residential homes and SME buildings. The preference is to have all investments in a one-off project and after hand it over to the owner who takes care of his own assets.

In the future, there will be a stronger relation between assets (heat pump, buffer, batteries), the energy market (to buy energy_kWh and grid capacity_W), and near real-time information about grid-situation, inbalance markets, etc.

The role of an integrator, or energy service company (ESCO), or service provider such as O-Nexus, is not commonly accepted yet and it takes time to show the asset owners the added value of these integrators.

3.6 Conclusions

- The base principle and technical possibilities for forecasting energy demand and steering thermal buffers are demonstrated.
- The steering protocol works on a basic level but it needs further optimization. For example: include ambient temperature forecast in the forecasting model.
- The business case has multiple layers such as saving energy cost, limiting grid congestion, improving CO2 footprint. The financial details must be validated in the pilot at TBI and demonstration projects.

4 CONCLUSIONS

We summarise the conclusions of this report in terms of each chapter.

4.1 InsiteSuite: corporate expansion (by Kropman)

As part of their activities within Task 2.4b, Kropman expanded the development of its InsiteSuite Supervisory Control and Data Acquisition (SCADA) system, that offers in-house and third-party solutions designed to help large-scale organizations and commercial buildings navigate the complexities of the energy transition. An overview of the two main components of its product, InsiteReports and InsiteView, was provided.

In particular, InsiteView has the capability of modular integration of applications such as predictive analytics and model-based controls (such as MPC). By leveraging optimization techniques (partly developed within B4B), it enables efficient energy management and operational improvements across various building systems. With predictive capabilities (partly developed within B4B), InsiteView helps anticipate changes in energy demand and system performance, ensuring proactive adjustments.

In order to demonstrate the integration of new functionalities developed via the B4B project, Kropman has successfully implemented small- and large-scale smart EV charging solutions, that are now fully operational at one of Kropman's office buildings and one InsiteSuite client. This deployment has enabled efficient management of the charging of a significant number of electric vehicles while optimizing energy usage and minimizing strain on the grid. By using intelligent algorithms (partly developed within B4B) and real-time data, the system dynamically adjusts charging schedules based on electricity demand, availability of renewable energy, and grid capacity. As a result, it was able to reduce peak energy consumption, actively control energy demand, create a better net load profile, lower operational costs, and contribute to a more sustainable and resilient energy infrastructure. This successful implementation served as a key milestone for InsiteSuite, demonstrating the effectiveness of its modular solutions and paving the way for further large-scale adoption.

Along with the further development of the InsiteSuite product, significant efforts were made by Kropman (supported by other consortium partners) in software development to create digital tools that enable real-time monitoring, predictive analytics, and automated energy management. Developing near precise forecasting methods for various types of buildings and control systems, as well as for emerging energy loads such as EV chargers, solar power systems, and electrical grid connections, is essential for effective energy management. This forecasting service developed within InsiteView enables the use of not only machine learning but also other prediction mechanisms. By utilizing these capabilities and the use of more complex models (black box, white box or mixed), the platform provides more accurate predictions for load management with Model Predictive Control (MPC), fault detection and diagnostics, temperature and comfort control and many more real-life applications. These software solutions were developed and designed to facilitate seamless integration with existing energy infrastructures.

Additionally, the enhancement of building management systems (BMS) hardware was a crucial part of the development and functional integration process carried out by Kropman. Existing BMS platforms were upgraded to incorporate demand-side management functionalities. This involved integrating smart sensors, IoT devices, and automation technologies to optimize energy distribution, ensure grid compliance, and improve overall operational efficiency.

4.2 Commercial implementation (by O-Nexus)

The participation of O-Nexus in Task 2.4b enabled them to find an opportunity to develop, investigate, and implement PCM thermal-buffering as an energy management solution in SME buildings. They approached Flamco/Aalberts Industries (manufacturer of thermal buffer and distribution systems) for cooperation and co-development. The test location at The Green Village and the B4B project helped them to get started.

To support the heat transition, O-Nexus developed steering algorithms in an innovative Home Energy Management System application that uses the Flamco FlexTherm and solves the problems encountered when implementing collective heating, particularly in the renovation of a gas-based system to all-electric.

They have demonstrated the basic principle (Proof of Concept) and technical possibilities for steering thermal buffers in The Green Village, and developed a partnership with Flamco and Comfort Partners. The next step for them is the validation of the system at the TBI training center in Amsterdam. This will be followed by a larger scale demonstration in a housing project.

Looking ahead, the business case for O-Nexus of the achieved results has multiple layers such as saving energy cost, limiting grid congestion, improving CO_2 footprint. The financial details must be validated in the pilot at TBI and other demonstration projects.

5 REFERENCES

Chamari, L., Walker, S., Petrova, E., Pauwels, P. (2025). Energy Demand Optimisation in PV- and EV-Integrated Buildings: A Supervisory Controller Based on MPC. Preprint without peer review available at *SSRN*: http://dx.doi.org/10.2139/ssrn.5238682

Hermans, B.A.L.M., Walker, S., Ludlage, J.H.A., Özkan, L. (2024). Model predictive control of vehicle charging stations in grid-connected microgrids: An implementation study. *Applied Energy*, Volume 368, 15 August 2024, 123210, https://doi.org/10.1016/j.apenergy.2024.123210

in 't Veld, R. (2023). Reshaping EV load profiles at an office by adopting smart charging strategies. *MSc thesis*, Eindhoven University of Technology, https://brains4buildings.org/wp-content/uploads/2023/06/202305-TUe-Master-Thesis-Roeland-in-t-Veld-Final-version.pdf

Khan, W., Somers, W., Walker, S., de Bont, K., Van der Velden, J., Zeiler, W. (2023). Comparison of electric vehicle load forecasting across different spatial levels with incorporated uncertainty estimation. *Energy*, Volume 283, 129213, https://doi.org/10.1016/j.energy.2023.129213

Kramer, R.P., Walker, S. (2025). Automatische Fout Detectie en Diagnose binnen bereik? *TVVL Magazine*, nr. 02, april 2025, pagina 12-17. https://tvvl.nl/kennisbank/tvvl-magazine-2-2025/

Reinders, K.J.H. (2022). Model Predictive Controller for a Battery Energy Storage System to reshape the energy demand curve of an office. *MSc thesis*, Eindhoven University of Technology, https://brains4buildings.org/wp-content/uploads/2023/01/202210-TUe-Model-Predictive-Controller-for-a-Battery-Energy-Storage-System-to-reshape-the-energy-demand-curve-of-an-office.pdf

Somers, W.P.A. (2023). Effects of data-driven forecasting models on controlling energy management systems. *MSc thesis*, Eindhoven University of Technology, https://brains4buildings.org/wp-content/uploads/2023/06/20230413-TUeMaster_Thesis_Somers_Ward.pdf

van Gastel, E. (2025). Thuisbatterijen volgend jaar opgenomen in norm energieprestatie nieuwbouw. *Solar Storage Magazine*, 27 maart 2025, https://solarmagazine.nl/nieuws-zonne-energie/i40103/thuisbatterijen-volgend-jaar-opgenomen-in-norm-energieprestatie-nieuwbouw.

CO_2-footprint data from the grid: https://co2monitor.nl/co2emissiefactor/terugblik or https://docs.co2signal.com/#introduction