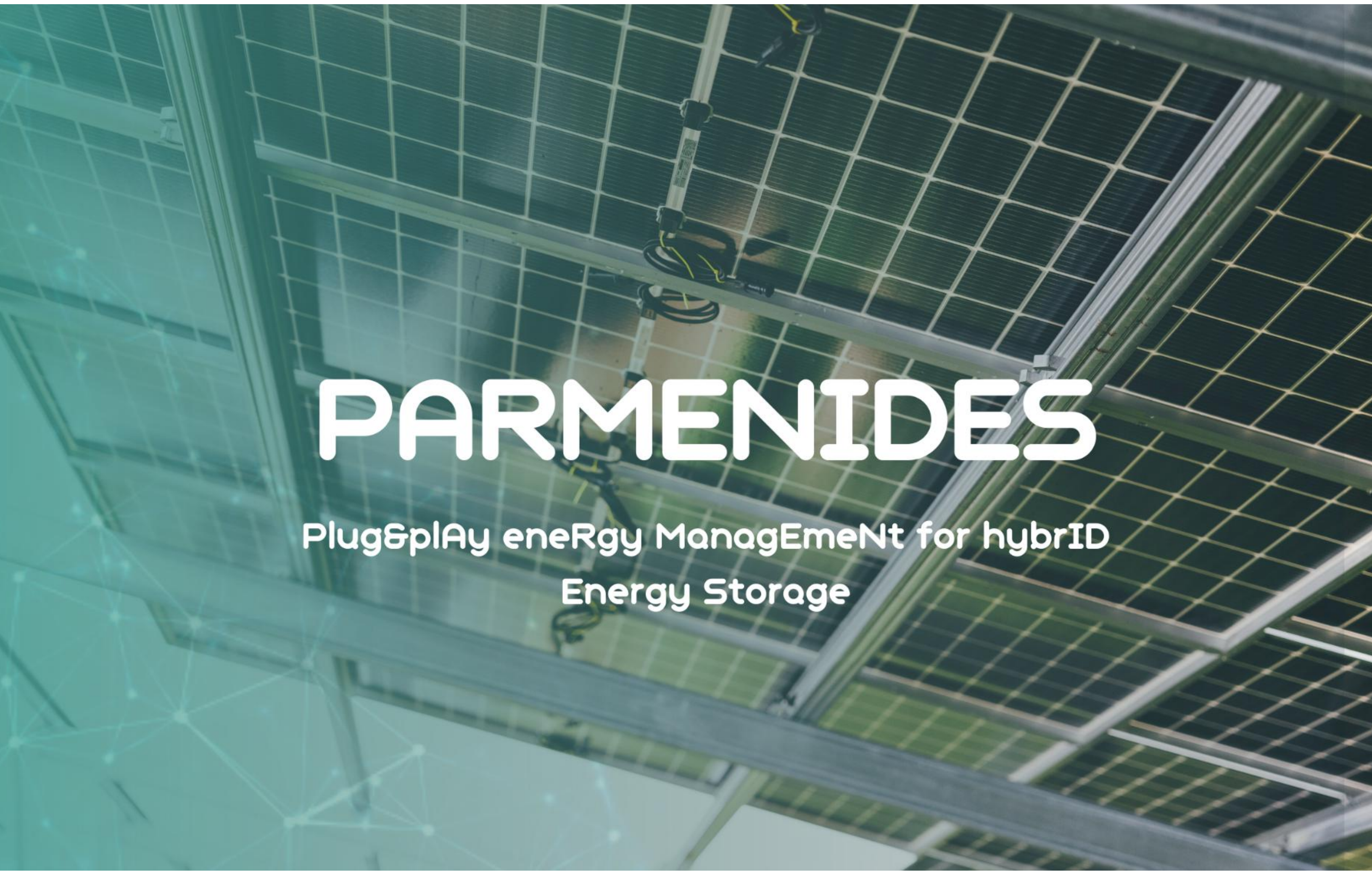

Deliverable D5.4

Dashboard evaluation & user acceptance: results and recommendations

Work Package 5

Disclaimer

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Executive summary

These deliverable reports the evaluation of the dashboards developed and deployed within the PARMENIDES project, with a focus on user acceptance, interpretability, behavioural response, and design effectiveness. The evaluation covers two complementary pilot contexts: a public-facing dashboard deployed in the Austrian pilot (Gasen) and a user-facing, interactive dashboard evaluated through structured tests in the Swedish pilot (KTH).

The Austrian pilot dashboard was designed as a public communication and engagement artefact, aimed at making Energy Community outcomes visible and meaningful to citizens and visitors. Evaluation results show high levels of acceptance, trust, and emotional engagement. Visual metaphors, narrative explanations, and the public placement of the screen were identified as key success factors in supporting

awareness, collective pride, and social legitimacy. The live deployment of the dashboard confirmed that the design logic remains robust under real-time data fluctuations, reinforcing credibility and public trust. Limitations mainly concerned information density and the absence of deeper interaction for advanced users, indicating opportunities for progressive disclosure and layered content.

The Swedish pilot dashboard was designed to support operational understanding, comfort–energy trade-offs, and informed decision-making for building occupants and facility managers. User testing results demonstrate strong perceived usefulness, particularly when comfort indicators were explicitly visualised alongside energy and emissions data. Users reported increased trust when system behaviour was transparent and when comfort was not perceived as being compromised. Potential friction points mainly concerned the interpretation of complex charts, highlighting the need for contextual guidance and onboarding support.

A cross-pilot synthesis shows that dashboard effectiveness depends not only on data accuracy, but on the ability to translate technical information into meaningful, actionable insights adapted to context and audience. Public dashboards are most effective when they reinforce social norms and collective identity, while operational dashboards are most effective when they support trade-off understanding and decision confidence and users-in-the-loop sustainability. Together, the Austrian and Swedish pilots demonstrate a replicable, human-centred approach to dashboard design that supports the adoption and acceptance of Energy Community solutions.

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Table of contents

1. Introduction

1.1.1 Purpose of the Deliverable

This deliverable reports on the evaluation and user acceptance of the dashboards developed in the PARMENIDES project. The objective is to assess how effectively the dashboards support understanding, trust, engagement, and decision-making across different user groups and deployment contexts, and to derive actionable recommendations for refinement and replication.

The deliverable covers two pilot deployments:

- **Austrian pilot (Gasen):** public-facing dashboard for citizen awareness and community engagement
- **Swedish pilot (KTH):** user-facing dashboard tested through structured user evaluations with building occupants and managers

1.1.2 Evaluation Scope

The evaluation focuses on:

- Usability and readability
- Perceived usefulness and value
- Behavioural response and acceptance
- Identified friction points and improvement opportunities

2. Evaluation Framework and Methodology

2.1. Evaluation Dimensions

The dashboards were evaluated along five dimensions:

1. Clarity & readability
2. Comprehension
3. Perceived usefulness
4. Trust & emotional engagement
5. Adoption readiness

2.2. Methods

- Observational analysis conducted in the Pilots
- Semi-structured interviews with stakeholders
- Expert review by project partners
- Qualitative feedback from stakeholders (Austrian Pilot)
- A/B usability testing (Swedish Pilot)

2.3. Dashboard Concepts and Pilot-Specific Objectives

Due to differences in context, audience, and objectives, each pilot required a distinct dashboard design:

- **Austria:** awareness, education, legitimacy, and social visibility
- **Sweden:** operational understanding, comfort–energy trade-offs, and decision support

3. Austrian Pilot – Public Dashboard Evaluation

3.1. Deployment Context

The Austrian dashboard was installed on the exterior wall of the Gasen municipality building, located on a highly frequented public path (see Figure 1). The dashboard is visible to citizens and visitors and functions as a public communication artefact that makes Energy Community performance tangible in everyday space.

Figure 1 Exterior wall of the Gasen Municipality Building

3.2. Screen Set Overview (Austria)

The Austrian dashboard consists of the following screen categories (Figures 2 to 13):

- Energy ecosystem overview
- Electricity generation vs demand
- Electricity consumption breakdown
- Electricity generation breakdown
- Battery storage system status
- Weather-dependent system behaviour
- Community impact indicators (CO_2, self-sufficiency, self-consumption)

Each screen includes explanatory sections ("What does this mean?" / "Why does it matter?") to support non-expert interpretation and learning.

3.3. Screen-by-Screen Evaluation and Behavioural Interpretation (Austria)

3.3.1 Energy System Overview Screen – System Literacy and Collective Understanding

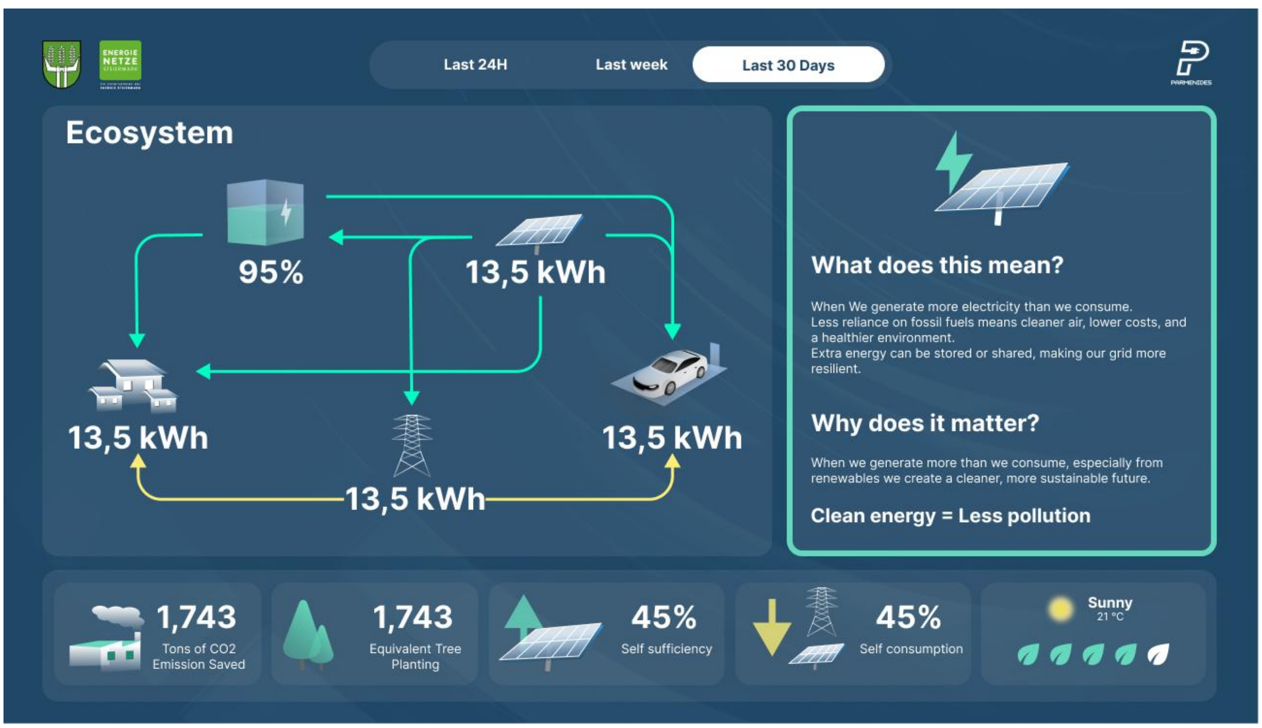

Figure 2 Energy System Overview

Screen objective. Visualise the local energy ecosystem and support holistic understanding of energy flows.

Explanation and interpretation. Arrows and animated flows make invisible energy processes visible, presenting the system as a loop rather than a linear chain. This supports mental model formation and reduces perceived complexity.

Evaluation results. Users were able to correctly describe system behaviour after short exposure. The screen was frequently used as an entry point for interpretation of other screens.

Behavioural effect. Supports system literacy, trust, and acceptance of collective energy solutions.

3.3.2 Electricity Generation vs Demand Screen – Self-Sufficiency and Performance Awareness

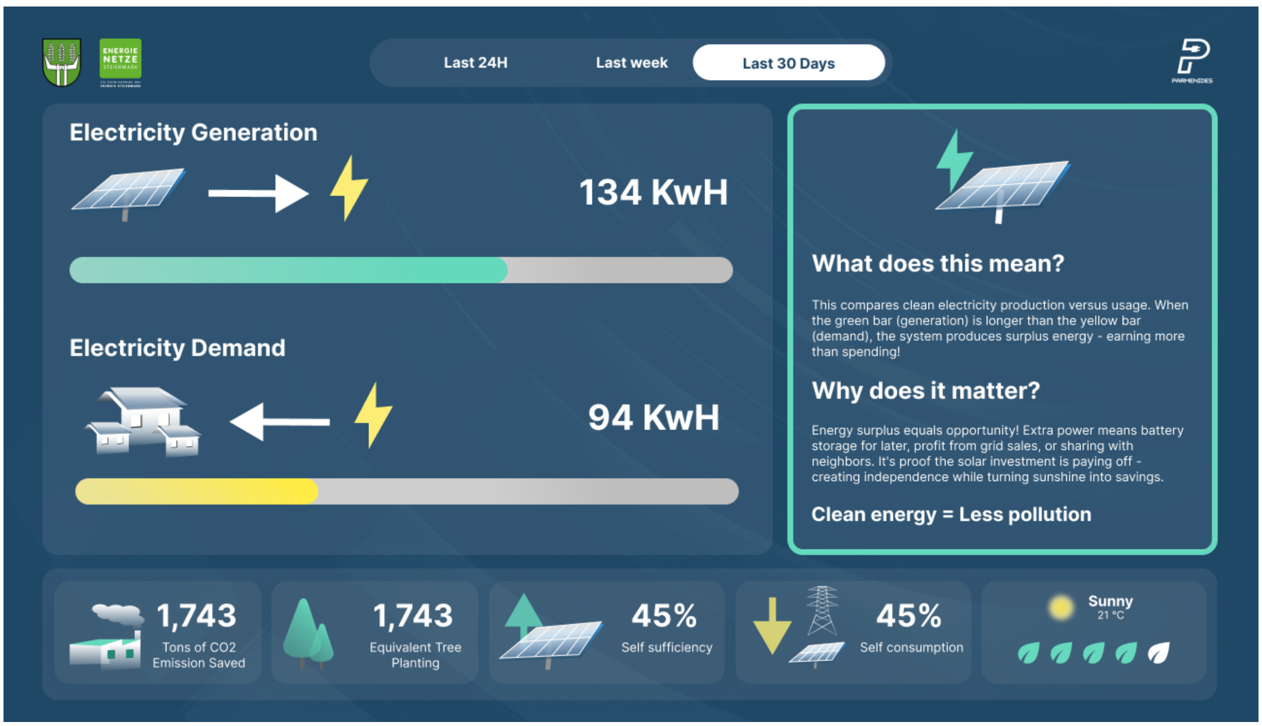

Figure 3 Electricity Production vs Demand Screen

Screen objective. Provide an immediate understanding of surplus vs deficit conditions at community level.

Explanation and interpretation. Visual bars compare renewable electricity production (134 kWh) with consumption (94 kWh). Explanatory panels link surplus to environmental and economic benefits.

Evaluation results. Users consistently understood surplus logic and associated it with positive community performance.

Behavioural effect. Reinforces positive feedback and collective efficacy.

3.3.3 Electricity Consumption Breakdown Screen – Source Awareness and Transparency

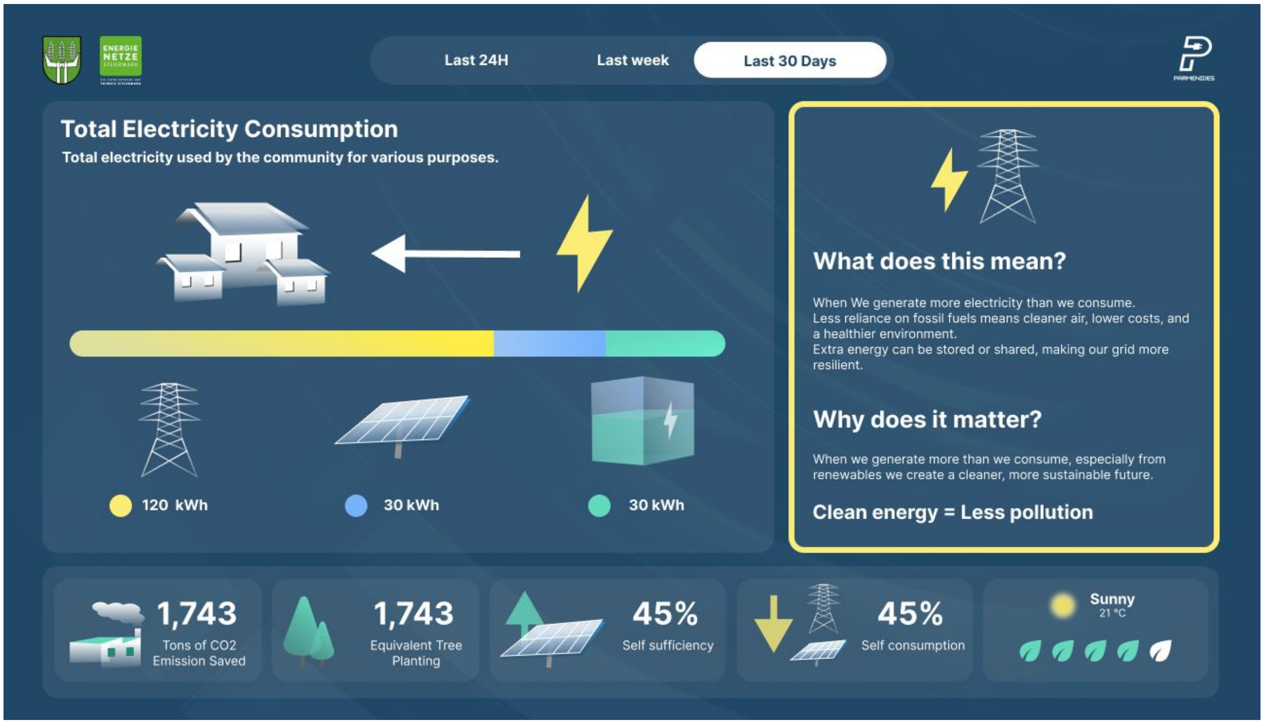

Figure 4 Electricity Consumption Breakdown Screen with Source Identification

Screen objective. Make the origin of electricity consumption visible.

Explanation and interpretation. Colour-coded bars show grid, PV, and storage contributions, supporting quick understanding of dependency.

Evaluation results. Users reported increased awareness and surprise when grid dependency was high.

Behavioural effect. Activates reflective awareness without inducing guilt.

3.3.4 Electricity Generation Breakdown Screen – Value Creation Visibility

Figure 5 Electricity Production Breakdown Screen with Value Creation

Screen objective. Show how locally produced electricity is used, stored, or exported.

Explanation and interpretation. Energy allocation is visualised as multiple value streams, reinforcing that generation creates benefits beyond self-use.

Evaluation results. Users perceived this as empowering and motivating.

Behavioural effect. Supports positive reinforcement and pride.

3.3.5 Battery Storage Screen – Reliability and System

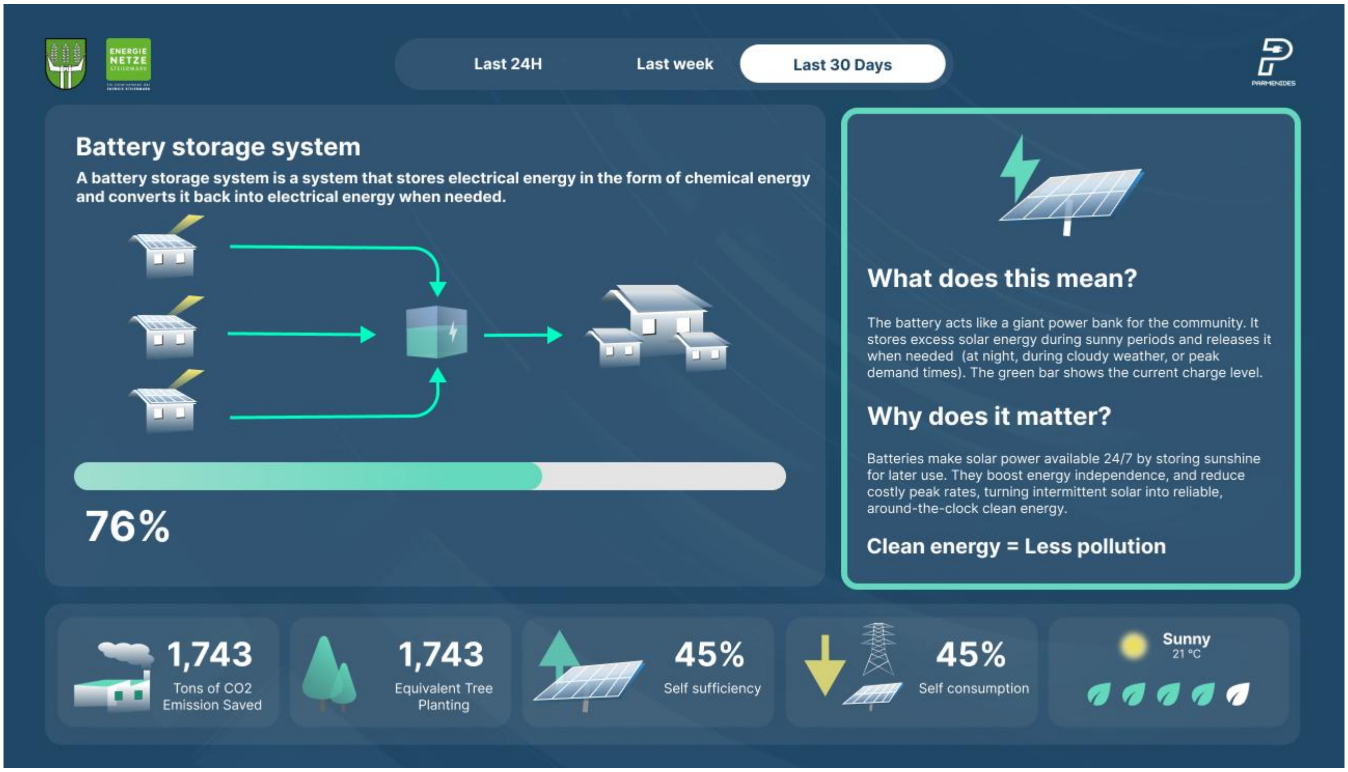

Figure 6 Battery Storage Screen

Screen objective. Explain the role of storage in balancing supply and demand.

Explanation and interpretation. The battery is framed as a community power bank, with a fill level indicating readiness.

Evaluation results. The metaphor was universally understood and reduced concerns about intermittency.

Behavioural effect. Builds trust and perceived reliability.

3.3.6 Weather-Dependent Behaviour Screen – Variability and Learning

Figure 7 Weather-Dependent Production Screen

Screen objective. Explain production variability through weather context.

Explanation and interpretation. Weather icons link natural conditions to energy outcomes.

Evaluation results. Users correctly attributed changes to weather rather than system failure.

Behavioural effect. Reduces misattribution and frustration.

3.3.7 Impact Indicators Screen – Boosting Community Energy Literacy

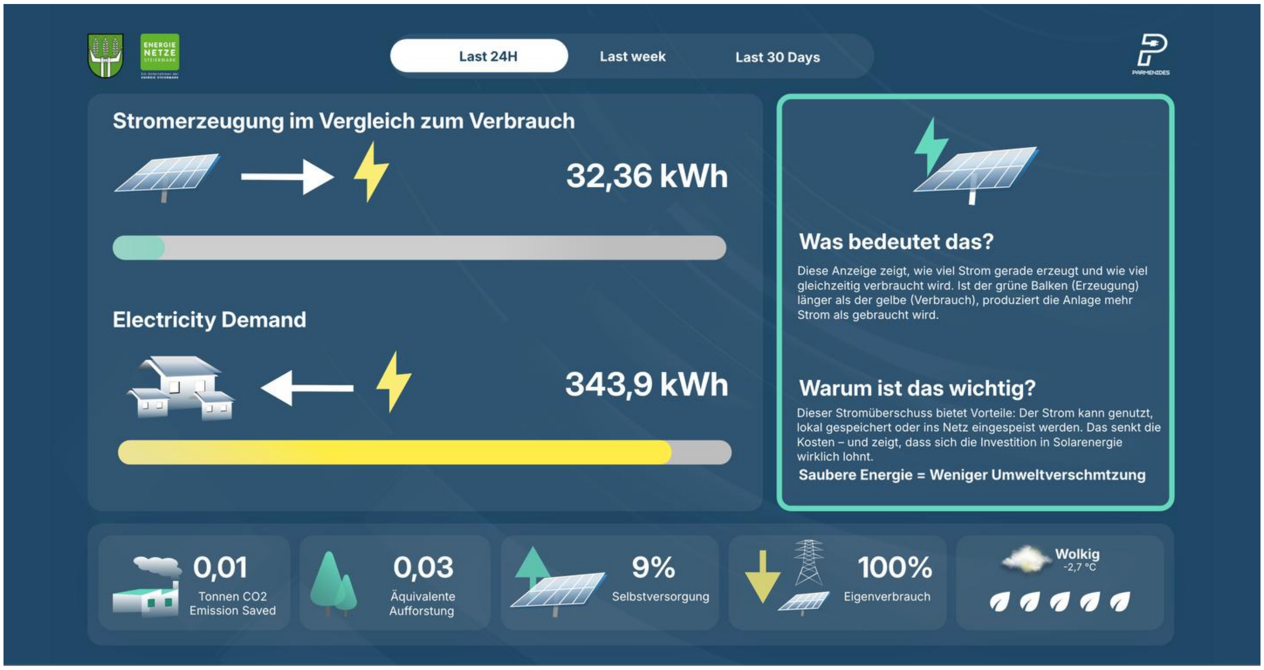

Figure 8 Comparison of Power Generation vs Consumption in the Community

This figure provides a comparison of power generation versus consumption over the last 24 hours, showing 32.36 kWh generated from solar energy against a demand of 343.9 kWh. The interface uses color-coded bars (green for generation and yellow for consumption) to show the balance; if the green bar were longer than the yellow, it would indicate a surplus that could be stored or sold back to the grid. Currently, the self-consumption rate is 100 %**,** meaning every bit of solar energy produced was used immediately by the community.

Screen objective. Translate abstract impact into tangible equivalents.

Explanation and interpretation. CO_2 savings and equivalent trees make impact relatable.

Evaluation results. Strong emotional engagement; frequently photographed and discussed.

Behavioural effect. Activates social norms, value, and learning.

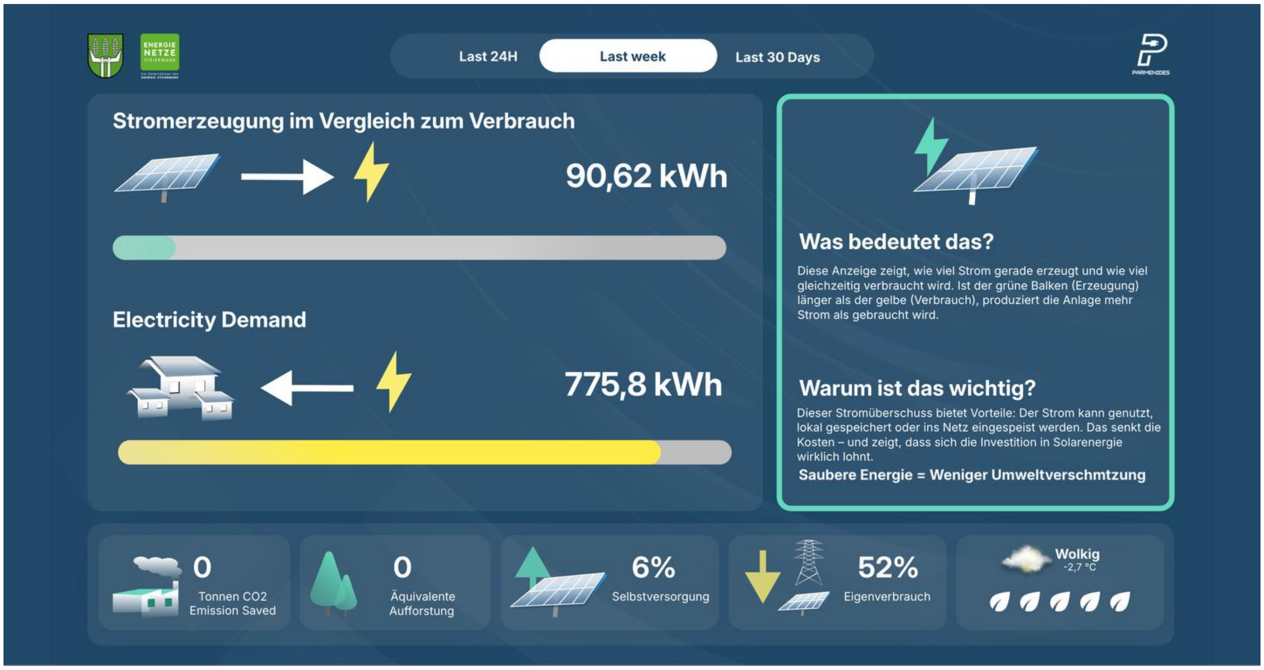

Figure 9 The Economic Value of Solar Investment

Like the previous figure, this displays generation versus consumption but for the last week, indicating 90.62 kWh of solar production and 775.8 kWh of electricity demand. The importance of this data is to demonstrate the economic value of solar investment; by using solar energy locally, the community reduces its overall energy costs. Over this week, the self-sufficiency rate was 6 %**,** and the self-consumption rate was 52 %**.**

Figure 10 Weather Impact

This figure focuses on the current weather conditions (Cloudy, -2.7°C) and explains that sunny days are essential for maximum efficiency and for fully charging the system's batteries. The text explains that sunny days are critical for the solar panels to reach maximum efficiency. These peak production hours are necessary to fully charge the batteries, which then compensate for periods like this one where production is low due to cloud cover.

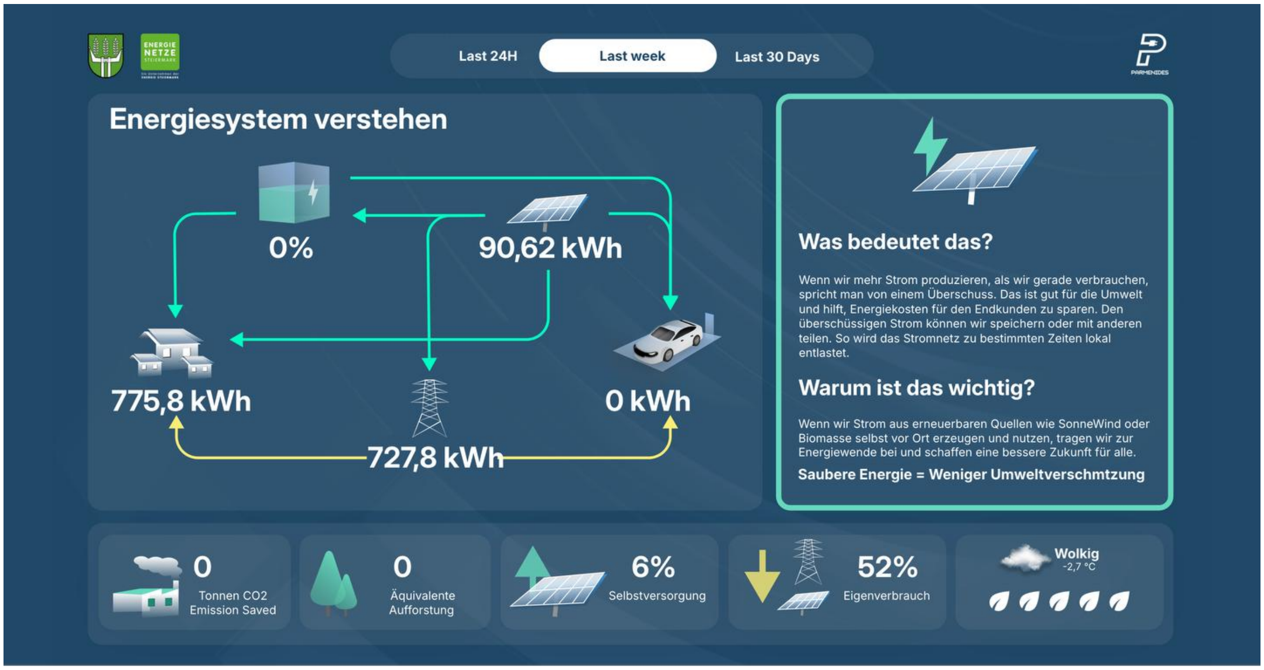

Figure 11 Understanding Energy System

Titled "Understanding the energy system," this figure provides a flowchart of energy movement between solar panels, the battery, the public grid, houses, and an electric vehicle, showing a total demand of 775.8 kWh for the last week. It tracks the movement of 90.62 kWh of solar energy as it is distributed between the battery (currently at 0 %), the houses, the public grid, and an electric vehicle (0 kWh used). It shows that the houses required 775.8 kWh in total, with 727.8 kWh being pulled from the public grid to make up the deficit. The goal of this system is to save energy costs for the end-user and relieve pressure on the public power grid.

Figure 12 The Energy Mix Consumed by the Community

This figure details the community's electricity consumption, using color-coded bars to distinguish between renewable energy (green/blue) and energy taken from the public grid (yellow). It visualizes the "Energy Mix" consumed by the community. It breaks down where the electricity came from: 326.6 kWh from the public grid (represented by a yellow icon) and 31.98 kWh from solar (blue icon), while the battery contributed nothing (0) in this period. The text emphasizes that choosing local renewable energy is like buying "regional food", it is sustainable and benefits the local region and climate.

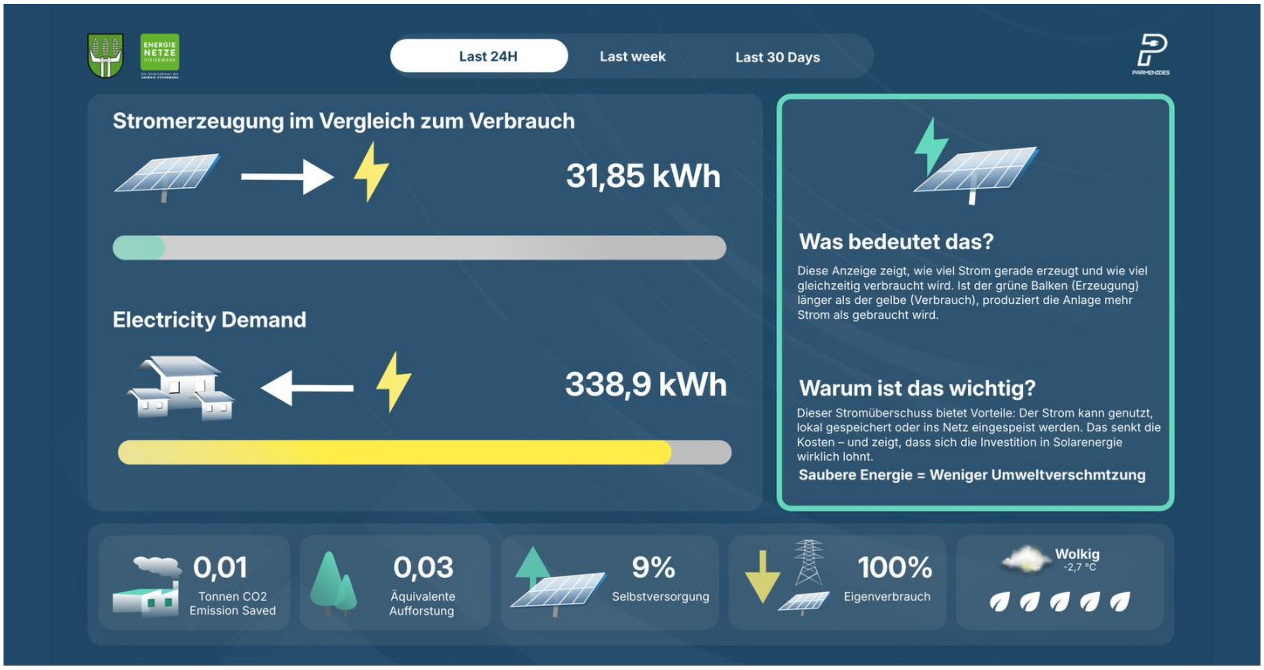

Figure 13 Environmental Impact

This figure shows another snapshot of the last 24 hours comparing solar generation (31.85 kWh) to electricity demand (338.9 kWh), emphasizing how surplus energy can be used locally or fed back into the grid. It reiterates that surplus energy provides a major advantage because it can be used locally or fed into the grid, which lowers costs and proves that the investment in solar energy is worthwhile. The bottom metrics show that this level of production resulted in 0.01 tons of CO_2 emissions saved and is equivalent to the environmental impact of 0.03 trees.

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3.4. Evaluation results

Following prototype evaluation, the dashboard was deployed as a live system aggregating real-time data from PV, consumption, storage, and grid exchange. The live screenshots confirm that the narrative structure and visual hierarchy remain robust under real-world variability.

3.4.1 Evaluation of Live Data Behaviour

- Users distinguish short-term fluctuations from long-term trends
- Explanatory panels prevent misinterpretation
- Real-time updates increase perceived credibility

3.4.2 Behavioural Effects of Real-Time Visibility

Live data strengthened the dashboard's role as a trusted public information source and triggered informal social discussion among citizens.

3.4.3 Robustness and Limitations

The live deployment highlighted the importance of contextual explanations, smoothing of extreme short-term fluctuations, and careful framing of performance vs status.

3.5. Summary of Austrian Pilot Findings

The Austrian dashboard successfully supports learning, awareness, trust, and social legitimacy. Its effectiveness relies on narrative framing, visual metaphors, and public visibility rather than technical depth.

4. Swedish Pilot – Dashboard Evaluation (KTH)

4.1. Pilot Context

The Swedish dashboard was tested with building occupants and facility managers to explore how it can support balancing comfort and energy use. It aims to gather feedback from occupants about their comfort levels and provide tools for flexible, ongoing comfort management, potentially as part of a "users-in-the-loop" approach to managing both demand and supply.

The testing sessions were aimed to gather feedback from end users (i.e., building occupants) about their thermal comfort in each moment of the day. Two slightly different interfaces were tested.

4.2. Screen-by-Screen Evaluation (Sweden)

4.2.1 Dashboards

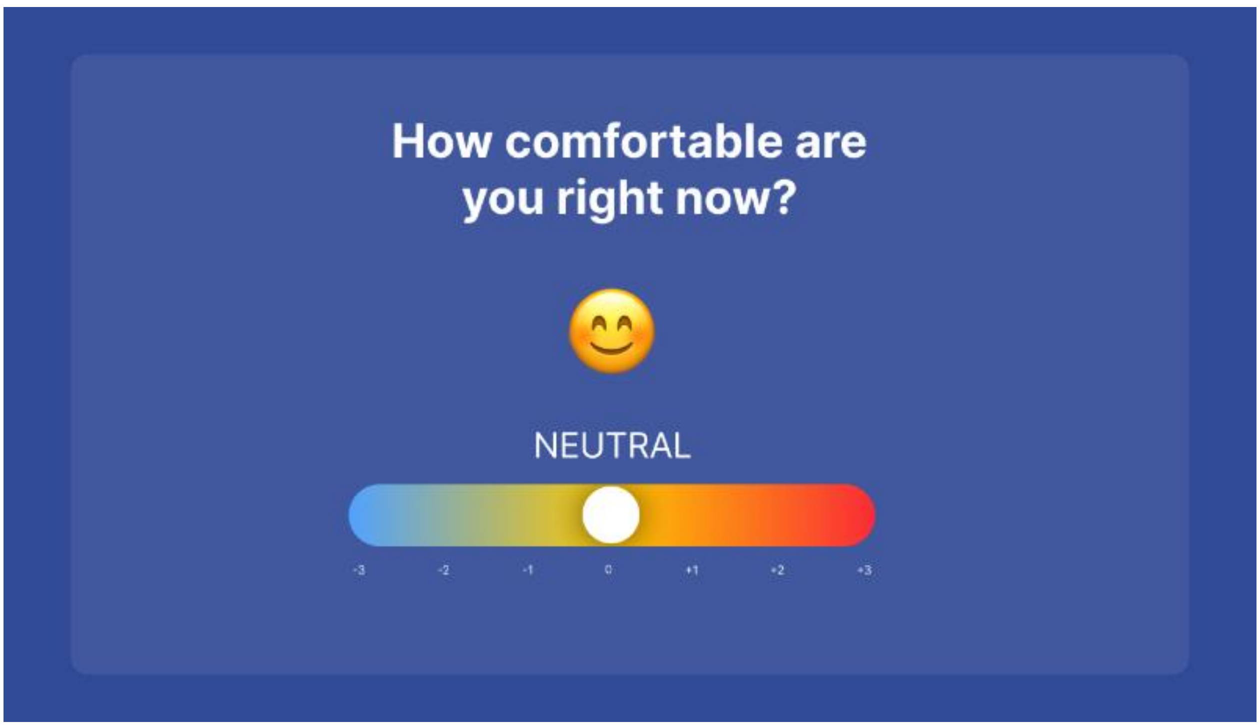

Figure 14 Comfort Perception and Assessment – Interface A

Figure 15 Comfort Perception and Assessment - Interface B

4.3. Methodology

Method: A/B testing.

4.3.1 Tasks:

The survey asked voluntary participants about their experience with two different interfaces (A and B) across 12 categories:

1. *Ease of Understanding*: How easy was it to understand the interface at first glance? (Very difficult, Somewhat difficult, Neutral, Somewhat easy, Very easy, No answer)

- This question aimed to gauge the initial impression of the interface's clarity and accessibility.

2. *First Feeling*: What was the initial feeling when users saw the interface? (Confident, Curious, Neutral, Confused/Overwhelmed)

- This question assessed users' immediate emotional response to the interface.

3. *Text Readability and Clarity*: How clear and understandable was the text and wording on the screens? (Strongly disagree, Disagree, Neutral, Somewhat agree, Strongly agree)

- This question evaluated the readability and clarity of the interface's language.

4. *Unclear Words/Labels*: Were there any words, labels, or messages that felt unclear? (Specifically, the word "Neutral" was mentioned as unclear by at least 10 % of respondents)

- This question aimed to identify specific elements that might confuse users.

5. *Visual Design*: How would you rate the visual design (colours, layout, icons)? (Very poor, Poor, Good, Very good, Excellent)

- This question evaluated the aesthetic appeal and organization of the interface.

6. *Intuitive Interaction*: Did interacting with the interface (buttons, slider) feel intuitive? (Strongly disagree, Disagree, Agree, Strongly agree, Neutral)

- This question assessed how easy it was for users to perform actions.

7. *Task Clarity*: Was it clear what you were supposed to do on each screen? (Strongly disagree, Disagree, Agree, Strongly agree, Neutral)

- This question gauged whether users understood the intended actions or tasks.

8. *Sense of Control*: Does the interface make you feel in control of your choice? (Strongly disagree, Disagree, Agree, Strongly agree, Neutral)

- This question evaluated how users perceived their agency and control over the interface.

9. *Trust in the Interface*: Do you trust what the interface is asking you to do? (Strongly disagree, Disagree, Agree, Strongly agree, Neutral)

- This question measured users' trust in the interface's suggestions and requests.

10. *Comfort with Sustainability Message*: How comfortable were you with the message about ENVIRO mode and sustainability? (Very comfortable, Somewhat comfortable, Neutral, Somewhat uncomfortable, Very uncomfortable)

- This question assessed how users felt about a specific feature or message related to sustainability.

11. *Overall Experience*: How would you rate your overall experience using this interface? (Very bad, Good, Very good)

- This question provided a summary evaluation of the user's general satisfaction with the interface.

12. *Regular Use Intent*: Would you be comfortable using this interface regularly? (Yes, Maybe, No)

- This question gauged users' likelihood of continuing to use the interface in the future.

4.4. Survey Results Summary

Around 80 participants fulfilled the questionnaire in 10 days overall, during which the tool was made available to the building occupants in the KTH premises.

4.4.1 Overall Ease of Understanding

- Interface A: 10 % Very Difficult, 30 % Neutral, 50 % Somewhat Easy to Very Easy

- Interface B: 20 % Very Difficult, 60 % Somewhat Easy, 20 % Very Easy

- Key Finding: No sensible difference between interface A and interface B.

4.4.2 User Feeling and Confidence

- Interface A: 10 % Confident, 50 % Neutral, 10 % Confused/Overwhelmed

- Interface B: 30 % Curious, 50 % Neutral, 10 % Confused/Overwhelmed

- Key Finding: No sensible difference between interface A and interface B.

4.4.3 Text Clarity

- Interface A: 30 % found the text unclear, with 10 % specifically confused by the word "Neutral"

- Interface B: 10 % found text unclear, with 10 % noting the word "Neutral" as confusing

- Recommendation: Clarify the meaning of "Neutral" or consider alternative labels.

4.4.4 Visual Design

- Interface A: 30 % Poor, 70 % Good / Very Good

- Interface B: 20 % Poor, 80 % Good/Very Good

- Key Finding: No sensible difference between interface A and interface B.

4.4.5 Task Clarity

- Both Interfaces: 60 % found it clear what to do on each screen, with slight variations

- Interface B: 60 % found it clear (vs. 60 % in A)

- Analysis: Both interfaces generally performed well here, with no significant difference.

4.4.6 Intuitive Interaction

- Interface A: 70 % Agree/Strongly Agree (Interacting felt intuitive)

- Interface B: 70 % Agree/Strongly Agree (Interacting felt intuitive)

- Key Finding: No significant difference in perceived intuitiveness

4.4.7 Control and Trust

- Interface A: 60 % Agree to 10 % Strongly Agree

- Interface B: 70 % Agree to 10 % Strongly Agree

- Key Finding: No significant difference in control and trust.

4.4.8 Comfort with Sustainability Message

- Interface A: 10 % Very Comfortable, 60 % Neutral, 10 % Uncomfortable

- Interface B: 10 % Very Comfortable, 50 % Neutral, 10 % Uncomfortable

- Analysis: No clear preference but slightly (not significantly) higher comfort with Interface B's message

4.4.9 Overall Experience

- Interface A: 60 % Good, 30 % Very Good

- Interface B: 70 % Good, 30 % Very Good

- Key Finding: B was rated slightly (not significantly) better overall

4.4.10 Regular Use

- Both Interfaces: 60-70 % would use regularly, 30 % Maybe, 0 % No

- No significant difference between A and B

4.4.11 Likes and One-Word Description

- Interface A: Simplicity, providing feedback, prompting feedback

- Interface B: Simple, engaging, promising

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4.5. Analysis and Recommendations

Both interfaces received positive feedback, but B was seen as slightly more "engaging" and "promising"

Labelling could be improved providing more contextual anchor: some users found the word "Neutral" confusing in both interfaces, suggesting clearer labels are needed.

No significant difference in task clarity or intuitiveness but B had an edge in user comfort and control.

The results also suggest merging Interface B's visual design and layout with Interface A's familiarity to address clarity and comfort issues.

Future applications should improve and clarify the meaning of "Neutral" or use alternative labels. The survey results also suggest considering additional feedback mechanisms to improve user comfort and trust, building on interfaces' strengths. Additional feedback should be used through prompts or tooltips to help users who found certain elements unclear.

4.6. Final remarks

Both interfaces have room for improvement, especially in clarifying the "Neutral" label and addressing potential confusions. Remarkably a good majority of people (around 70 % of testers) answered they would use the tool to provide feedback to the system managers. Those results suggest that the tool could be successfully implemented in the ordinary managerial routines and use the feedback to plan and monitor the perception of comfort among the building occupants.

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5. Conclusion

The evaluation confirms that dashboards are effective adoption tools when designed as behavioural interfaces rather than data displays. The Austrian and Swedish pilots demonstrate complementary strengths: public legitimacy and operational decision support. Together, they provide a replicable, human-centred model for Energy Community dashboard design.

6. Annex

6.1. List of Figures


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Plug&plAy eneRgy ManagEmeNt for hybrID
Energy Storage