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Sustainable
plus energy
neighbourhoods

WP2 Development and Demonstration of plus energy multi-storey apartment buildings in four climatic zones

D2.9 INTEGRATED ENERGY DESIGN GUIDELINES FOR SUSTAINABLE PLUS ENERGY NEIGHBOURHOODS

[Report pending for approval]

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This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement N 869918.

PROJECT ACRONYM .... syn.ikia
PROJECT NUMBER 869918
PROJECT TITLE .... Sustainable Plus Energy Neighbourhoods
WEBSITE .... www.synikia.eu

syn.ikia

Technical References

Deliverable (number)	D2.9			
Deliverable Name	IED^N guidelines of sustainable plus energy neighbourhoods			
Work Package (number)	2			
Task number	2.1.2, 2.2.2, 2.3.2, 2.4.2			
Dissemination Level	PU			
Date of Delivery	31.10.2023			
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Reviewers	Joana Ortiz, IREC, Niki Gaitani, NTNU			
Status	V6 – Final version for submission to the EC			
Document history	Version	Name	Role	Date
First draft	**V1**	Tommy Kleiven	Author, NTNU	26.01.2021
Second draft	**V2**	Inger Andresen	WP2 lead	02.09.2022
Third draft	**V3**	Tonje Healey Trulsrud	Author, NTNU	06.08.2023
Final draft for review	**V4**	Inger Andresen	WP2 lead	07.10.2023
Review	**V5**	Joana Ortiz	Review, IREC	20.10.2023
Final version	**V6**	Inger Andresen	WP2 lead, NTNU	24.10.2023

Executive Summary

This report is a part of the syn.ikia[1], an EU-funded project under the Horizon 2020 Research and Innovation programme, aiming at developing sustainable neighbourhoods with surplus renewable energy across Europe.

The goal of this report is to present a guideline for Integrated Energy Design for Neighbourhoods (IED^N). The document also includes descriptions of the planning and design processes of Sustainable Plus Energy Neighbourhoods (SPEN) demonstration projects, located in Spain, Austria, the Netherlands, and Norway, which are all a part of the syn.ikia project.

A SPEN is a highly energy efficient and energy flexible neighbourhood with a surplus of energy from renewable sources. It consists of a group of interconnected buildings with associated infrastructure, located both within a confined geographical boundary and a virtual boundary. A SPEN aims to reduce its direct and indirect energy use towards zero over the year, with increased generation and use of renewable energy (Salom et al 2020[2]).

Additionally, the syn.ikia definition of a SPEN covers the following five main objectives:

- Net zero greenhouse gas emissions and carbon footprint reduction.
- Active management of annual local or regional surplus production of renewable energy and power performance (self-consumption, peak shaving, flexibility).
- Cost efficiency and economic sustainability according to a life cycle assessment.
- Improved indoor environment for well-being and satisfaction for the inhabitants.
- Social inclusiveness, interaction and empowerment related to co-use, shared services & infrastructure, and affordable living.

The process guideline described in this report is generalized based on the experiences from the four syn.ikia demonstration projects and recommendations from existing guidelines and literature on integrated energy design and neighbourhood planning. Each project will have a process sequence that is different from each other, with some deviations from the phases used in this IED^N guideline. However, the guideline aims to capture the most significant tasks and focus areas to include in the planning and design of SPENs. The experiences from the syn.ikia design teams highlighted a set of key tasks and focus areas that are significant for achieving SPENs. Based on this, the IED^N guidelines includes description of process, methods, and tools to apply in the planning and design phases of such neighbourhood projects. The guidelines are organized in four main planning and design phases: 1) Masterplan, 2) Zoning Plan and Detailed Plan, 3) Schematic Design and Design Development, and 4) Detailed Design. Within each of these stages, a set of key activities are described:

Masterplan: Perform a Stakeholder Mapping, Set up a Multidisciplinary Team, Set Goals and Ambitions, Organize Workshops, Engage the Local Community.

Zoning Plan and Detailed Plan: Make Measurable Goals, Address Policies and Regulatory Drivers and Barriers, Engage the Local Community, Make a Quality Agreement, Organize Workshops, Evaluate the Potential for Energy Efficiency, Renewable Energy, and Energy Sharing.

Schematic Design and Design Development: Set up a Multidisciplinary Design Team and Organize Workshops, Use Suitable Design Strategies and Tools, Evaluate Different Design Options through Scenario Analyses, Design an Integrated Energy System, Develop a Green Area Concept, Design for Sharing Concepts, Develop Suitable Business Models.

Detailed Design: Design Building Details and Check Performance, Design for Energy Flexibility, Organize Energy Communities, Plan the Monitoring, Make Contracts that Incentivize High Operational Performance, Prepare for the Operation Phase

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[1] https://www.synikia.eu/

[2] https://www.synikia.eu/resource-types/technical-reports/

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1. Roles and Responsibilities

Name	Role	Responsibility
NTNU	Task 2.19 leader. Coordinator of Deliverable contents and edition; Author and chapter editor	Introduction, Methodology, Guidelines. Supporting the Norwegian Demo.
AREA	Demo Leader – Dutch Demo	Design process in the Dutch demo
INCASOL	Demo Leader – Spanish Demo	Design process in the Spanish demo
IREC	Research Partner	Supporting the design of the Spanish demo
SIR	Research Partner – Main contact Austrian Demo	Design process in the Austrian demo
ABUD	Research Partner	Supporting the design of the Austrian Demo
ARCA NOVA	Demo Leader – Norwegian Demo	Design process in the demo

2. Introduction

The aim of this report is to improve the understanding of how we can plan and design Sustainable Plus Energy Neighbourhoods (SPENs) in Europe.

A SPEN is a highly energy efficient and energy flexible neighbourhood with a surplus of energy from renewable sources. It consists of a group of interconnected buildings with associated infrastructure, located both within a confined geographical boundary and a virtual boundary. A SPEN aims to reduce its direct and indirect energy use towards zero over the year, with increased generation and use of renewable energy (Salom et al 2020).

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- Cost efficiency and economic sustainability according to a life cycle assessment.
- Improved indoor environment for well-being and satisfaction for the inhabitants.
- Social inclusiveness, interaction and empowerment related to co-use, shared services & infrastructure, and affordable living.

This report includes descriptions of the planning and design processes for four SPEN demonstration projects, located in Spain, Austria, the Netherlands, and Norway, which are all a part of the syn.ikia project. The demonstration projects have implemented the principles of integrated energy design on a neighbourhood scale, and data from the projects is valuable information for how to plan and design SPENs. Therefore, the Integrated Energy Design for Neighbourhoods (IED^N) guideline has been created based on experiences and learnings from the development of the four neighbourhood demos within the syn.ikia project. The target groups for the IED^N guideline are stakeholders involved in the planning and design of SPENs; developers, urban planners, housing cooperations, architects, engineers, and energy specialists.

The report is structured as follows:

Section 3. Methodology describes the methods used to develop the guidelines, including research of previous IED guidelines, desk research of Positive Energy Districts (PED) guidelines, dedicated workshops in the syn.ikia consortium, interviews with experts from the demonstration projects, comparison between a conventional and the syn.ikia process for the demonstration projects.

Section ***4. A guideline for planning and design of Sustainable Plus Energy Neighbourhoods****,* presents the IED^N guidelines structured into different planning and design phases, along with examples from the syn.ikia demonstration cases.

Appendix A includes a glossary of terms used in the report.

Appendix B includes descriptions of the IED^N processes for each of the four syn.ikia demonstrations projects.

3. Methodology

The methods that we used for developing the IED^N guidelines include review of existing literature and guidelines, followed by workshops and discussions with the different partners and demo developers in the syn.ikia consortium. The literature review was focused on IED guidelines for buildings and guidelines for PED. Three workshops on the IED^N process were held within the syn.ikia consortium. In addition, the report draws on previous work performed in the syn.ikia project, in particular on the *D2.1 Report on design plus energy neighbourhoods in each of the four climatic types* (Finocchiaro et al 2021). The D2.1 report describes the design of the demonstration projects with a special focus on simulations of design options and scenario analyses of user behaviours and future climate scenarios.

3.1 Review of existing Integrated Energy Design Guidelines

IED is a process that aims to ensure that foreseen issues with a significant impact on energy and environmental performances are discussed, understood, and dealt with at the beginning of the design process, and followed up through the entire development of the project (Solidar 2003). The IED process implies that time is spent early in the design process by a multidisciplinary design team and that passive energy design (i.e., utilisation of natural ventilation, daylight, shading, and thermal mass) plays a significant role in achieving the ambitious goal of a net zero energy building or even a plus energy building.

The IED process was developed and described for the building scale within the International Energy Agency (IEA) Solar heating and cooling Task 23 (Solidar 2003) and was further developed in the EU project INTEND Andresen et al 2009). The INTEND guideline for the IED process consists of 9 steps (Andresen et al 2009), as shown in Figure 1. Different variations of the IED process have also been described and applied by several other authors and research projects, e.g. (Brunsgaard et al 2014; Hegger et al 2008; Yudelson 2009; Zimmermann 2006).

1. Select a **multi-disciplinary design team** from day one, which are skilled in energy/environmental issues and are motivated for close cooperation and openness.

2. **Analyse the boundary conditions** of the project and the client's needs and demands and formulate a set of specific goals for the project.

3. Make a **Quality Assurance Program** and a **Quality Control Plan** to follow-ups throughout the project.

4. Arrange a **kick-off workshop** to make sure that all team members have a common understanding of the design task.

5. Facilitate **close cooperation** between the architect, engineers and relevant experts through co-localisation or through a series of workshops during concept design phase.

6. **Update the Quality Control Plan** and document the energy performance at critical points (milestones) during the design.

7. Make **contracts that encourage** integrated design and construction.

8. **Motivate and educate** construction workers and apply appropriate quality tests.

9. Make a **user manual** for operation and maintenance of the building.

Figure 1. The 9 steps of the IED process as described in the INTEND project, from (Andresen et al 2009).

3.2 Review of Existing PED Guidelines

The concept of PED emerged from the EU Strategic Energy Technology Plan that aims to realise 100 PEDs by 2025. PED is the main topic for several research projects and networks across Europe, such as IEA Annex 83 – Positive Energy Districts, Cost Action C19125 – PED-EU-NET, Cities4PEDs, Atelier, Sparcs, Making City, +CityXchange, FME ZEN, and ARV. These projects explore and describe barriers, challenges, and opportunities in terms of regulations and policy, incentives, market, and technological and social issues. The projects also describe a wide range of key performance indicators, governance strategies, technologies, and methods and tools for planning.

The EU projects SCIS, Atelier, Making-City, Sparcs, and +CityXchange have developed a 'Positive Energy Districts Solution Booklet" to provide a framework and solutions for a city to develop PEDs (Vandevyvere et al 2020). The booklet contains an overview of a wide range of issues such as technological solutions, tools and methods for urban planning, societal and consumer aspects, business models and financing, see Figure 2. In general, it can be said that the PED guidelines focus mostly on the perspective of municipal and city planners.

Figure 2. Copy of the Table of Contents from the Positive Energy Districts Solution Booklet (Vandevyvere et al 2020).

After reviewing the different guidelines and articles on IED and PEDs, we concluded the IED^{N} would be somewhere in between the planning process of PEDs and the IED process of individual buildings. It includes more planning phases and involves more stakeholders that in an typical IED process, but the tasks resemble more the ones of the IED process than those of a PED. Thus, we concluded that the IED process described by the INTEND guideline was the most suitable to use as a starting point to create an integrated energy design process adopted for the neighbourhood scale, abbreviated to IED^{N}.

3.3 Workshops on the IED^N process

Three workshops on the IED^N process have been organized in the syn.ikia consortium. The workshops are summarized in this chapter.

Workshop 1: The IED process as a starting point

An initial version of the IED process that was discussed and developed in a workshop where representatives from the syn.ikia demonstration projects were present, together with several other syn.ikia partners. The 7-step process that the demos were asked to test and give feedback on for improvements is shown in Figure 3. The expectations were that important steps might be missing or that others could be superfluous, or that some steps just needed revision. The main conclusion was that most of the steps were considered relevant and useful in an IEDN process but had to be tailored to the different phases of development, further detailed, and related to the different stakeholder in the planning and design process.

The 7-step IED^N design process

*1. **IEDN Design Team** From day one, select a multi-disciplinary design team that is skilled in energy/environmental issues and motivated for close cooperation and openness.*

*2. **Boundary conditions and ambitions** Analyse the boundary conditions of the project. Which stakeholders are/should be involved? What are the client's needs and demands? Clarify the project ambition and formulate a set of specific goals for the project. Scenarios for future developments.*

*3. **Quality Assurance** Make a Quality Assurance Program and a Quality Control Plan for follow-ups throughout the project.*

*4. **IEDN kick-off workshop** Arrange a kick-off workshop to make sure that all stakeholders and team members have a common understanding of the project and its goals.*

*5. **Design team Workshops, methods and tools used** Facilitate close cooperation between stakeholders (e.g. landowner, municipality, energy- and utility companies) and members of the design team (e.g. urban planners, architects, engineers) through a series of workshops during the project design phase. Which methods and design tools are being used?*

*6. **Document QA** Update the Quality Control Plan and document the energy and environmental performance at critical points (milestones) during the design.*

*7. **Contracting** Make contracts that encourage integrated design and construction.*

Figure 3. The IED process that was discussed in the initial workshop.

Workshop 2: From a conventional process to the IED^N process

The syn.ikia team arranged a second workshop in Den Bosch, the Netherlands in March 2022, where the focus was to identify the key issues in each of the phases that were different from a traditional process. Participants from all syn.ikia partners were present at the workshop.

The following figures show presentations from the workshop. Figure 4 displays the iterative process for the phases from Detailed plan to Design Development. Initial considerations and experiences were that the early phases highly affect the result and performance outcome of the process and final project result.

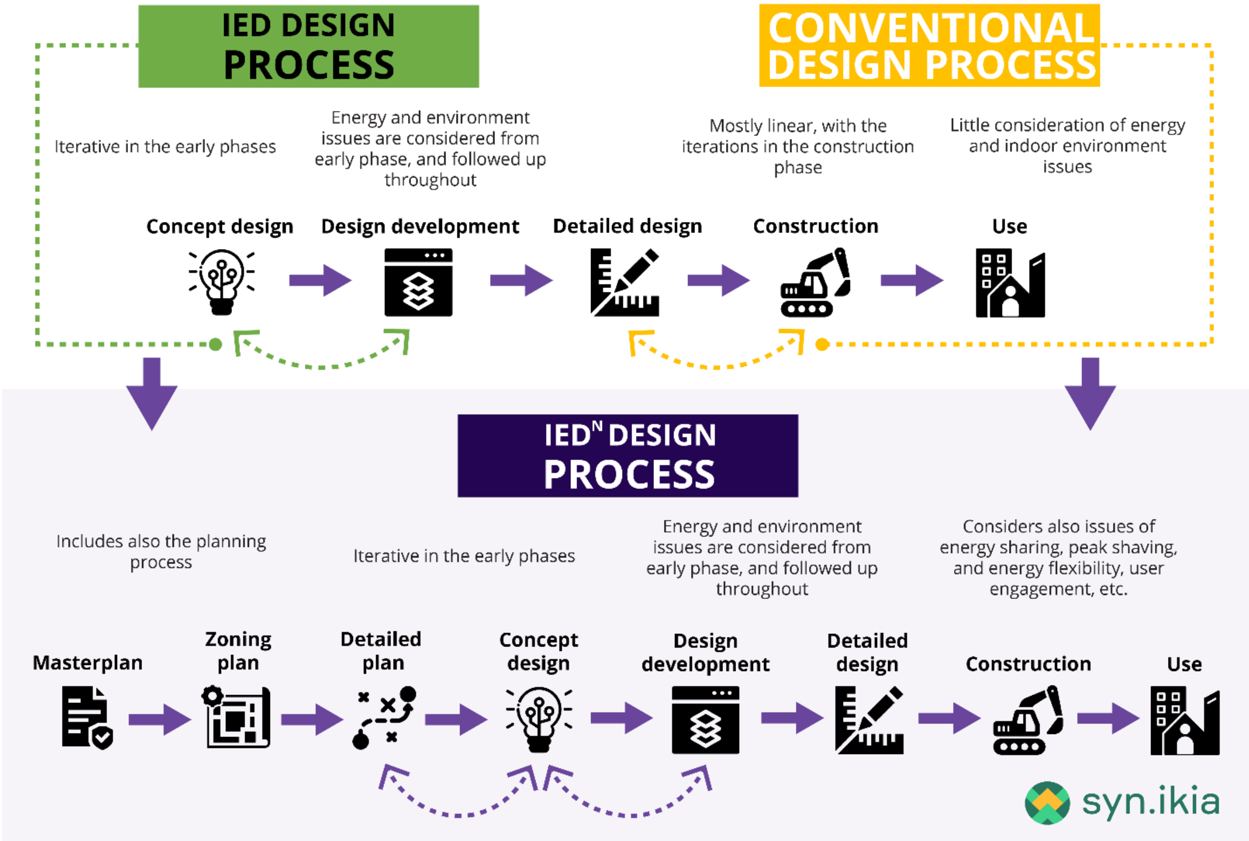


Figure 4. Illustrations of the IED and IED^N processes versus the conventional process, as presented at the workshop.

The planning and design phases of neighbourhoods may extend over several years and include many stages and iterations. The names and nature of each phase vary between countries, but the team chose to define 3 distinct planning phases (Masterplan, Zoning Plan, and Detailed Plan), and 3 distinct design phases (Concept Design, Design Development, and Detailed Design). Each phase has certain critical issues that are especially important for the project to achieve its goals. Figure 5 shows an initial illustration of some critical factors that were presented at the workshop.

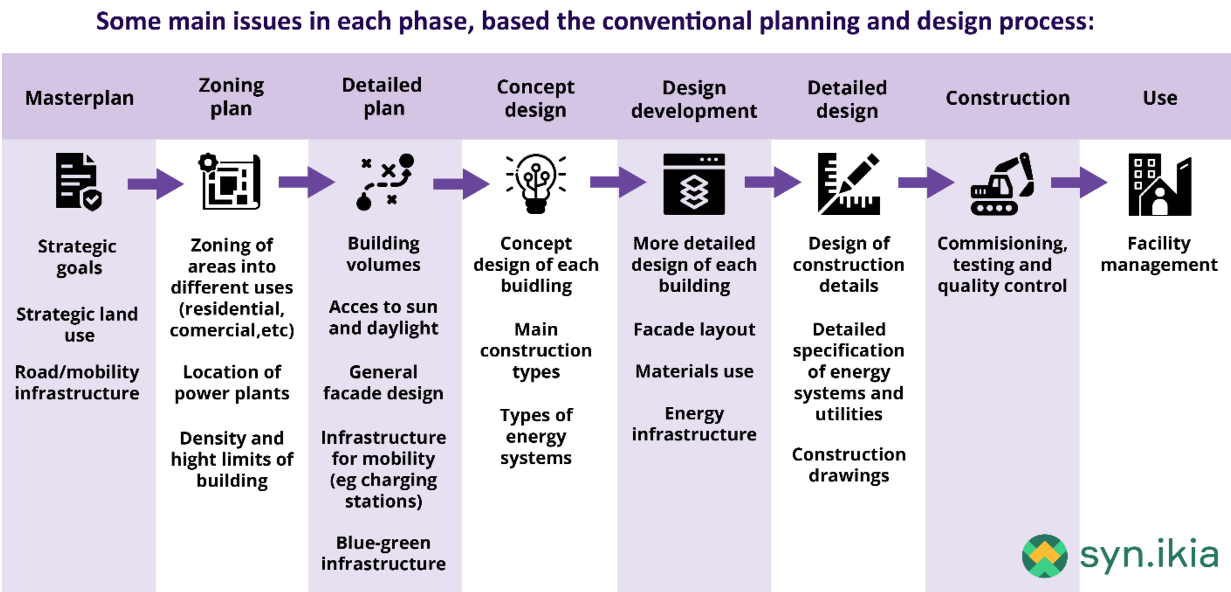


Figure 5: Presentation of some critical factors for design of sustainable plus energy neighbourhoods, and difference between a conventional process and the IED^N process.

The workshop participants discussed what the main SPEN issues are in each of the phases, and what questions are important to ask. The illustration in Figure 6 shows examples of questions to be asked for each phase, ranging from overall targets of the municipality to the future needs of users.

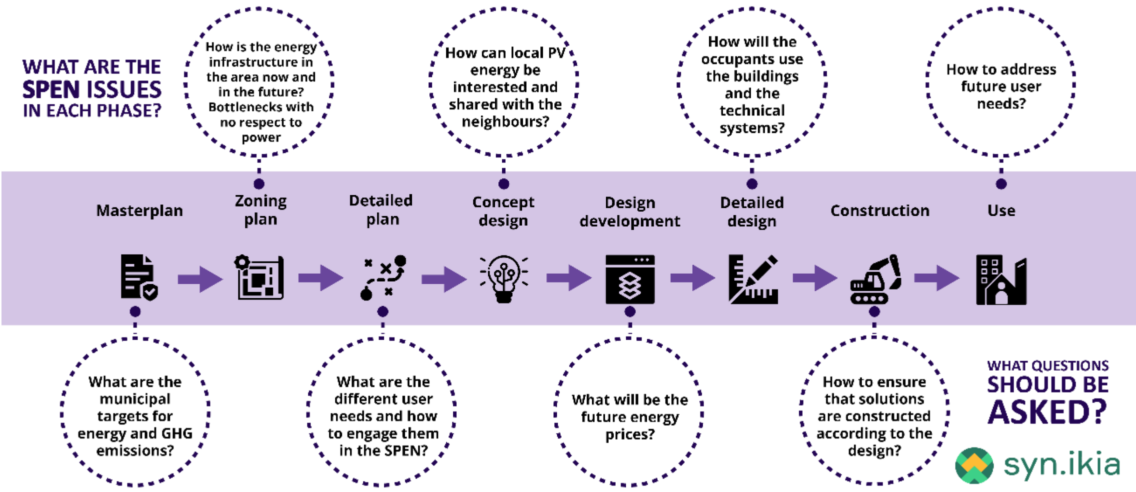


Figure 6: Examples of issues in each phase of planning and designing SPEN's.

The workshop results are presented in Figure 7. The participants emphasised the early planning and design phases as significant for the project success. As mentioned above, the planning and design phases may have different names and content in each country and region, but we have chosen to divide the process into the following phases:

Overall strategies for energy and mobility systems need to be addressed in the Masterplan, as well as mapping of the existing conditions to set renovation strategies and considerations of cultural heritage protection. Citizen engagement should start in this phase as well, where residents can take part in the development of their neighbourhood, to ensure development is in line with the community's interests.

The **Zoning Plan** focuses more on the types of buildings, their shape, and land utilization. These are aspects that can affect the design features of the buildings to reduce energy consumption. Social aspects are most visible in this phase, with the mentioning of social housing, social services, and social infrastructure.

The **Detailed Plan** phase emphasizes renewable energy systems and issues with building standards, as well as financial risks. Further, façade regulations affect architectural quality and solar energy potential for renewable energy generation, as well as daylight access.

The **Schematic Design** introduces the sharing concept for neighbourhoods, further considerations of the type of energy system (centralized/decentralized), and landscape design of green and recreational areas. User engagement and building functions are also elements of this phase. Typically, the photovoltaic concept for energy generation is developed in this phase.

The **Design Development** phase focuses on detailing the energy system, including HVAC and façade design, and also considering resource efficiency and low carbon materials and construction systems. The design is becoming more detailed, and the project ambitions and goals need to be revisited, checked, and implemented in the development of the design.

The last design phase, **Detailed Design**, concerns the building specific details. However, it is also mentioned as a time to organize energy communities. In the construction phase, it is important to follow-up on the quality and performance of the project.

Lastly, in the **Operational Phase** of a SPEN and similar neighbourhoods, it was recommended to have an energy manager to monitor and control the energy systems due to their complexity. Users should be involved and informed about how to operate the systems. It is necessary to have a responsible partner for the performance of the neighbourhood to ensure that the operations meet the design target.

SYN.IKIA WORKSHOP 2

MASTERPLAN

Conventional planning and design process issues

Strategic goals

Strategic land use Road/mobility infrastructure

WORKSHOP results on the IEDN process

Demographic targets: who lives here or use the neighbourhood?

Environmental targets for the project to steer it in the right direction form the beginning.

Cooperative planning process allows for new and improved solutions to enhance sustainability of the project. Steering group moderated to ensure efficient cooperation.

Energy Performance Certificates (EPS's) to target energy performance at an early stage. Include renovation targets for inefficient building mass.

Assessment of the infrastructure. How is the existing infrastructure, and does it need to be improved to enhance environmental sustainability? How is the grid capacity?

Heritage protection in the area, and its role in the project.

Access for EV Charging to reduce fossile fuel cars.

Public consultation

Mobility targets for improved public transportation

Decarbonization strategy of the region/country and its effect on the project.

Schemes for energy supply with focus on renewable energy.

ZONING PLAN

Conventional planning and design process issues

Zoning of areas into different uses (residential, commercial, etc.)

Location of power plants

Density and height limits of buildings

WORKSHOP results on the IEDN process

Density of buildings: affects daylight and solar access

Height regulation of buildings

Building and roof shape: affects the energy efficiency of the building.

Building orientation for energy efficient design

Social Housing – what is the availability in the area?

What kind of buildings already exist? Private/common/public

Land Property: who owns the land, what are the regulations?

Social services for the community

Central parking, EV charging and public transport to reduce mobility emissions.

Outdoor areas and recreational spaces

Social infrastructure

DETAILED PLAN

Conventional planning and design process issues

Building volumes and access to sun and daylight

General façade design

Infrastructure and mobility (e.g. charging stations)

Blue-green infrastructure

WORKSHOP results on the IEDN process

Target group

Regulation for façade, which affects architectural quality.

Solar access and potential energy generation

Property of soil to assess possible heat pump systems

Building standards for code compliance

Renovation: analyse energy systems

Legal issues

Utilities

Financial risks of testing new solutions

Renewable energy generation in public spaces

SCHEMATIC DESIGN

Conventional planning and design process issues

Concept design of each building

Main construction types

Types of energy systems

WORKSHOP results on the IEDN process

Sharing concept for the neighbourhood: for example common spaces, cars, and tools.

Centralized energy concept with a main energy central for the neighborhood or decentralized energy concept, with separate systems for each unit.

What type of buildings are in the neighbourhood? Private/common/public, mixed use?

Green area concept: are there dedicated areas for recreational activities outdoors and greenery to improve the qualities of the neighbourhood in terms of cleaner air, water management, and facilitating for meeting places inbetween the buildings.

PV concept: What is the potential for solar energy generation, and how i it best integrated into the built environment.

User engagement: continue the dialogue with the neighbourhood residents about the project development.

DESIGN DEVELOPMENT

Conventional planning and design process issues

More detailed design of each building

Façade layout

Material use

Energy infrastructure

WORKSHOP results on the IEDN process

Materials for construction: focus on environmentally friendly, local and durable materials to reduce emissions and resource consumption.

Energy supply user friendliness

Design of the energy system

DETAILED DESIGN

Conventional planning and design process issues

Design of construction details

Detailed specification of energy systems and utilities

Construction drawings

WORKSHOP results on the IEDN process

HVAC system design with focus on reducing operational energy use, while ensuring a comfortable environment for users

Quality check to ensure design is in line with the project targets

For social housing: a moderated process to find tenants starts.

Organization of energy communities

CONSTRUCTION

Conventional planning and design process issues

Commissioning, testing and quality control

WORKSHOP results on the IEDN process

Guarantee insurance: to hold partners and stakeholders responsible for their deliveries and tasks.

Control of building and neighbourhood performance to ensure energy efficiency and that systems works as intended in the design.

Commissioning of buildings

USE

Conventional planning and design process issues

Facility management

WORKSHOP results on the IEDN process

User guides for energy conscious behavior

Activities to inform and involve users in the neighbourhood.

Monitoring of the buildings and neighbourhood

Energy manager to operate the buildings

Responsible partner for performance to ensure operation meets design targets.

Figure 7: A summary of main issues and important topics to be addressed in the different planning and design phases, as entered by the participants in the workshop.

Workshop 3: How should an ideal IED^N process be like?

The third workshop was held in Salzburg in April 2023 with representatives from all the syn.ikia partners. The topic of the workshop was "How should an ideal IED^N process be like?", and the participants were divided into groups with representatives from different demo project in each group.

The following questions were discussed within each group:

1 What are the 3 most important issues and at what stages in the process should they be addressed?
2 What are the main DOs and DON'Ts related to the different issues and activities?

The results from the first question by the four groups in the workshop are presented in Figure 9, while the results from the second question from are presented in Table 1 below.

The workshop results showed that the participants emphasized the importance of setting ambitions and formulate clear goals in the beginning of the project, where all four groups mentioned this activity specifically, or as a subtask in the cooperative moderated process. Secondly, three of the four groups mentioned stakeholder involvement as critical. That includes an early involvement of a wide range of stakeholders, covering the different fields of expertise within the project. This is also linked to creating a project team where responsibilities are clearly defined. Further, the items "cooperative and moderated process" and "collaboration and communication" stress the issues of creating a good environment for collaboration with a dedicated manager of the process, regular in-person meetings, and communication with the public to engage the citizens and spread awareness of SPENs. Another topic highlighted by two groups is the significance of integrated energy design combined with wellbeing and a renewable energy focus from the beginning. Lastly, finding and developing sustainable business models and funding sources are important for the realization of SPENs.

Figure 8: Picture from the workshop in Salzburg.

SYN.IKIA IEDN WORKSHOP 3

GROUP 1

How should an ideal IEDN process be like?

What are the 3 most important issues and at what stages in the process should they be addressed?

RESULTS

1. Setting ambitions

DO's: Think outside the box; Smart goals that are clear to everyone and generate a win-win for all; specify the goals

DON'Ts: Define the goals alone

2. Putting together a project team

DO's: Open minded people for new topics; Covering all disciplines and perspectives in the team; Involve in early stages; Define roles and responsibilities; Supplementary partners next to core team, flexible amount of organizations; Good project managers.

DON'Ts: No strong contracts; Not only team members that only think about their business cases.

3. Collaboration and communication

DO's: Define a common aim and structure this, engagement with the municipality; regular meetings; make public events; make external people aware of the definitions of SPENS and the common aim of the projects; stakeholder analysis.

DON'Ts: Avoid too much digital communication; make it unprofessional, informal; don't avoid end-users.

GROUP 2

How should an ideal IEDN process be like?

What are the 3 most important issues and at what stages in the process should they be addressed?

RESULTS

1. Business model and funding sources for realization and operation of SPENS

DO's: Finding the right business model in the local context of where the SPEN should be realized, including its future residents.

DON'Ts: Focus on sustainable funding sources for realizing the project with its specific measures/ innovations only for the planning of the project. To realize SPENs, it is neccesary with sustainable funding sources during the operation as well.

2. Renewable energy generation and energy flexibility on neighbourhood level

DO's: Ensuring local renewable energy production with high local energy consumption rates by ensuring energy flexibility of buildings.

DON'Ts: Focus only on the building scale, for realizing SPENs these concepts need to work on the neighbourhood level.

3. Use the IEDN process from beginning

DO's: Implementation of IEDN planning concepts already in early planning stages, including definition and allocation of responsibilities. Additionally, implementation of iterative improvement loops through monitoring from beginning of the planning until the building operation.

GROUP 3

How should an ideal IEDN process be like?

What are the 3 most important issues and at what stages in the process should they be addressed?

RESULTS

1. Clear goals and ambitions

DO's: Setting clear goals and ambitions for neighbourhood scale in the early definition stage.

DON'Ts: Don't get stuck only with energy goals.

2. Quality assurance and optimization

DO's: Energy optimisation and quality assurance needs to be done in the concept phase . Evaluate different design options in the concept phase

3. Stakeholder involvement

DO's: Engagement of multi-stakeholders, needs to be done in the early definition stage of the project.

GROUP 4

How should an ideal IEDN process be like?

What are the 3 most important issues and at what stages in the process should they be addressed?

RESULTS

1. Cooperative and moderated process

DO's: Give continuity to the process
Mitigate hands-off where ideas can be lost.
Clear goals to create a common picture for all, should be created in a quality agreement.

DON'Ts: The chair should not be a developer nor an investor.

2. Identify the different stakeholders in the different stages on the IEDN

DO's: Interface between construction and energy experts (make an early understanding).
Municipality "buy-in": They need to know what a SPEN is and be motivated to implement one for the citizens.

3. Integrated building and energy concept

DO's: Occupant wellbeing (air quality, noise, light, temperature, size of things).
Use the 6 dimensions of Klimaaktiv as a template:
1. Project management (how to form the group), 2. Communication, 3. Urban planning, 4. Building, 5. Energy, water, sanitation, 6. Mobility

Figure 9: A summary of the workshops results from the four groups.

Table 1: Results from Workshop 3 on the second question.

Topic / Issue / Activity	DO	DON'T
Building design	• Iterative analysis of alternatives to improve the solution from the energy efficiency point of view. • Use less primary material and construction materials based on renewable resources. • Calculate LCA for assessing life cycle-based energy demand and emissions. • Enable circularity of building materials by e.g., implementation of building material passports. • Explore different building scenarios, including iterative process	Don't focus on the single building, take into consideration the surroundings and neighbourhood scale as well.
Renewable energy generation	• Analyze concepts that ensure flexibility of buildings in context of the SPEN. • Realize the maximum possible implementation of renewables even if they ambition is above the regulations. • On-site generation.	Don't use carbon offsets.
Energy sharing	• Incorporate energy providers to find business models for energy sharing also in a SPEN. • Consider the need for energy management.	Don't be limited to the building regulations.
Smartness and flexibility	• Allocate responsibilities in case MPC doesn't work as planned during SPEN operation. • Standardization of flexibility of heat pumps and appliances to reduce engineering costs. • Be smart and flexible.	Don't make too complex systems.
Setting ambitions	• Start in the concept phase and discuss it among all actors.	Don't make fuzzy goals.
Putting together a project team	• Set-up multidisciplinary team. • Multidisciplinary approach and have a good project and knowledgeable leader.	Don't forget to include experts on energy and environment in early phases.
Collaboration and communication	• Implementation of local backup solutions. • Provide easy communication language that is understandable for everyone.	Avoid scientific language and only digital meeting.
Quality assurance	• Set-up quality assurance plan and allocate responsibilities to stakeholders. in the SPEN planning and operation process.	Don't forget to follow-up the plan.
The use of methods and tools	• Plan for an iterative process, use the simulation tools to check the performance throughout the process.	Not only check the final design.
Business models	• Involve contractors and suppliers in early stages to find business models that fit the local context including the future inhabitants of the SPEN.	Don't forget to check local regulations.

3.4 Comparison of a conventional process and the syn.ikia demonstration case processes

During the analysis of the planning and design processes for the syn.ikia demonstration projects, the differences between a conventional process and the syn.ikia process for the projects were mapped. Figure 10 shows the results of the mapping. The highlighted text in green is what is special for the syn.ikia projects, and thus different from a conventional process.

In the Masterplan, the possibilities for sharing and storing of energy, should be considered. This includes a mapping of the existing energy infrastructure, current and future energy uses, the possibilities for renewable energy generation, and ownership structure of buildings and systems. Results from the Austrian demo highlighted the importance of developing a Quality Assurance Agreement and a Quality Assurance Plan for the project. The purpose of the Quality Assurance Agreement is to formulate goals, align interests of stakeholders involved, and to plan how to achieve high quality in each of the planning and design phases and all the way throughout construction and operation.

In the Zoning Plan, the energy concept for the neighbourhood should be conceptualized. That includes energy and power use in the neighbourhood, renewable energy supply, and energy flexibility. Citizen involvement is also a part of this phase, where the project team should actively engage the community and listen to their viewpoints and inputs to the project aim and ambition. This ranges from functions and services needed in the area to aesthetics, and benefits of energy efficiency and renewable energy.

In the detailed plan, the energy concept is further developed with a focus on energy efficiency and energy flexibility. The citizen engagement continues in this phase, and workshops with a wide range of involved parties can be helpful to develop the project and find appropriate solutions.

In the Schematic Design phase, the differences between a conventional process and the syn.ikia process is evident, where the focus on energy efficiency and flexibility steers the design process. The demonstration projects have received specialized support to incorporate energy efficiency and flexibility in the design of the buildings and energy systems. This focus and support continue throughout the design phases to construction, commissioning, and operation, and involves several stakeholders and experts on different energy domains, such as energy consultants, energy systems providers, and energy and utility companies.

The operational phase includes extensive monitoring of the building and neighbourhood performance. That requires management of large quantities of data and analysis of the data to improve performance of the operations and reduce energy consumption, while maintaining high indoor environmental quality.

	Masterplan	Zoning plan	Detailed plan	Schematic design	Design development	Detailed design	Construction and commissioning	Operation/use
Spanish	There were no differences on this document, as it was already approved upon the beginning of the project.	There were no differences on this document, as it was already approved upon the beginning of the project.	There were no differences on this document, as it was already approved upon the beginning of the project.	Specialized technical support on energy efficiency (IREC)	Specialized technical support on energy efficiency (IREC)	Specialized technical support on energy efficiency (IREC)	Centralized energy system instead of individual units per apartmentn due to PEB ambition.	Due to the centralized system for HVAC and DHW, energy management is needed. The building will be monitored and data collected. Have detailed information on power generation and consumption.
Dutch	While drawing the urban plan, we make a drawing of the desired layout of a certain area, showing all elements that require space (the plots, greenery, roads, parking spaces and water)	Draft of the Zoning plan, which consists of three parts: the explanation, the rules and the representation (or plan map).	After the received judgements have been answered, the municipal council adopts the zoning plan.	In addition to the standard program of requirements, other requirements have been set in the field of energy efficiency (EPC = 0) and in the field of being able to charge electric cars.	Energy scenarios were investigated instead of using the standard solutions. TRNSYS software was used to determine the energy demand of the building.	Communication with heat pump suppliers to ensure possibility of using available data and to control the heat pumps remotel.	Several site visits were made by TNO to get a good picture of what was installed. The contractor has been informed by TNO how the installation should be properly installed and how monitoring equipment should be installed.	Specific attention to the monitoring equipment installed. Continuously informing the residents.
	With the Syn.ikia demo project, in addition to the traditional design factors, we look at the possibilities of sharing and storing energy locally.	The Environmental dialogue	The Environmental Dialogue					
Austrian	General urban design	Regulted by law	Urban design concerns	Building concerns	Mainly energy concerns	Regulated by law and standards	Only the project area	Only the project area
	Additional quality agreement. Workshops for the project.	Explanatory notes checked: Number of green spaces, type of energy supply Workshops for the project.	The urban design includes detailed plans for additional topics (mobility, energy, buildings, processes) and also for the neighborhood.	Building design, but it includes detailed designs for additional topics (mobility, energy, buildings, processes) and also for the neighborhood.	Includes detailed developments for additional topics (mobility, energy, buildings, processes) and also for the neighborhood.	Includes details for additional topics (mobility, energy, buildings, processes) and also for the neighborhood.	Measures in the neighborhood planned, not only for the buildings.	Interconnected with the neighborhood (energy community, social, mobility)
Norwegian	The municipal plan does not have any specific plan for housing.	Exisiting oning plan from 2005.	Got permission to raise the roof from the municipality, and then design the roof for energy generation. Where allowed to increase from 5 to 6 floors.	Schematic design and detailed plan were done simultaneously. Placing of the PV panels.		Development of design and interactions to meet the energy ambition.	Risk assessment is very important: both on the market and for technology.	Extensive monitoring equipment installed. Continuous improvement of energy system operations.
		Made an energy concept plan.						

Figure 2: Difference between a conventional project process and the syn.ikia demonstration projects processes.

4. A guideline for planning and design of Sustainable Plus Energy Neighbourhoods, IED^N

Based on the knowledge and experiences gained from the development of the demonstration projects, a guideline for planning and design of Sustainable Plus Energy Neighbourhoods (SPEN's) has been made to facilitate the Integrated Energy Design of Neighbourhood (IED^N) process.

The IED^N guideline is divided into four main phases with associated tasks described for the IED^N process, as shown in Figure 11. The name and nature of the different phases may vary between countries and regions, but the methods and principles described for the different phases are still relevant for different the local contexts.

Figure 3: The planning and design phases with the associated IED^N tasks described in the guideline.

The first phase is called *Masterplan* or may also be called *Framework Plan.* Here, an overall framework with ambitions and goals for the neighbourhood development is described, relating it to the overall strategic goals for the municipality and the district, and linking it to the needs and demands of the local community. For this phase, the guidelines included in this report are mainly based on experiences from the Austrian demo project, since this phase was not included in the other syn.ikia demo projects.

The phase *Zoning Plan and Detailed Plan* concerns formal plans and regulations for the neighbourhood development. The Zoning Plan describes how the area should be used, designed, and developed, and include overall functions requirements and regulations. In the Detailed Plan, the neighbourhood is further detailed with respect to infrastructure, space use and layout, and building volumes.

In the phases called *Schematic Design* and *Design development*, the process changes from an overall focus on the area planning to a closer focus on building and energy system design. In the Schematic Design phase, the overall design of the buildings, outdoor spaces, and energy infrastructure is developed. The process is iterative, where different design schematics are evaluated based on the project goals aided by simulation software to analyse the designs' performances. During the *Design Development* phase, the design gets more detailed, with layouts of buildings and energy systems, including descriptions of passive and active energy features.

The last design phase, *Detailed Design,* is where the buildings and systems are designed in detail, and construction documents are prepared.

The following paragraphs provide description of the different IED^N tasks within each of the four main design and planning phases. Many of the tasks are interrelated, so iteration may be needed between the tasks within a stage, and several tasks may also need to be repeated or further developed in later stages. Thus, the guide should not be viewed as a rigid recipe to be followed in strict consecutive order, but should be adapted and used according to the context and needs for the specific IED^N project at hand.

Masterplan (Framework Plan)

Perform a Stakeholder Mapping

A stakeholder analysis involves identifying distinct groups or individuals that could be directly involved in the development or are indirectly affected by the development. Relevant stakeholders include different departments in the municipality and the district, property developers, infrastructure operators, energy suppliers, funding bodies, neighbours, etc. Experiences from successful projects in Austria show that a thorough stakeholder analysis is key to establishing a good environment of cooperation and communication, as well as to reduce or avoid potential conflicts (SIR 2021).

Set up a Multidisciplinary Team

The planning process is cooperative and requires a multidisciplinary project team. Select a project team that consists of a wide range of stakeholders, developers, landowners, energy and environment specialists, energy and utility companies, architects, and urban planners. The team should cover all disciplines and perspectives present in the neighbourhood development, and the team members should be open to new solutions and collaboration across expert fields. Involving energy specialists early in the project improves the opportunities for finding optimal energy solutions, including possibilities for untapping the potential for energy flexibility.

In the Austrian case, a steering group consisting of key stakeholders, decision-makers, and external experts was set up in the early planning phase. The tasks of the steering group were to gather information, discuss and formulate goals, follow-up the progress, and take important strategic decisions along the development of the project. To have a neutral and professional leadership of the steering group, an external experiences project facilitator was engaged to lead the group throughout the planning process.

Set Goals and Ambitions

Setting the right goals from the beginning provides a clear direction for the planning and design processes. Countries and municipalities often have decarbonization strategies and/or environmental goals. The project team should be familiar with the local environmental strategies and their effects on the project. There should be a connection between goals of the masterplan and the regional and national strategies. That is, the project should address and contribute to achieving e.g., the national and local decarbonization strategies and environmental goals. The goals should be clear and address the energy and environmental performance of the area. That includes issues related to energy supply and use, energy flexibility, and greenhouse gas emissions. In addition, the goals should address social sustainability and wellbeing of the inhabitants and users of the area. High performance neighborhoods should also be attractive, affordable, and inclusive.

In the Austrian demo project, some main ambitions and principles for the development were established in the early planning phase. The main principle was to create high-quality, affordable housing, and a new social center for the Gneis district through the integration of the kindergarten and commercial or social uses. In this way, the team aimed to achieve a socially acceptable and sustainable concept of housing with open spaces, and sustainable energy and transport systems. The overall aim was to achieve a high quality of life for residents, as well as to take into account aspects of sustainability and climate protection. These ambitions and goals were formalized in a Quality Agreement (see page 28).

Organize Workshops

Organize initial workshops for the stakeholders to share knowledge, collaborate and develop concepts that are energy efficient and environmentally friendly. The workshops should be tailored towards the project goals, and address the main topics of energy efficiency, renewable energy supply, how to reduce the greenhouse gas emissions, and how to enhance the social sustainability. The workshops should be linked to the development of the energy concepts for the area. They can also be tailored to include the local citizens, to provide opportunities for dialogue and inputs from the neighbourhood into the project planning. Thematic workshops allow for finding solutions to specific topics, and developing different options that can be further evaluated to find optimal solutions. It is important that workshop participants are motivated, engaged, and openminded. The critical evaluation of ideas and possibilities should be performed in the end, or after a workshop, not during brainstorming and development of ideas.

Engage the Local Community

Citizen engagement should start in the Masterplan phase. Allow residents to take part in the development of their neighbourhood. Listen to the community, their interests, what services and functions they would prefer, and map ongoing activities and the use of the area. A positive dialogue with the local community will enhance the project acceptance and improve the project outcome.

Figure 12. Lively interest from residents and neighbours at a public meeting in the GNICE development in Salzburg. Photo: SIR.

Zoning Plan and Detailed Plan

Make Measurable Goals

Develop the project goals into measurable concrete indicators, often called Key Performance Indicators (KPIs). These indicators allow the project goals to be measurable throughout the planning, design, and operation phases neighbourhoods, so that the project team can easily check that project is on track towards the goals. The KPIs should be simple to understand and possible to assess by means of accessible project data. The syn.ikia project has developed a set of KPI's categorized in the following topics: Energy and Environment, Economic, Indoor Environmental Quality (IEQ), Social Sustainability, and Smartness and Flexibility, see Figure 13. Each topic has measurable performance indicators, which are used in the planning and design of the projects and in the operational phase to follow-up and verify the performance. The KPI's are used to analyze designs and to verify compliance with the project goals, and to measure the actual performance in operation.

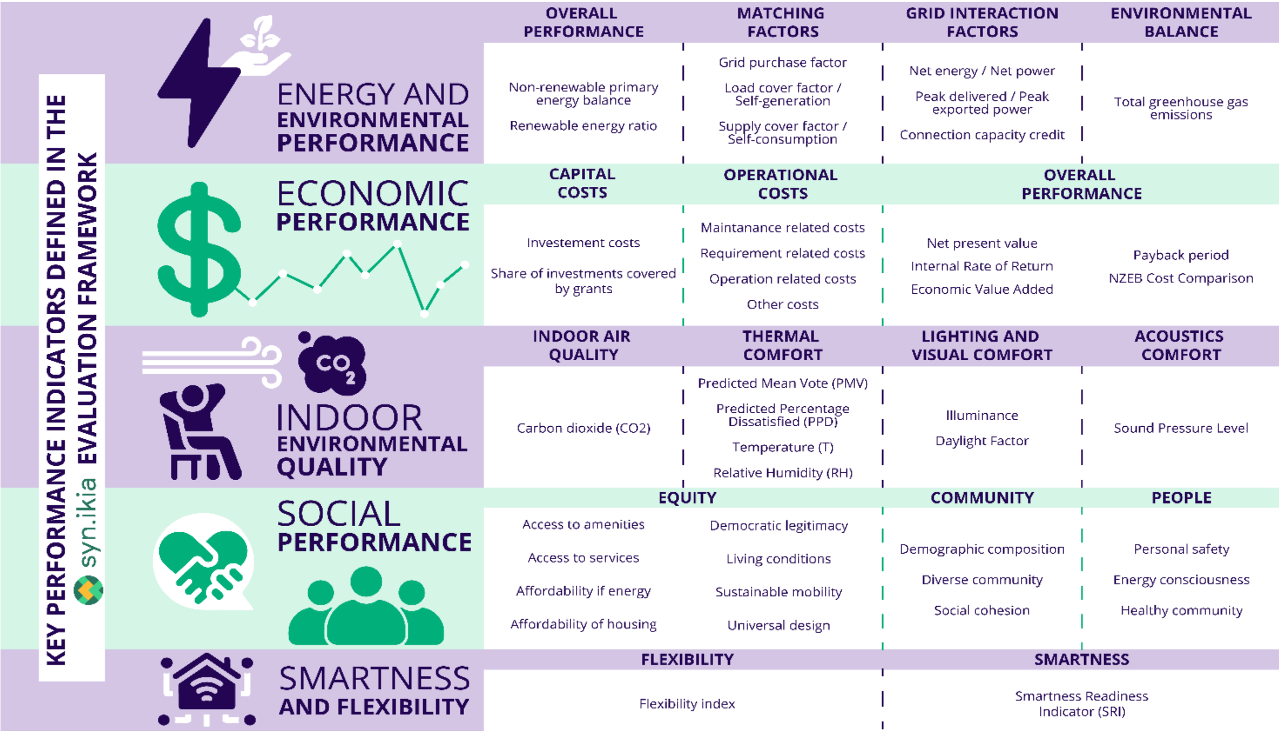
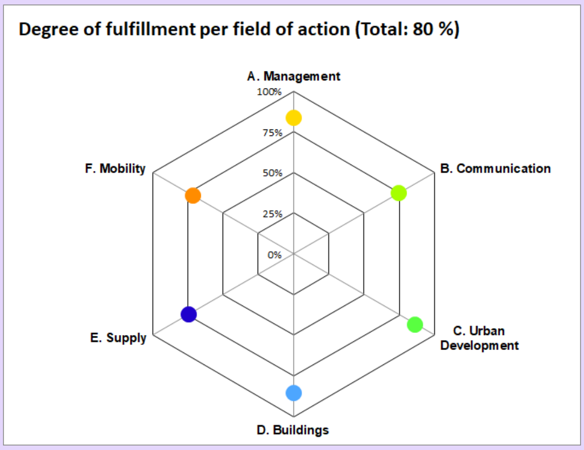


Figure 13. An overview of the Key Performance Indicators specified in the syn.ikia project. Based on (Salom et al 2020).

Box 1: Alignment of measurable goals in the Austrian demonstration project

The Austrian demonstration project included the environmental certification schemes [Klimaaktiv] and [Greenpass], in addition to the syn.ikia project goals and KPI's. The Klimaaktiv standard is an instrument from the Austrian ministry for climate and is used to define and declare quality standards for buildings and housing settlements. The declaration for single buildings defines a standard for the energy performance and sustainability. The declaration for a housing settlement defines the quality criteria into six fields: Management – Communication – Urban planning – Buildings – Utilities – Mobility.



The demo project "GNICE" archives 80 %, which is the "Silver" status (ref figure to the right). The main focus in the project is a collaborative development of high-quality outdoor spaces with high proportion of greenery; Greenpass© certified, buildings of mixed constructions with low heat demand; Klimaaktiv© certified, efficient energy supply with heat pumps combined with PV systems; plus-energy© certified, and high quality and sustainable mobility concepts with mobility point; Klimaaktiv mobil© certified.

Address Policies and Regulatory Drivers and Barriers

Addressing policies and regulatory drivers and barriers, especially in terms of energy efficiency and energy sharing between units or buildings, is a central issue in this phase. The regulations affect the energy concept of the project, and thus needs to be understood at an early point in the planning process. Ownership models and site borders also affect how energy can be distributed between units. Both current and future policies and regulations should be addressed, since neighbourhood developments usually are lengthy processes that extend over several years. The syn.ikia report *D5.1 Barriers and Opportunities of Plus-Energy Neighborhoods in the National and Local Regulatory Framework* (Boll et al 2021) provides and overview of legislation and policies relevant to SPENs, within the demo site countries and on the EU level.

Box 2: Current regulatory and policy drivers and barriers for SPENs in Austria

Drivers	• The national regulatory framework is empowering consumers and small actors such as SPENs to play an active role in the energy market, allowing them to produce, share, store and sell self-generated energy. The definitions of CSC, REC and CEC were transposed according to the REDII and EMD. • Austria offers a range of financial incentives for renewable energy production such as reduced network charges, taxes and levies. • Local production and consumption are encouraged, the REC being limited to physical boundaries of the local grid (low voltage), or the regional grid (medium voltage). It needs to be located within the territory of a single distribution system operator. • Strong leadership from the public sector, with municipalities promoting and participating in RECs. • RECs are not limited to electricity, they can also include heating from various renewable energy sources.
Barriers	• RECs require a legal entity, which is a significant barrier for SPENs. Private SPEN developers do not have the capacity to establish a REC, but if available in the SPEN location, a REC provides a good framework for the SPEN for selling excess energy to third parties.

REC: Renewable Energy Community
CSC: Collective Self-Consumption
REDII: Renewable Energy Directive II
EMD: Electricity Market Design
Drivers and barriers were identified by syn.ikia partners and presented in the Factsheets: Policy recommendations for Sustainable Plus Energy Neighbourhoods and Buildings (2023). Factsheets for each of the demo-site countries can be found here: *https://www.synikia.eu/policy-recommendations-for-sustainable-plus-energy-neighbourhoods-and-buildings/*

Engage the Local Community

Engaging the local community in the planning process involves sharing of information about the project and making a platform for the local community to take part in the process. Including the local community in the project and allowing them to provide feedback on plans and designs, and express their needs, will most likely improve the process flow of the project, with reduced friction, and enhance the project outcome, where it is more tailored towards the needs of the residents and users of the area. There are many ways to engage the community. For example, organization of meetings, workshops, setting up a stand or meeting place in the neighbourhood, presence on social media, etc. Find a method that reaches out to the community and ensures a dialogue between the project team and representatives of the community.

The community engagement activities should ideally continue throughout the planning and design phases.

Box 3 : The Dutch Environmental Dialogue.

Prior to the planning phase of the urban plan, the Dutch developer conducted a dialogue with stakeholders from the plan area. The stakeholders were mostly neighbours, either residential or people who work there, and they were invited by letter to participate in the environmental dialogue, which was organized in two rounds.

During the first meeting, information was provided about the construction plan and a dialogue was held with those who were present. The stakeholders were asked for input on several topics: accessibility (of the area), property separation, building height, positioning, and green structure. The urban plan was then composed with the input from the first round.

During the second meeting, the project team explained how the input from the previous meeting was incorporated into the plan, and those present were again given the opportunity to respond.

Valuable information was obtained from the two rounds of the environmental dialogue for the construction plan. The discussion was mostly about building height, density, and privacy regarding positioning and sizing of windows. This was incorporated into the urban plan, and the zoning plan was further elaborated and brought into procedure. It is not mandatory to have an environmental dialogue in the Netherlands, but it was very beneficial as it reduced the resistance to the project. Partly thanks to the extensive environmental dialogue, no objections were lodged against the plan during the zoning plan procedure.

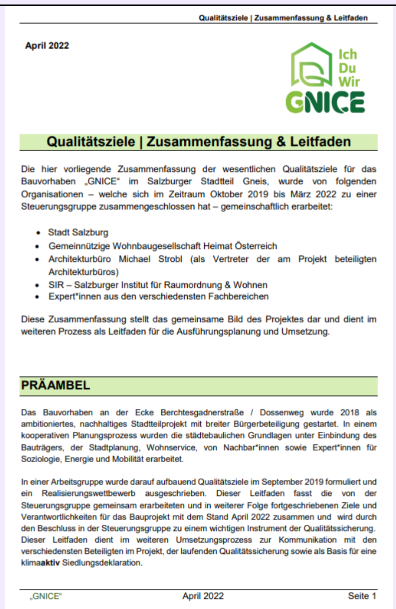
Make a Quality Agreement

Make a Quality Agreement where the project goals (referring to the master plan), responsibilities, and rules are clearly defined. The agreement is between all stakeholders involved in the project and provides a solid foundation for the cooperation throughout the project. The Quality Agreement ensures that the project meets its energy and performance goals. The agreement includes a Quality Assurance Plan for the project process, where significant tasks for the project performance are specified, to be followed-up in the different stages of the project.

Box 4: The Austrian Quality Assurance Process.

In the Austrian demo, all phases will be accompanied by a quality assurance process. The main elements of this process are defined in the quality agreement and the Klimaaktiv standard, which are used as checklists and ensure that the goals are reached. The outcomes are reports that document the progress and quality of the project.

The quality agreement is an agreement between the project developer, the city of Salzburg, the architects, and other relevant planners, that describes the goals/qualities for six topics (management, communication, urban development, buildings, energy, and mobility). The quality agreement is the result of a communication process and expresses what goals must be fulfilled at the end of the project to ensure that all stakeholders say: “It is a successful project”. It is a summary and documentation of the main visions, ideas and measures that were discussed and set as objectives within the development process. It shall also be used as a communication instrument when new people join the project team. It is evaluated in each phase of the project, and at the end. On one hand, the document is a guideline for all relevant stakeholders that are a part of the project in the planning, implementation, and use phases. On the other hand, it functions as a quality check at the end of the project, to understand if the project was implemented successfully or whether some qualities were lost in the process. It is a voluntarily instrument and not legally binding.



Qualitätsziele | Zusammenfassung & Leitfaden

April 2022

Ich Du Wir GNICE

Qualitätsziele | Zusammenfassung & Leitfaden

Die hier vorliegende Zusammenfassung der wesentlichen Qualitätsziele für das Bauvorhaben „GNICE“ im Salzburger Stadtteil Gneis, wurde von folgenden Organisationen – welche sich im Zeitraum Oktober 2019 bis März 2022 zu einer Steuerungsgruppe zusammengeschlossen hat – gemeinschaftlich erarbeitet:

- Stadt Salzburg
- Gemeinnützige Wohnbaugesellschaft Heimat Österreich
- Architekturbüro Michael Strobl (als Vertreter der am Projekt beteiligten Architekturbüros)
- SIR – Salzburger Institut für Raumordnung & Wohnen
- Expert*innen aus den verschiedensten Fachbereichen

Diese Zusammenfassung stellt das gemeinsame Bild des Projektes dar und dient im weiteren Prozess als Leitfaden für die Ausführungsplanung und Umsetzung.

PRÄAMBEL

Das Bauvorhaben an der Ecke Berchtesgadnerstraße / Dossenweg wurde 2018 als ambitioniertes, nachhaltiges Stadtteilprojekt mit breiter Bürgerbeteiligung gestartet. In einem kooperativen Planungsprozess wurden die städtebaulichen Grundlagen unter Einbindung des Bauträgers, der Stadtplanung, Wohnservice, von Nachbar*innen sowie Expert*innen für Soziologie, Energie und Mobilität erarbeitet.

In einer Arbeitsgruppe wurde darauf aufbauend Qualitätsziele im September 2019 formuliert und ein Realisierungswettbewerb ausgeschrieben. Dieser Leitfaden fasst die von der Steuerungsgruppe gemeinsam erarbeiteten und in weiterer Folge fortgeschriebenen Ziele und Verantwortlichkeiten für das Bauprojekt mit dem Stand April 2022 zusammen und wird durch den Beschluss in der Steuerungsgruppe zu einem wichtigen Instrument der Qualitätssicherung. Dieser Leitfaden dient im weiteren Umsetzungsprozess zur Kommunikation mit den verschiedensten Beteiligten im Projekt, der laufenden Qualitätssicherung sowie als Basis für eine klima**aktiv** Siedlungsdeklaration.

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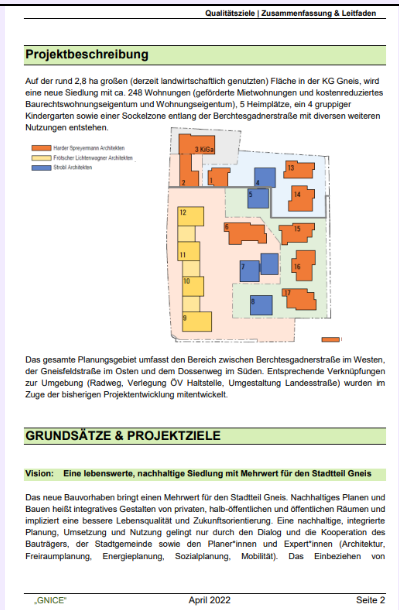

Qualitätsziele | Zusammenfassung & Leitfaden

Projektbeschreibung

Auf der rund 2,8 ha großen (derzeit landwirtschaftlich genutzten) Fläche in der KG Gneis, wird eine neue Siedlung mit ca. 248 Wohnungen (geförderte Mietwohnungen und kostenreduziertes Baurechtswohnungseigentum und Wohnungseigentum), 5 Heimplätze, ein 4 gruppiger Kindergarten sowie einer Sockelzone entlang der Berchtesgadnerstraße mit diversen weiteren Nutzungen entstehen.

Das gesamte Planungsgebiet umfasst den Bereich zwischen Berchtesgadnerstraße im Westen, der Gneisfeldstraße im Osten und dem Dossenweg im Süden. Entsprechende Verknüpfungen zur Umgebung (Radweg, Verlegung ÖV Haltstelle, Umgestaltung Landesstraße) wurden im Zuge der bisherigen Projektentwicklung mitentwickelt.

GRUNDSÄTZE & PROJEKTZIELE

Vision: Eine lebenswerte, nachhaltige Siedlung mit Mehrwert für den Stadtteil Gneis

Das neue Bauvorhaben bringt einen Mehrwert für den Stadtteil Gneis. Nachhaltiges Planen und Bauen heißt integratives Gestalten von privaten, halb-öffentlichen und öffentlichen Räumen und impliziert eine bessere Lebensqualität und Zukunftsorientierung. Eine nachhaltige, integrierte Planung, Umsetzung und Nutzung gelingt nur durch den Dialog und die Kooperation des Bauträgers, der Stadtgemeinde sowie den Planer*innen und Expert*innen (Architektur, Freiraumplanung, Energieplanung, Sozialplanung, Mobilität). Das Einbeziehen von

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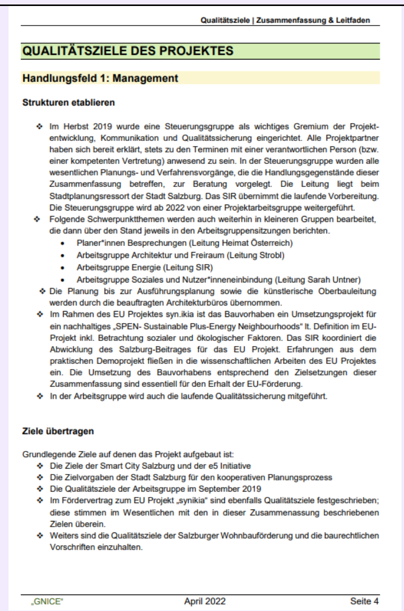

Qualitätsziele | Zusammenfassung & Leitfaden

QUALITÄTSZIELE DES PROJEKTES

Handlungsfeld 1: Management

Strukturen etablieren

- Im Herbst 2019 wurde eine Steuerungsgruppe als wichtiges Gremium der Projektentwicklung, Kommunikation und Qualitätssicherung eingerichtet. Alle Projektpartner haben sich bereit erklärt, stets zu den Terminen mit einer verantwortlichen Person (bzw. einer kompetenten Vertretung) anwesend zu sein. In der Steuerungsgruppe wurden alle wesentlichen Planungs- und Verfahrensvorgänge, die die Handlungsgegenstände dieser Zusammenfassung betreffen, zur Beratung vorgelegt. Die Leitung liegt beim Stadtplanungsressort der Stadt Salzburg. Das SIR übernimmt die laufende Vorbereitung. Die Steuerungsgruppe wird ab 2022 von einer Projektarbeitsgruppe weitergeführt.
- Folgende Schwerpunktthemen werden auch weiterhin in kleineren Gruppen bearbeitet, die dann über den Stand jeweils in den Arbeitsgruppensitzungen berichten.
  - Planer*innen Besprechungen (Leitung Heimat Österreich)
  - Arbeitsgruppe Architektur und Freiraum (Leitung Strobl)
  - Arbeitsgruppe Energie (Leitung SIR)
  - Arbeitsgruppe Soziales und Nutzer*inneneinbindung (Leitung Sarah Untner)
- Die Planung bis zur Ausführungsplanung sowie die künstlerische Oberbauleitung werden durch die beauftragten Architekturbüros übernommen.
- Im Rahmen des EU Projektes syn.ikia ist das Bauvorhaben ein Umsetzungsprojekt für ein nachhaltiges „SPEN- Sustainable Plus-Energy Neighbourhoods" lt. Definition im EU-Projekt inkl. Betrachtung sozialer und ökologischer Faktoren. Das SIR koordiniert die Abwicklung des Salzburg-Beitrages für das EU Projekt. Erfahrungen aus dem praktischen Demoprojekt fließen in die wissenschaftlichen Arbeiten des EU Projektes ein. Die Umsetzung des Bauvorhabens entsprechend den Zielsetzungen dieser Zusammenfassung sind essentiell für den Erhalt der EU-Förderung.
- In der Arbeitsgruppe wird auch die laufende Qualitätssicherung mitgeführt.

Ziele übertragen

Grundlegende Ziele auf denen das Projekt aufgebaut ist:
- Die Ziele der Smart City Salzburg und der e5 Initiative
- Die Zielvorgaben der Stadt Salzburg für den kooperativen Planungsprozess
- Die Qualitätsziele der Arbeitsgruppe im September 2019
- Im Fördervertrag zum EU Projekt „synikia" sind ebenfalls Qualitätsziele festgeschrieben; diese stimmen im Wesentlichen mit den in dieser Zusammenassung beschriebenen Zielen überein.
- Weiters sind die Qualitätsziele der Salzburger Wohnbauförderung und die baurechtlichen Vorschriften einzuhalten.

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An excerpt from the quality agreement of the project, which served as a guideline for the process with defined ambitions and goals, and a checklist to ensure that all objectives were considered in each of the project phases.

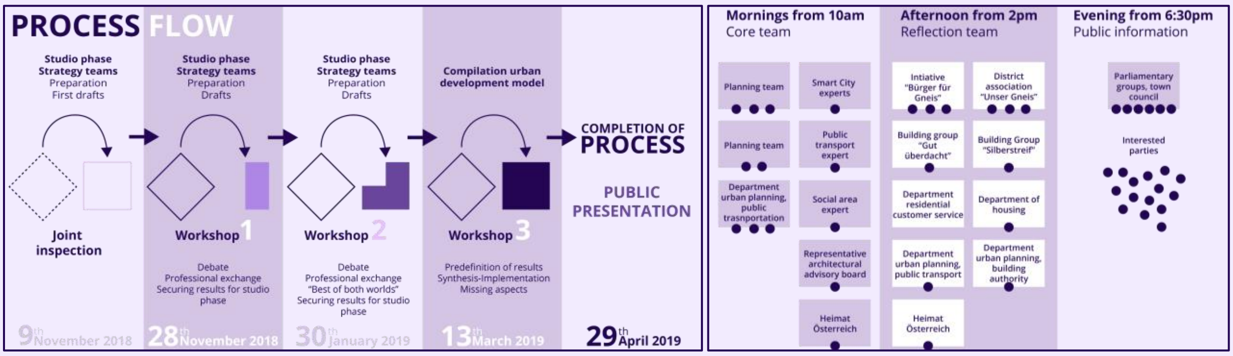
Organize Workshops

Organize thematic workshops for the stakeholders. This allows the stakeholders and experts to focus on specific topics and issues, and to find possible solutions. The workshops should be tailored towards the project goals, and address important topics such as energy efficiency, renewable energy supply, reducing energy and greenhouse gas emissions on a neighbourhood level, and how to enhance the social sustainability.

The thematic workshops should be repeated during the planning process as the plan develops and new insight is needed. There may also be a need to continue the workshops into the design phases.

Box 5: Workshops in the Austrian demo project GNICE.

In the planning phase, the building developer and city of Salzburg tried to include all interested stakeholders in the development process by a cooperative planning process, with a joint inspection, workshop 1, workshop 2, workshop 3 and public presentation. Each workshop had different goals and participants, as it is visualized below.



The figure to the left shows a representation of the procedures and dates for the pre-planning phase: joint inspection, workshop 1, workshop 2, workshop 3 and public presentation. The figure to the right displays the program for one of the workshops. More details are provided in Appendix B.

A photo from one of the workshops. The workshops gathered high interest from the community. A social planner was responsible for the social planning consultation, and to ensure public relation and participation in the project.

Evaluate the Potential for Energy Efficiency, Renewable Energy, and Energy Sharing

Focus on energy efficiency and integrated energy design for the buildings and neighbourhood. The *Zoning Plan* focuses on the types of buildings, their shape, and land utilization. These are aspects affect the passive design features of the buildings, and consequently, the energy efficiency. Further, façade regulations addressed in the *Detailed Plan* affect architectural quality and solar energy potential for renewable energy generation, as well as daylight access.

Several factors such as local climate, landscape and terrain, and soil properties may affect the potential for energy efficiency measures and local energy generation. The efficiency of building integrated systems, such as BIPV, can be affected by the layout of the buildings and their orientation. Local grid capacities may limit the possibilities for import of export of electricity in the area. Also, investment costs and current and future energy and power prices are of course important to consider. Therefore, to get a proper overview of the current and potential energy and power use, and utilization of renewable energy in the area, it is recommended to apply urban simulation tools. In syn.ikia, different urban simulation tools have been reviewed, and the results are described in *D3.5 Analysis of shared infrastructure in Plus Energy Neighbourhoods* (Salom et al 2023). Commercially available tools such as URBANopt, CEA, and UMI may be used to model different neighbourhood layouts, and get predictions of energy loads, demands, and renewable energy generation, as illustrated in Figure 14. However, the study also showed that the available tools are not yet able to analyse and optimize energy flows in a large building or within a group of buildings and examine their interaction with the shared electrical grid infrastructure.

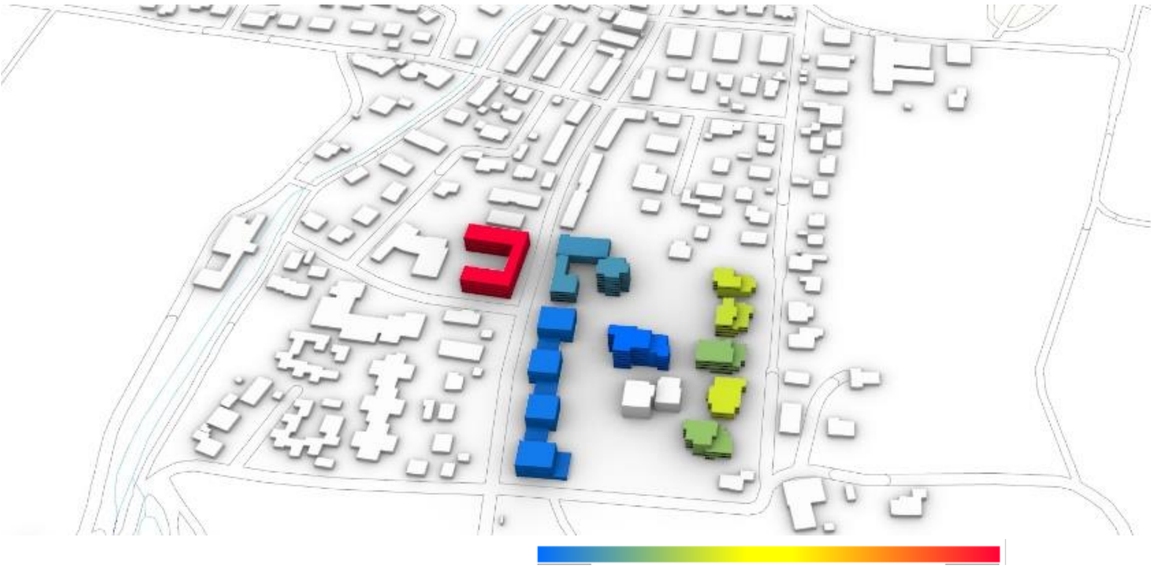


Figure 14. Example of simulation output from UMI – Operational energy kWh/m2y

What is missing in the urban simulation tools currently available on the market, is the possibility to optimise or intelligently control energy demands, loads, and local energy production between several buildings, including the capacity of the respective grid infrastructure with related emissions and prices. The issue of flexibility plays an important role here and has not yet been considered in depth in available simulation tools. Therefore, within the syn.ikia project, a new Urban Simulation tool is being developed that provides the following functionalities (Salom et al 2023):

- Co-simulation of building performances with electric grids
- Evaluation of energy sharing between different users in a community grid
- Enhancement of buildings' operation by activation of energy flexibility with advanced control.

Further description of the tool may be found in the syn.ikia report D3.5 Urban Simulation Tool Prototype (Salom et al. 2023).

Develop a Green Area Concept

Develop concepts for the green spaces in the neighbourhood that combine rainwater management with spaces for the residents to meet, play and be outdoors. Account for future climate scenarios with more flash rain and drought, the urban heat island effect (especially in dense urban areas in warm climates), and use local plants for biodiversity.

Box 10: Green area concept for the Norwegian demo

The Norwegian demo project also involved the planning and design of a large outdoor area around a small lake (Sorgenfridammen) at the 'heart' of Verksbyen. A consultant company assisted in the development of a landscape plan for the park areas. In connection with the development of Verksbyen, a company for nature conservation was commissioned by the developer, in cooperation with the municipality and other stakeholders, to investigate the possibilities of safeguarding the lake onsite, Sorgenfridammen, as an attractive area for nesting wetland birds and biological diversity, within the framework of the adopted regulatory plan.

Image from arcanova.no

Schematic Design and Design Development

Set up a Multidisciplinary Design Team and Organize Workshops

As project moves from the planning phase into the design phase, the project setup changes, as some of the participants from the planning phase will step back, and new participants will come in. At this transition, it is important that the ambitions, goals, and learning from in the planning phase are carried on into the design phase. An effective way to pass on the knowledge could be to arrange a common workshop with all the key participants from both phases, where the outcome of the planning phase is presented and discussed with the new team members.

Further, throughout the schematic design phase and into the design development, it is recommended to facilitate the integrated energy design by regular thematic workshops between the architects, engineers, and energy/environment specialists of the team. The first workshop should include all the participants focusing on the overall goals and agreeing how to work together in an efficient way. In case the design team is not experienced in integrated energy design, an IED^{N} facilitator may be introduced to coach the team throughout the process. Following the initial overall workshop, thematic workshops on key topics such as energy systems, indoor environmental quality, life cycle costs, etc., should be arranged.

Use Suitable Design Strategies and Tools

Energy simulation tools were used in the syn.ikia demo projects to test and analyse different design options for energy efficiency, energy generation, and flexibility. Various passive design features, such as envelope construction, shading strategies, and size and placement of window openings were tested for energy performance and indoor environment quality. Active design options, such as type of heating and ventilation systems were also simulated and evaluated according to the same criteria.

Trade-offs between architectural design, energy performance, and economical aspects were performed to achieve high architectural quality, a plus energy balance, and affordable solutions. For example, the Norwegian demonstration project worked extensively on the façade design with placement of building integrated photovoltaic panels (BIPV) to ensure an architectural expression of the façade that would be welcoming for the residents and at the same time generate sufficient electricity. In the Spanish demo, the research partner IREC, performed energy simulations together with the engineer from the design team, and the developer, INCASÓL, did the economic analysis for the proposed solution.

Figure 15 shows 10 general steps in a design strategy to achieving a SPEN, where the first two steps of the pyramid are the most significant in the zoning and detailed plan, and the next eight steps are mainly detailed in the design phases. However, close integration between the different steps is important as the different topics are very much interconnected, thus design iterations are needed in the early stages. Proper consideration of all the topics in the early stages would save time and resources later in the process when changes are more difficult and costly to implement.

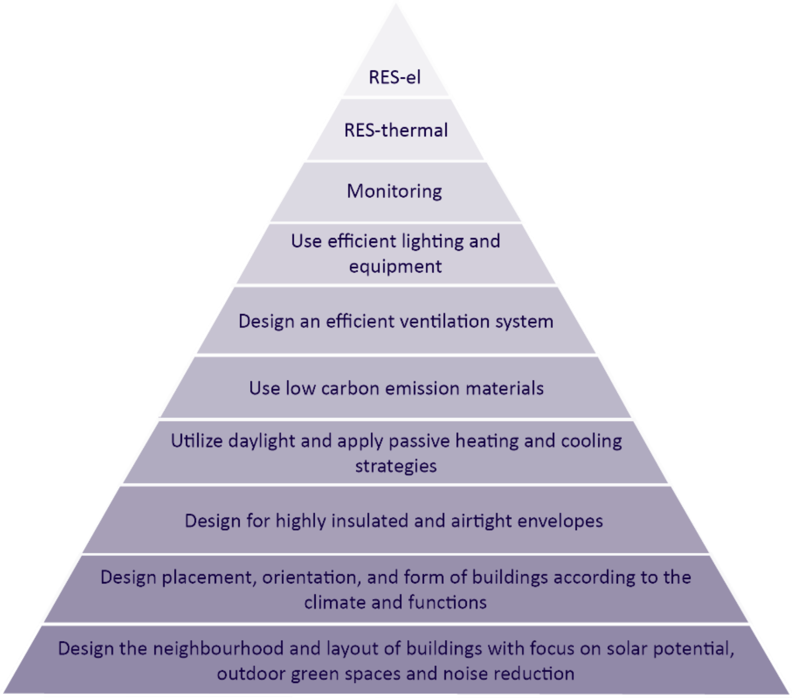


Figure 15: 10 steps to SPEN, inspired by the 10 steps to Zero Emission Buildings as described in (Hestnes and Eik-Nes 2017).

Starting from the bottom of the pyramid, the layout of the buildings in the neighbourhood should account for solar access. This includes positioning buildings with sufficient space between to allow for passive heating and access to daylight.

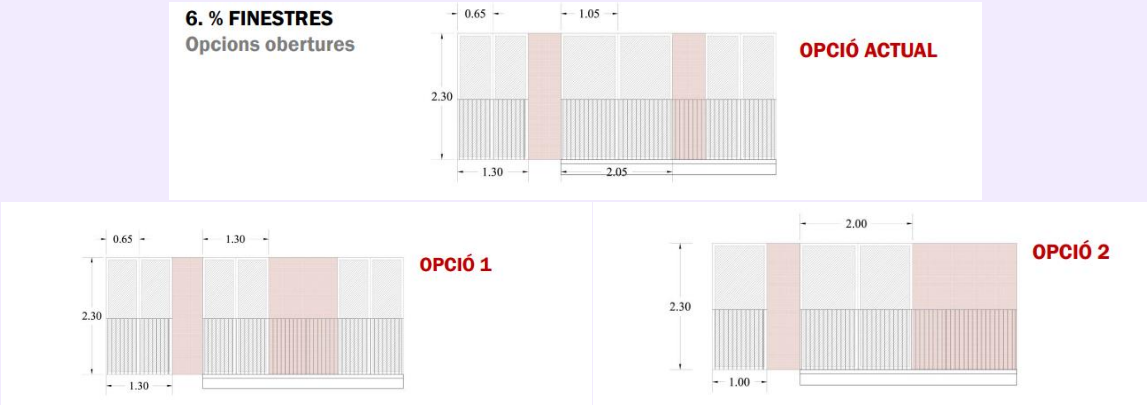
The outdoor air quality of the area should be addressed. A dense urban area can benefit from incorporating more greenery to improve the outdoor air quality and improve thermal comfort. Noise pollution can also be an issue in urban areas. Buildings and landscape can function as "noise barriers", where careful positioning and orientation of buildings can improve and reduce noise levels.

The placement, orientation, and form of the buildings should be tailored to the climate. For example, in a heating dominated climate on the northern hemisphere, south-oriented buildings are appropriate to utilize passive heating, and thus reduce the heating consumption. In addition, a compact shape reduces the heat loss and is consequently more energy efficient in heating dominated climates. In general, the building envelope should be highly insulated and airtight, to reduce heat loss and improve the energy efficiency of the building. On the other hand, in warm climates where the need for cooling is significant, a balance between must be found, since very high levels of insulation and airtightness can cause overheating problems in summer.

Utilization of daylight is important for visual comfort and to reduce the electric energy need for lights and for cooling. Passive heating and cooling strategies imply the application of shading strategies, utilization of natural ventilation strategies, and façade and fenestration design. Natural ventilation means using e.g., window openings, temperature differences and wind to drive the outside air through the building, providing fresh air and cooling down the interior. It is affected by the microclimate, including local temperature differences, wind direction and velocities, and buildings shape, composition, and structure (thermal mass). If the air quality allows for it, natural ventilation should be planned for all or parts of the year in warm climates, as it may significantly improve the thermal comfort and avoid the need for mechanical cooling. In colder climates like the Nordic, natural ventilation may be an efficient strategy in the warm season, while mechanical ventilation with heat recovery is recommended in the cold season.

Box 6: Simulations of design options by the Spanish demo.

The facade design in the Spanish demo went through an iterative design process. IREC, the syn.ikia research partner, studied the thermal insulation of the wall design, and proposed a thicker wall with more insulation than the initial design, which the architect then incorporated into the design. The same process was performed for the openings of the building. Here, IREC analysed three different window configurations proposed by the architect, shown below. IREC performed energy and indoor environment analyses together with the engineer from the design team, and afterwards INCASÓL did the economic analysis for the proposed solution. Option 1 was chosen based on the analysis by IREC, with the goal of achieving a comfortable plus energy building.



Different window configurations proposed by the architects and analysed by IREC in terms of energy and indoor environment.

The use of materials with a low carbon footprint means taking into account the type of materials, their origin of production, type of transport, durability, and maintenance issues, i.e., all issues that leads to greenhouse gas emission during the lifetime of the neighbourhood. A compact and efficient building with a high degree of area efficiency and spaces for mixed use, will be beneficial. Setting requirements with respect to flexibility in use may be challenging, as it may both limit and enhance the possibilities for achieving low life cycle emissions. In most cases, it is therefore necessary to find a trade-off that balances the investment in a high degree of flexibility and an efficient tailor-made design. As a general rule, foundations, structural systems, and the building envelope represent the main parts of the carbon footprint, so it may be a good idea to start by focusing on these elements.

Efficient mechanical ventilation systems with heat recovery are usually selected in plus energy developments, especially in cold climates. In any case, the energy use for fans should be minimized through designing systems with low pressure drops, including demand control, short and spacious distribution channels, as well as taking advantage of thermal buoyancy for extracting air. In addition, ventilation air volumes should be minimized by utilizing thermal mass to avoid overheating, and by using low-emitting materials to minimize indoor air pollutants.

Energy efficient light and equipment involves selecting and specifying components that have energy label A+++, making sure that the equipment is not oversized, and that it can be easily controlled. A monitoring and visualization system should be included, so that the occupants and building operators can follow and adjust the energy use in a smart way.

The last two steps in the pyramid involve selecting appropriate energy supply systems based on renewable sources. Options for renewable thermal energy systems include different types of heat pump systems, solar thermal collector systems, and biofuel systems. Also, there is a choice between local systems with storage in each apartment or building, or central systems that serve the entire neighbourhood. The choice depends on a range of different factors, such as local ground conditions, solar availability, the availability of local suppliers and expertise, etc. The demo projects in syn.ikia have all chosen different kinds of heat pump systems, and three out of four projects have designed centralized systems for the neighbourhood (ref. Box 8 and Finocchiaro et al 2021 for a further description). A general advice is to keep the system as simple as possible, and taking into account the maintenance and operation requirements.

When it comes to renewable electric energy systems, options include photovoltaics (PV), wind power, hydro power, and CHP machines based on biofuels. All the syn.ikia demo projects have chosen to design building adapted/integrated photovoltaic systems, due to considerations of cost-efficiency and maintenance. A detailed description of the PV system design may be found in (Finocchiaro et al 2021).

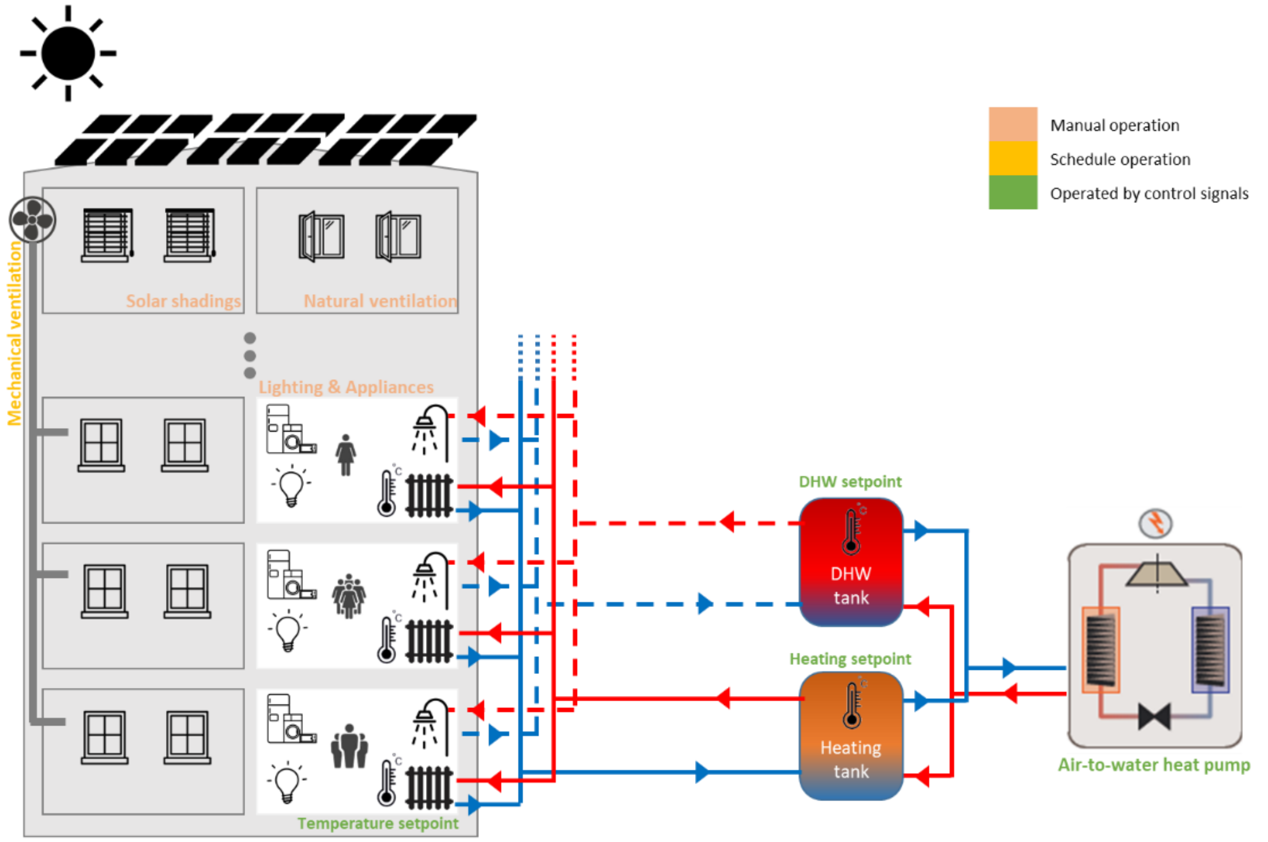


Figure 16. Schematic illustration of the energy systems in the Spanish demo project.

Design tools are constantly evolving, and there is a vast amount of different design tools for energy simulations and parametric design studies. Tools should be used for a specific purpose, and not for the sake of using design tools themselves, as they are time consuming to use. Useful tools are those that are able to integrate the different technical systems with the building design, and that can provide visual presentations of the different key performance indicators. However, one should select tools that the design team is confident in using, as the outcome and reliability of the tools depend on the input, understanding, and skills of the users. In appendix B, the tools used in the different syn.ikia demo projects are listed.

Box 7: Design tools in the Norwegian demo.

The architect experienced a lack of tools in the preliminary stages as it is difficult to know the implication of design choices. For example, for the building called Panorama, the balconies limit façade area for PV generation and the design team found that to have energy generation on the balconies is not worth it compared to the impact on the aesthetics and resulting energy generation.

Now, the architect has access to a program (DataTree) which uses AI simulations to balance the daylight access and energy generation. This gives earlier input for different design configurations and makes it easier and faster to understand design implications. However, for this demo project they had to manually test it out with daylight access and energy generation.

Representatives from the architectural company in the project, Griff Arkitektur.

Evaluate Different Design Options through Scenario Analyses

In syn.ikia, different design options were generated for each demo project based on the local climate, building code, and available renewable resources. Designs were analyzed and compared based on energy simulation software. The demonstration projects used the KPI's developed in syn.ikia to evaluate design options. The "best" designs were then tested with simulations of different scenarios, to evaluate the performance under different climate change scenarios by the IPPC, user behaviour patterns, and systems controls for increased energy flexibility. The aim was to ensure high performance under varying and not optimal conditions, and the performance criteria were energy consumption and thermal comfort.

Analysis of different user behavior patterns, climate change scenarios and HVAC system settings for energy flexibility provide feedback on the robustness of the designs in changing conditions. The scenarios should be developed according to different models for use of the buildings and neighbourhood, and possible future changes in climate and energy prices (Figure 17).

Finally, designs were either approved and further developed or altered based on the simulation results and economic viability. The process is described in detail in *D.2.1 Report on Design Plus Energy Neighbourhoods in Each of the Four Climatic Types* (Finocchiaro et al 2021) and summarized in a scientific article (Andresen et al 2023).

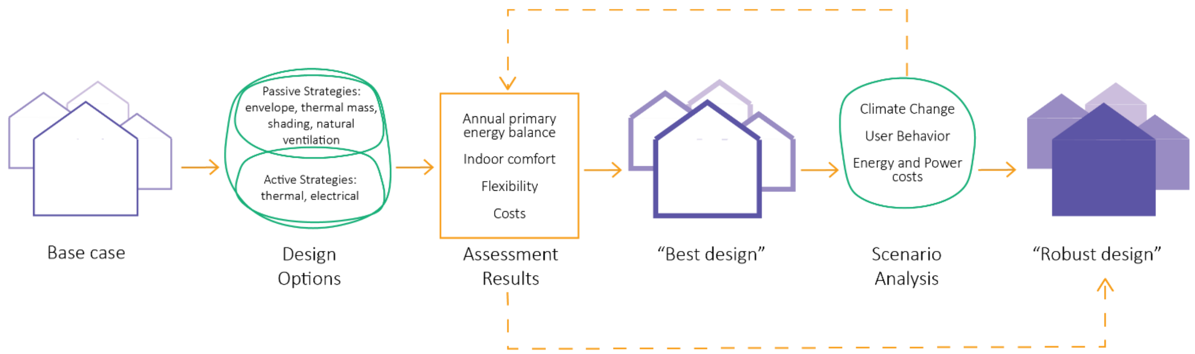


Figure 17: An illustration of the iterative nature of integrated energy design, from (Andresen et al 2022).

Design an Integrated Energy System

Evaluate the energy system design, with HVAC systems, thermal and electrical renewable energy supply, and storage systems. Consider the pros and cons of centralized vs decentralized systems, and with respect to the different performance goals. The different options for renewable energy sources should be evaluated from a lifecycle perspective, considering greenhouse gas emissions, life cycle costs and benefits, and users' needs. The energy system needs to be evaluated both on the building level and on the neighbourhood level, taking into account distribution losses, energy flexibility, and architectural qualities. Regarding design for energy flexibility, see pages 44 and 45.

Figure 18 shows the energy concept system diagram for the Dutch demo project. Box 8 presents the energy systems and building characteristics in each of the demo projects, and Box 9 show an example of design of BIPV in the Norwegian demo project.

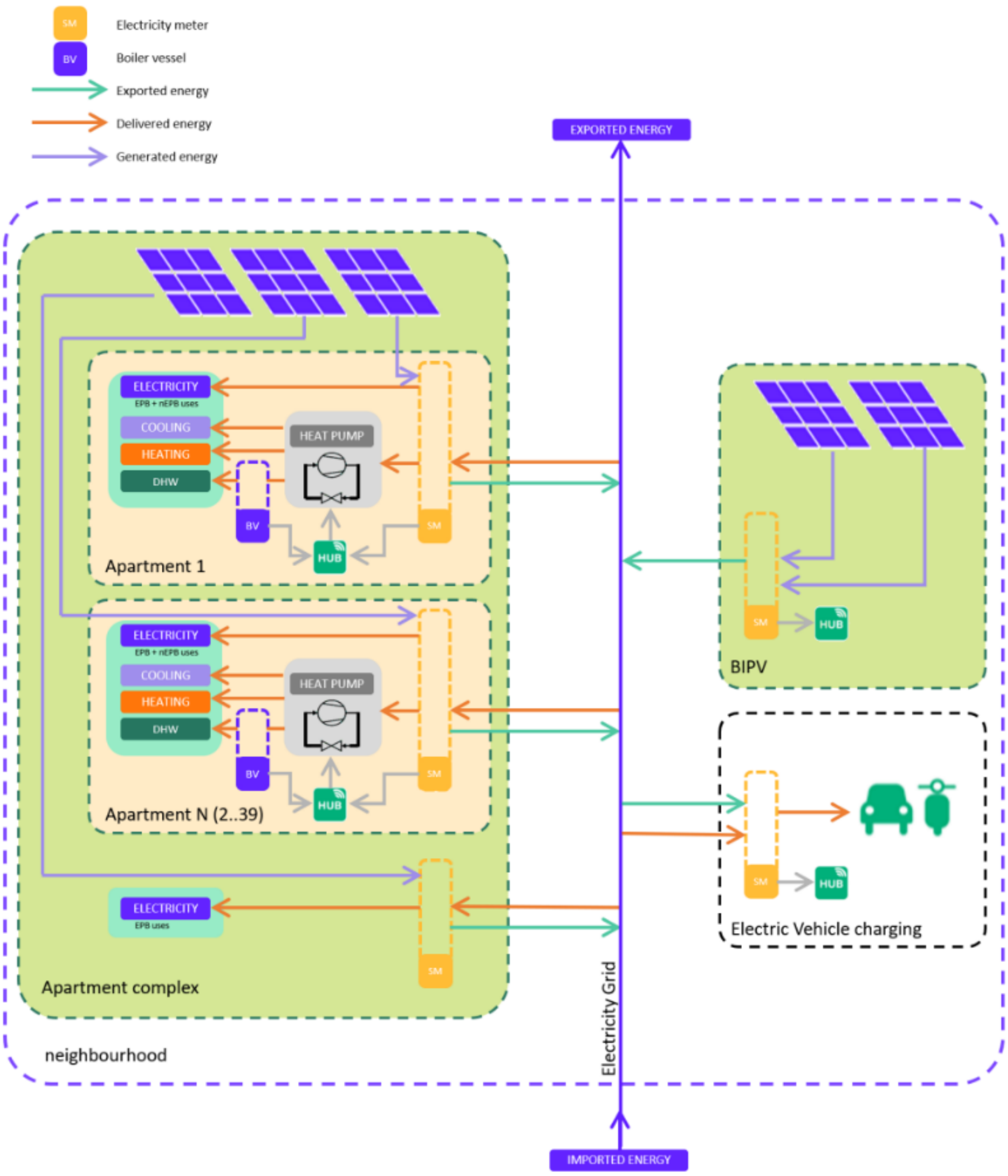


Figure 18: A conceptual figure of the energy concept with flexibility strategies for the Dutch demo. The different system boundaries are represented by dashed lines. The heat pump receives electricity for the PV panels and from the electricity grid when necessary. The heat pump then provides heating, cooling, and DHW, and is controlled by a MPC (Model Predictive Control) to introduce flexibility by filling the DHW vessel when the MPC finds it most optimal.

Box 8: Building characteristics and energy systems in the demo projects			
Santa Coloma de Gramenet, Barcelona, Spain	*Loopkantstraat, Uden, The Netherlands*	*Gewin Gneis, Salzburg, Austria*	*Verksbyen, Fredrikstad, Norway*
Mediterranean climate	Marine climate	Continental climate	Subarctic climate
Well insulated and air-tight envelope compared to the Spanish building code, with moderate glazing area. Natural ventilation and moveable solar shading provide sufficient cooling and remove the need for active cooling. A four-pipe air-to-water heat pump provides thermal supply to low temperature radiators and DHW and could potentially provide cooling in the future if needed. Roof mounted southeast oriented PV panels provide electricity.	Well insulated and air-tight envelope. Moderate glazing area. The apartments have mechanical exhaust ventilation with CO^2 sensors and air-take in the façade. Individual GSHP provide thermal energy supply for space heating and cooling, and DHW, which is a cost-efficient solution in the Dutch market. The heat pump will be controlled by a model predictive control (MPC) for energy flexibility. Roof mounted PV panels provide electricity.	Well insulated and air-tight envelope with moderate glazing area. Exhaust ventilation and an effective common GSHP for heating and cooling conditions the buildings. The solution was based on a tradeoff between construction costs and energy operation costs and was considered the most cost-effective. Building integrated PV panels on roofs and facades provides electricity.	Well insulated and airtight envelope compared to the Norwegian building code, with solar shading. The apartments have individual units for balanced ventilation with high heat recovery efficiency. Thermal energy supply is from a central system with a GSHP. The system is coupled with a propane heat pump for space heating with hydronic radiant floors and a CO_2 heat pump for DHW. Auxiliary heat is covered by district heating. Building integrated PV panels on roofs and facades supply the buildings with electricity.

Box 9: Simulation of BIPV generation on the façade in the Norwegian demo

In the Norwegian demonstration project, the ambition was to implement solar panels as a natural part of the buildings, where the energy generation on roofs and facades were to be integrated in the architecture. The aim was to reduce the technological look and add a more rustic character to the project. The architect expressed *"It is challenging to ensure good aesthetics by introducing PV panels on the façade"*. The developer and the architect had continuous meetings to solve design issues, which was an ongoing process for a long time due to challenges with meeting the energy ambition. The architect worked extensively on the façade design to achieve sufficient energy generation, while maintaining a desired architectural expression. Both the overall look of the architecture and more detailed studies were done to test the options in small and large scales. All the facades went through an iterative process, where detailed 3D models were used for evaluation of different design solutions. The different options were evaluated upon the criteria of visual aesthetics, technical solution, solar energy generation, and cost.

Illustration to test the placement of PV panels on the facade and roof to maximize the energy performance.

syn.ikia

Design for Sharing Concepts

Sharing concepts for neighbourhoods minimize the use of resources and energy consumption, and SPEN's should share more than energy. Organize workshops with the local community and future residents and brainstorm possible sharing concepts and how they would be organized and managed. Examples of sharing opportunities are EVs, bikes, common spaces.

Box 11: Sharing concepts for the community and mobility points in the Austrian demo,

Good cooperation between the developer and the community is important, as several significant topics do not end at the border of the planning field (bicycle infrastructure, recreation areas, public transport and car-sharing, energy communities with the neighbourhood, social exchange).

In the Austrian demo, the phases from detailed plan to schematic design, design development and detailed design included focus on mobility solutions, in addition to a strong focus on energy efficiency and renewable energy supply. An energy community is to be formed in the operational phase, and common bicycles are implemented to improve sustainable mobility and social qualities.

The specific measure implemented for the mobility concept includes moving the existing bus station, implementing a mobility point, and establishing a central parking station for all cars of the neighbourhood.

Picture of the Mobility Hub in the Austrian demo project WirInHauser. Photo: SIR.

Perform Quality Assurance and Risk Assessment

In innovative and forward-thinking projects, new methods and untested systems are often a part of the project. The implementation of new solutions increases the project financial risk, as there is more uncertainty with respect to their performance. However, the possible benefits could be significant to the project's success. Thus, a quality assurance including a risk assessment, focusing on both financial and technical aspects, should be performed at an early stage in the project, and followed-up throughout the project development.

Box 12: Risk Assessment and Quality Assurance in the Norwegian demo

Photo from arcanova.no

According to the Norwegian developer Arca Nova, quality assurance is closely linked to risk management. The increasing use of interconnected and innovative digital systems to perform critical tasks introduces new vulnerabilities compared to traditional buildings. It is therefore of great importance to put a high focus on ICT security during the design, planning, construction, and commissioning phases. The project has innovative, partly immature, and partly complex ICT solutions. Errors in these solutions, especially in an early phase of the project, will be particularly unfortunate. A systematic approach to risk is therefore important throughout the planning and construction phase.

In the Norwegian demo project, an energy consulting company was involved in the quality assurance process in the early design phase, to control preliminary performance goals. The goal of plus energy and to meet the passive house standard was constantly reviewed and internally checked to see if the project was on the right track to reach the ambition. The feasibility included a risk assessment of the energy concept, which provided an upfront heads up about possible issues. The section describes the most significant risk related issues, their consequence potential, the existing knowledge about the function, and the complexity. For example, the energy management system is concluded as a high-risk function, with a large consequence potential if a malfunction in the energy system occurs, with varying experience for control of the different installations the system comprises of, and the complexity is high due to involving a large set of housing units with many components in total.

The energy system planned for Verksbyen is challenging in terms of risk. This does not mean that it will not be possible to establish a well-functioning system with sufficient risk control, but it will require systematic risk management as it includes novel solutions. To handle this risk, the developer established a separate company owned by the developer, to function as energy manager for Verksbyen, and manage all solar installations, energy centrals, distribution of energy between buildings and measurements of both solar and thermal energies. This includes administration and management of local power production, storage, and monitoring.

Develop Sustainable Business Models

SPENs should be developed with sustainable business models. To fully utilize the renewable energy generation and balance the generation and consumption, excess energy could for instance be shared between buildings, shared with electromobility, and/or stored locally. The business models should specifically address how the renewable energy generation on site should be distributed and shared within and outside of the system boundary of the neighbourhood project. The syn.ikia report *D6.6 Evaluation of Existing Business Models as well as Identification and Design of Novel Business Models* (Kandpal et al 2023) describe and analyze different business models for SPENs and may serve as a reference guide for possible models to use. The main business models that the syn.ikia partners have identified as promising for community-based initiatives (SPENs) are Peer-to-Peer (P2P) energy trading, Power Purchase Agreement (PPA), retailer/aggregator models, shared ownership of energy assets, and the inter-SPEN concept (Table 2). The models are described in the syn.ikia report D6.6 (Kandpal et al 2023). By leveraging these emerging business models, SPENs can foster numerous benefits:

- Lower Energy Costs: Once installed, solar PV panels and other renewable energy technologies often produce electricity at a lower cost than traditional energy sources. This can lead to significant savings on utility bills for the community members.
- Energy Independence: By generating their own power, communities reduce their dependence on the grid and the volatility of energy prices. This can provide improved financial stability.
- Revenue Generation: Excess power generated can often be sold back to the grid, providing another source of revenue for the community.
- Grants and Incentives: Governments and other entities often provide grants, tax credits, or other incentives for the installation of renewable energy systems, which can offset initial costs and increase the rate of return on these investments.

Table 2. Examples of business models suitable for SPENs. From syn.ikia report D5.2 Four Factsheets with Policy Recommendations for Sustainable Plus Energy Neighbourhoods (Taranu and Dorizas 2023).

Business model	Description	Relevance for SPENs
P2P or local electricity market	Promote collective self-consumption by creating a marketplace among prosumers and consumers.	Energy sharing among positive energy buildings in a SPEN. It incentivises and rewards plus-energy buildings. It encourages the community as a whole to share electricity and achieve net gain.
Joint shared assets	Shared energy assets and investments such as batteries, PV panels, etc.	Assesses the added value of SPEN projects compared to business as usual. Determines the optimal investments and the source of revenues (individual, collective, or both).
SPEN as an energy retailer	The SPEN becomes a retailer that buys power directly from wholesale markets, hence reducing costs by avoiding an intermediary (currently retailers).	Assuming that an advanced energy management system is available in the SPEN, it automatises the hourly energy balance and predicts demand commitments in the power market. It brings advantages regarding more choices of energy suppliers and independence from retailers. This challenges the status quo and has the potential to add more revenues to consumers by avoiding the transaction costs of a retailer.
PPA	Power Purchase Agreements for low carbon energy might be of interest for industry or public buildings to certify guarantees of origin.	PPAs offer the possibility of a long-term commitment to sell surplus energy from SPENs to external players interested in acquiring certified renewable energy.
Inter-SPEN	The surplus energy of a SPEN can be traded or offered to an open marketplace, for example within a REC.	Trading surplus energy outside a SPEN may incentivise additional investments in energy efficiency and renewable energy. The surplus energy could be bought by aggregators, other neigh-bourhoods or SPENs, industry, retailers, etc. RECs and CECs may enable small actors to enter the electricity market.
SPEN flexibility services	Business models based on DSF (Demand Side Flexibility): Shifting demand according to energy availability to reduce peak loads and reduce grid congestion. The DSF avoids additional investments in grid upgrades.	The SPEN provides energy flexibility to external actors such as distribution system operators, aggregators, local grid, EV smart charging, etc. The SPEN, through the energy management system, engages in DSF that brings financial benefits to the consumers.

Detailed design

Design Building Details and Check Performance

In this phase, the construction of the building is detailed, focusing on specific products and material layers and their properties with respect to thermal insulation and air tightness, solar and daylight properties, thermal mass, and embodied greenhouse gas emissions. Also, relevant properties with respect to acoustics, fire, moisture, and structural integrity needs to be checked and specified. Select low carbon materials and high-performance construction systems for the buildings. The initial energy simulations were performed based on preliminary assumptions. With more detailing of the design, new simulations should be performed to ensure that performance goals are possible to achieve and implemented in the design. This includes a detailed simulation of the energy performance on an hourly basis, as well as the performance with respect to indoor environmental quality. In particular, it is important to check the performance with respect thermal comfort to avoid overheating and excessive use of cooling energy. Also, the life-cycle cost calculations should be updated at this stage.

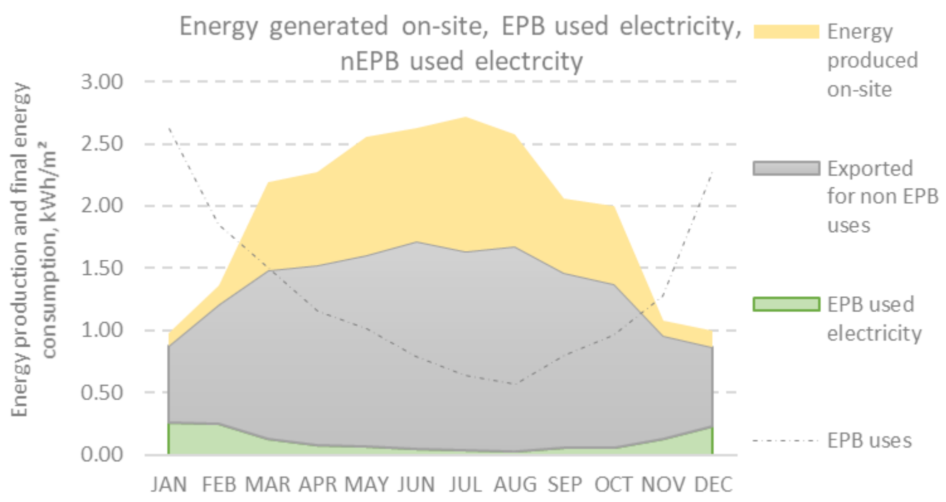


Figure 19. Example of graphical presentation of a detailed annual energy performance simulation of a building. From (Finocchiaro et al 2021).

Design for Energy Flexibility

In the context of SPENs, energy flexibility is the ability of a building or a neighbourhood to adjust its energy use and generation in response to external factors such as local climate conditions, user needs, and grid demands. In syn.ikia, designing for energy flexibility means to apply appropriate strategies for demand side management to respond to different requirements or 'signals' from the surrounding grid, such as cost signals, CO_2 signals, etc. In practice, achieving energy flexibility in buildings typically means using different types of storage and controls to shift the energy use from periods with a high price of energy or high greenhouse gas emissions (typically when there is low production from renewables in the grid) to periods with low energy price (e.g., when there is a high amount of renewable generation in the grid). Energy storage may include the utilization of the buildings thermal mass, DHW tanks or buffer tanks in combination with space heating and cooling systems, or electric batteries (in electric vehicles or stationary systems). To harvest the energy flexibility potential of the storage, an energy service and control system is also needed.

Control strategies for energy flexibility range from simple systems such as a heat pump being switched on and off according to predefined times, to more complex model-based controls including forecast of weather, occupant behaviour, and energy prices. The so-called Model Predictive Control (MPC) is and advanced control technique that optimizes the energy performance of a building or a neighbourhood based on feedback from the operation of the energy systems and forecasts of energy prices, weather, and energy use. An application based on MPC has been developed within syn.ikia and has been tested in some of the demo projects designs. This is further described in the syn.ikia report *D3.5 Analysis of Shared Infrastructure in Sustainable Plus Energy Neighbourhoods* (Salom et al 2023).

Box 13: Heat pump controls for energy flexibility in the Dutch demo.

The Dutch project team worked extensively on developing a model predictive control (MPC) of the heat pump to increase the efficiency of the system. For the syn.ikia project, it was necessary to find a heat pump provider that would allow the team to control the heat-pump. The initial heat pump supplier, Alfa-innotec, did not agree on these terms, but the company ITO agreed and could provide access to the settings of the heat pump. The contractor was resistant to using a different heat pump than what they were used to, but after a meeting with AREA, the contractor, and ITO, they agreed on installing the heat pump, as it was important for the syn.ikia project to develop a control for the heat pump. The monitoring equipment was installed after construction, and then the team had to adjust the settings of the heat pump.

Photo: TNO.

The syn.ikia report *D3.4 Guidelines for Realizing Energy Flexibility* (Mossallam et al 2021) provides guidelines for energy flexibility on the building component level. Specifically, the report focuses on utilizing the flexibility of HVAC systems (i.e., space heating) and domestic hot water (DHW) production to promote the consumption of on-site generated solar energy and to reduce the imported electricity from the grid. A summary of the recommended strategies is shown in Box 14.

The syn.ikia report *D4.2 Characterization of the Thermodynamic Properties of the Demonstration Cases* (Thodi et al 2022) focuses on the HVAC system modelling and MPC design. Here, the scope of the MPC is to provide an optimal schedule for the electricity use of the HVAC system using predictions and forecasts. Specifically, the MPC design maximizes the electricity consumption of the HVAC system during periods when the electricity price is low and minimizes the use when the price is high. In addition, the designed controller enables considering the HVAC system constraints with respect to occupants' thermal comfort.

Design for optimal energy flexibility of buildings and neighbourhoods is not a straight-forward task. Compared to e.g., energy efficiency of buildings, energy flexibility represents a relatively new area of research and innovation, and use cases and experiences from real-life pilot projects are still scarce. In syn.ikia, the reports

D4.5 Operational Neighbourhood Models to Control and Optimize the Operation of the HVAC Systems and the Overall Energy Flow (Tohidi et al 2023) and *D4.6 Operational neighbourhood models to control and optimize the operation of the HVAC systems and the overall energy flow* (2024) will provide further insights and guidelines into the issue of energy flexibility for SPENs.

Box 14. Guidelines for flexibility measures in space and DHW heating, based on syn.ikia report *D3.4 Guidelines for Realizing Energy Flexibility* (Mossallam et al 2021).

For space heating:

- Downward flexibility in a well-insulated building saves more energy than upward flexibility because of lower energy demand and reduced heat losses due to the lower setpoint for space heating.
- If the user acceptance is limited and does not allow downward flexibility (i.e., reducing the room setpoint), the flexibility potential of the downward strategy is reduced substantially.
- Even with floor heating, the flexibility potential in space heating is limited in well-insulated buildings, due to the narrow comfort band width.
- The flexibility potential can be increased by using a storage tank; controlling the tank temperature has less impact on the user comfort than using the thermal mass of the building.

For domestic hot water:

- A storage tank using a wide water temperature range will result in a relatively larger available flexibility.
- The size of the tank has a significant influence on the flexibility. The tank capacity should at least be in the order of the daily DHW demand.
- Downward flexibility during the night saves energy because of increased use of solar energy during the day and reduced heat losses.
- In case of a heat pump, upward flexibility is limited, because of reduced efficiency of the heat pump and increased heat losses.
- Using a separate legionella control (once a week) a higher temperature range is allowed leading to a higher downward flexibility (low temperature heat exchanger/substation is an alternative to avoid legionella problems and increases the overall system efficiency).

Organize Energy Communities

If relevant, organize energy communities in the neighbourhood, which allow citizens to be actively involved in the energy market, providing financial benefits to the prosumer (end-consumers who also produce energy).

Box 15. Energy Communities

Energy communities can take any form of legal entity, for instance that of an association, a cooperative, a partnership, a non- profit organisation, or a small/medium-sized enterprise. The advantage of a getting organised in an energy community is that it allow participants to directly trade electricity. In an energy community, participants may choose the type of technology they want to use (PV, windmills, biomass systems, etc.), where to install it, and the price at which they sell the electricity. The profits of producing renewable energy will also belong to the community.

There are two different types of energy communities: Shared self-consumption and local energy communities:

- In shared self-consumption communities, the neighbours agree to contract the installation of solar panels (e.g., on the roof of their building) to produce electricity and distribute it among all homes in the community.
- In local energy communities, the neighbours form a non-profit organization committed to establishing sustainable and environmentally friendly habits. To do this, they generate and market energy, seeking benefits for the neighbours and associates though the reduction of energy costs.

In the syn.ikia report *D3.5 Analysis of Shared Infrastructures in Sustainable Plus Energy Neighbourhoods* (Salom et al 2023), you may find descriptions of 6 different examples of energy communities in Europe.

The European Commission also has more information about energy communities, here: energy communities.

Plan the Monitoring

The monitoring of the buildings should be planned in detail in this phase. The energy metering and monitoring should be divided into different energy uses, so that the performance can be compared to the design performance predictions. Also, the monitoring should include indoor environment parameters such as temperature and air quality. In addition, post occupancy surveys of user's satisfaction are recommended. Monitoring data should be easily accessible and possible to use to assess and improve the operational performance of the buildings and neighbourhood. It is recommended to integrate all energy monitoring in one system to allow for better control and comparison of the different energy uses. The monitoring data should be structured so that it is possible to verify the Key Performance Indicators and goals of the project. In the syn.ikia report *D2.7 Report on the Commissioning of Sustainable Plus Energy Neighbourhoods in the Four Climatic Zones*, monitoring plans for the four syn.ikia demo projects are described.

Box 16: The Energy Manager in the Spanish demo project

The need for an energy manager emerged when it was decided to have a central energy system to increase the energy efficiency of the buildings, and to ensure efficient operations and reach a plus energy balance for the apartment building.

The responsibilities of the energy manager are divided into five aspects; energy management of the building, maintenance of the building, full-service guarantee for the energy service, improvements, and renovations of the facilities to maintain positive energy building conditions, and investments in energy saving and renewable energy. Thus, the energy manager will have several tasks; operation of the building, invoice the apartments, maintenance of the building and facilities, manage the PV system and energy sharing to other buildings. In previous projects, the housing developer INCASÒL have not commissioned any centralized energy systems. The practise has been that the facility manager (Catalan Housing Agency – a public group) do the maintenance of the buildings, and there are specialized contracts for each aspect (elevator, electrical system, parking, etc.).

In the role description of the energy manager, it is stated that the manager must work to achieve the positive energy balance as considered in the syn.ikia project, optimize the power, and offer a competitive price to both the user and the promoter, acting as an investor if necessary, and acting as an aggregator according to the indications of the European Energy Efficiency Directive. Management includes production, distribution, and marketing. The manager will act as a contact person and negotiator with the different operators on behalf of INCASÒL, and always with their timely authorization.

The manager will be responsible for the coordination and treatment of all the existing production facilities in the building, which make up the set of renewables that provide shared energy to the sector. For this reason, the manager will coordinate the energy community (s) or other bilateral relations in which the described property is incorporated. Further, the manager will deal with the issues arising from the charging of the electric vehicle, acting as a charge manager, and ensuring compliance with the requirements prescribed in the specific regulations. The energy manager will be ensuring the global security of both thermal and electrical installations and at the level of building and housing, as well as in public and private spaces.

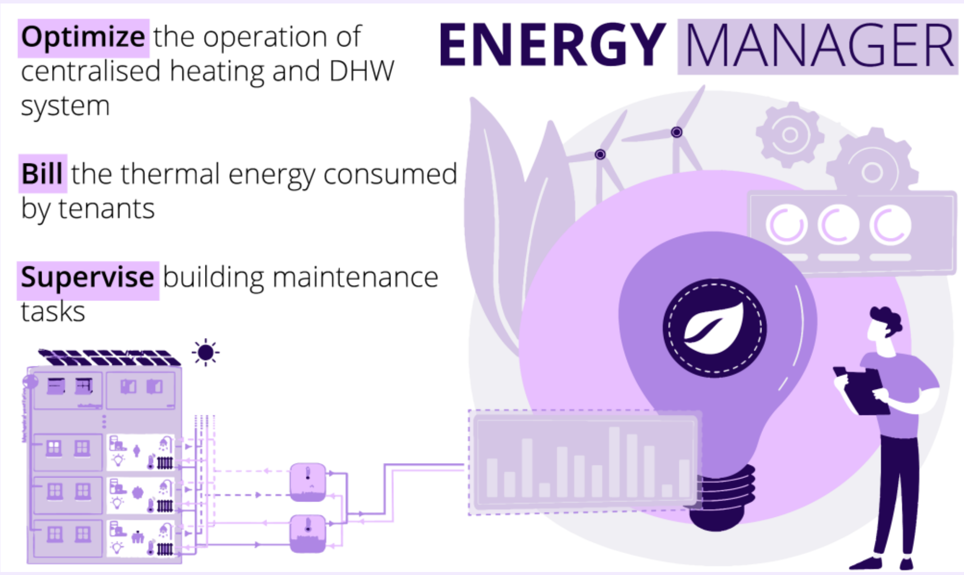


Figure 4: An overview of the specifications of the Energy Manager.

Make Contracts that Incentivize High Operational Performance

Contracts that incentivize and encourage high operational performance of the buildings and systems may be useful to ensure optimal performance. In traditional construction contracts, fees are often set as a percentage of the total budget, or a flat rate. This may have the effect of focusing on quantities and reduction of costs, instead of optimizing the total quality of the project. There are several ways of making contracts that incentivize co-operation and overall performance optimization. One such type of contract is the *Partnering* contract (ref e.g., Thomas and Thomas 2005). Partnering contracts are built on formalized mutual objectives (e.g., as set out in the Quality Assurance Plan) and agreed upon problem resolution methods including continuous search for improvements. A partnering contract may also include a sort of Performance Contracting, which may include agreed-upon targets for energy performance of the building and neighbourhood. Simply put, the contract may work like this: If the building or neighbourhood uses less energy than the target, the developer/client pays the design team and contractors a pro-rated bonus. Conversely, if the building or neighborhood uses more energy than agreed-upon, the design team and contractors must pay a pro-rated penalty.

Prepare for the Operation Phase

To prepare for the transition to the operation phase, several activities should be carried out, such as performing a thorough commissioning to test and verify the performance of the building and neighbourhood systems, inform, and train construction workers, and make a monitoring plan to follow-up during operation.

The general framework of the commissioning process of the syn.ikia demonstration projects is presented in Figure 20. The commissioning activities are embedded in the project initiation and design, construction, and occupancy (operation). The developed commissioning framework of syn.ikia is mainly based on the well-established market standards and guidelines BREEAM, LEED, and the GSA Commissioning Guide (GSA 2020), and adopted to the syn.ikia project requirements and specifications. Performance tests have to be a part of the construction and commissioning phases. For example, air tightness tests and thermography measurements should be done to check the performance of the envelope before the construction is closed.

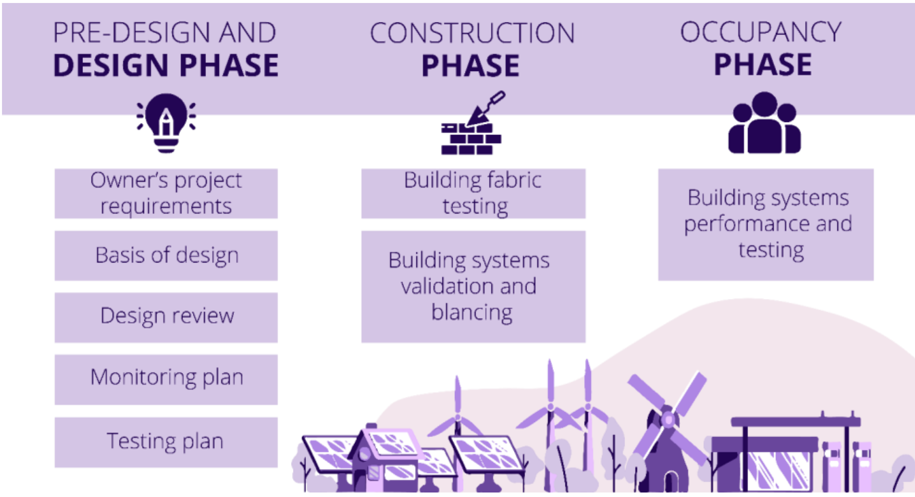


Figure 19. Activities included in the commissioning process of syn.ikia demonstration projects. Based on Satola et al (2023).

Another important activity is to inform and train construction workers and contractors about the specific systems and construction details that have been designed. This may be done in an interactive workshop at the start of the construction process and may be followed by special sessions when the different systems are being installed.

Finally, making plans and systems for engaging the residents of the buildings is important for ensuring the optimal operation of the neighbourhood. Make the residents aware of what it means to live in a sustainable plus energy neighbourhood, and how one can contribute with a sustainable lifestyle with a lower environmental footprint. This may be done by providing information of how the different systems in the buildings and neighbourhoods work optimally, and providing a platform for the residents to give feedback on their experiences with the neighbourhood. The platform for providing feedback needs to be simple and should not require technical skills or building operational knowledge. An example of such a platform is shown in Box 17.

Box 17. An online decision support tool for users

The syn.ikia's Neighbourhood Scale User Engagement Process is currently being developed to become a user-friendly online engagement platform to empower building users to control their energy systems and adapt their behaviour accordingly. The main goal is to empower user's control of energy, environmental awareness, and behavioural change through user-friendly digital platforms, user engagement methods, and tools and training.

The FeedMe is a mobile phone app to empower users (residents) by enabling them to give direct feedback on the buildings' services and satisfaction related to the indoor climate. The app is specifically tailored for the syn.ikia demos – so it will engage users by giving specific information on the building and by sharing energy savings tips. In the long run, the app should help tenants be more aware of factors such as indoor air quality, humidity, noise, temperature, and light; and should serve as a tool to 'nudge' people's behaviour so they can make better decisions to manage all these factors and have an optimal experience in their apartments. Residents will be able to contact building managers if they have complaints. The primary target users of the app are the tenants and building managers of the four demos. The app will enhance resident engagement in different ways:

• It will engage and empower users through a user friendly and intuitive app

• It will bring awareness about plus energy buildings for tenants: tenants can check the 'energy savings' tips provided by the app

• It will enable direct contact with building managers in case of recurring issues. Building managers will have access to the responses given by tenants.

From syn.ikia report D7.9 Online Decision Support, (Barrett and Cortes 2022).

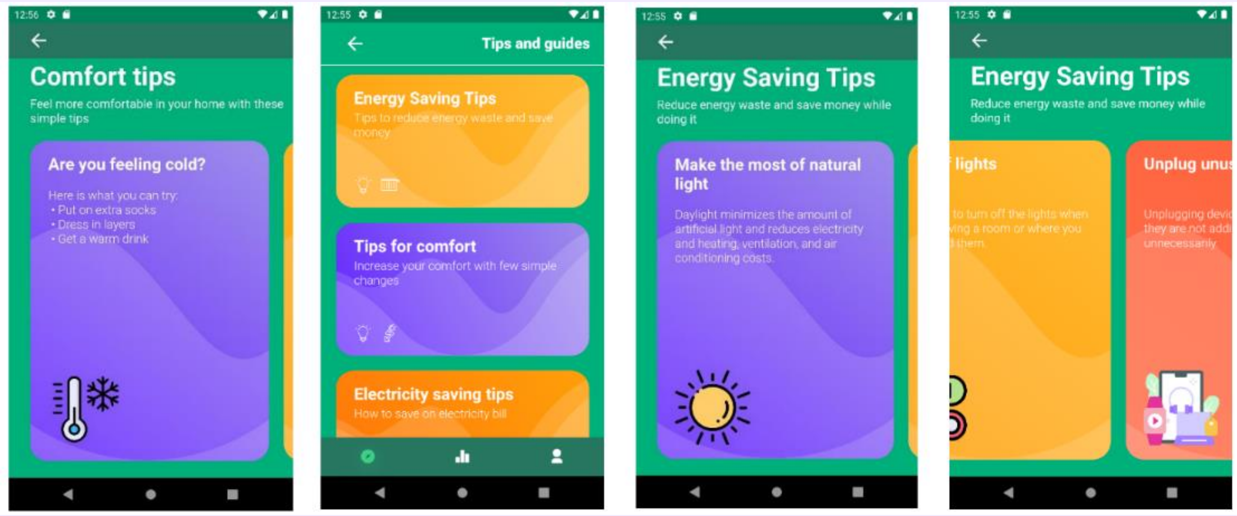


Figure 20. The image shows content in the FeedMe app.

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6. Appendix A – Glossary of Terms

BIPV = Building Integrated Photovoltaics

CEC = Citizen Energy Community

CSC = Collective Self-Consumption

DH = District Heating

DHW = Domestic Hot Water

DSF = Demand-Side Flexibility

EED = Energy Efficiency Directive

EMD = Electricity Market Design

EPBD = Energy Performance of Buildings Directive

EV = Electric Vehicle

GSHP = Ground Source Heat Pump

HVAC = Heating, Ventilation, and Air-Conditioning

IED = Integrated Energy Design

IED^N = Integrated Energy Design for Neighbourhoods

KPI = Key Performance Indicator

LCA = Life Cycle Analysis

LCC = Life Cycle Costs

NZEB = Nearly Zero-Energy Building

P2P = Peer-to-Peer

PPA = Power Purchase Agreement

PEB = Positive Energy Building

PED = Positive Energy District

PV = Photovoltaics

SPEN = Sustainable Plus Energy Neighbourhood

SRI = Smart Readiness Indicator

7. Appendix B – The IED^N processes in the syn.ikia demo projects

This section describes the IED^N process for each of the four SPEN demonstration projects in detail. In depth description of the context and energy design features of each demo can be found in *D.2.1 Report on Design Plus Energy Neighbourhoods in Each of the Four Climatic Types*. The demos are in different stages of the process and need to respond to their local context with climate, culture, and regulations. The SPENs are residential projects, where three projects are social housing for rent and one project includes private apartments for sale on the market (the demo project in Norway).

Santa Coloma de Gramenet, Barcelona, Spain

Figure 21: Image of the demonstration project in Santa Coloma de Gramenet, Barcelona, Spain.

Project Description

The demo project is an apartment building in the Fondo neighbourhood in Santa Coloma de Gramenet. It is a dense area with old buildings (+50/60 years), narrow streets, medium building heights (GF+3 or GF+4), and there is a need to reduce the density of the urban tissue. Our urban intervention creates a large new square, and a new axis of communication in the area.

The original buildings on site lacked access to daylight, and where demolished. The demo building was initially planned to connect to a District Heating network (DH), but due to delays of constructing the new district heating network in the area, the approach changed, and the project turned into a digital network of renewable energy, with integrated energy generation and consumption.

Project Team

The project is developed by the public developer INCASÒL, and the syn.ikia partner in the project is IREC. The design is developed by the architecture company Ravetllat Arquitectes, together with the structural engineer STATIC Enginyeria and energy advisor QJ Estudis. The construction company is independent of the design team. ECOPENTA provides the energy certificate for the project. Budget management is performed by UTE BAC 3 and quality control is performed by BAC. A dedicated energy manager will manage operations of the building.

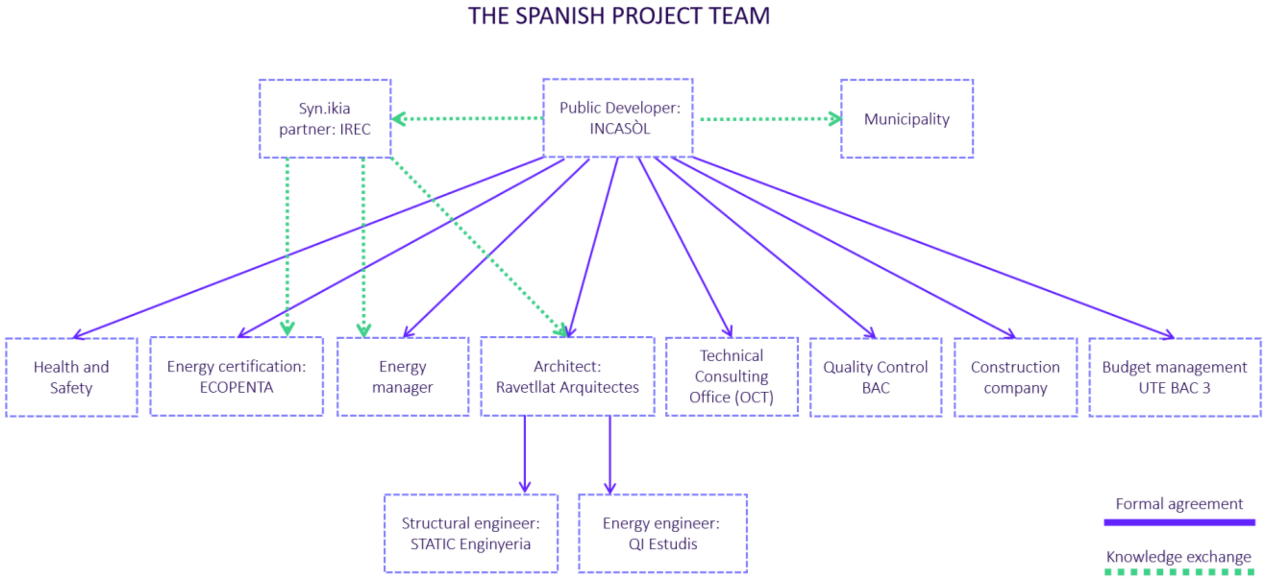


Figure 22: A representation of the project team of the Spanish demo and the contractual relationships and knowledge exchange.

Project Ambition and Boundary Conditions

The main objective of the project is to create a sustainable positive energy neighbourhood, in line with the syn.ikia ambition. Thus, the intention is to link energy consumption to the demands of heating and domestic hot water (DHW). Measures at both the passive and active level are taken to fulfil and achieve the three basic lines of the 2030 horizon: efficiency, renewables, and energy market (sharing energy).

In addition, the project wants to demonstrate the economic feasibility of constructing energy efficient buildings with energy generation.

The current energy crisis has triggered the citizens interests in energy cost, and thus solutions that can lower the energy bill. In INCASÒL's case, users of public housing are particularly economically aware since their resources are more limited compared to the rest of the citizens. As public developers, they seek to protect the tenants, who in many cases suffer from delicate personal financial conditions. Thus, for years, public developers have been promoting the improvement of both building envelopes and facility efficiency and, lately, of renewable generation, especially electricity (thermal energy has already been mandatory since the early 2000s).

The current energy market and regulations determine the framework for energy generation and self-consumption, but there are still many factors that limit flexibility and scope. As barriers, the following are worth mentioning: Limitation of the distance between generation and self-consumption and the impossibility of bidirectional and flexible distribution of the generated electricity. At the same time, the low price paid for surplus of energy penalizes the generation of electricity. As an example, for new developments, both residential and commercial, the low voltage electrotechnical regulation requires an over-dimensioning of the extension networks, a fact that involves unnecessary costs for the user, building scale and neighbourhood.

The new requirements of the Building Technical Code represent improved energy efficiency of new buildings to reach the level of positive energy buildings.

In short, the main obstacles are not economic or social, they are in fact regulatory. At the present, this regulatory framework is outdated and against the political interests in environmental and energy matters.

Design Process

Collaboration and communication

The project had meetings with all participants, meetings with IREC, architect and facility management, and others, depending on the meeting topic. If IREC needed technical input, they would directly contact the architect (without INCASÒL being present). The general meetings were not very frequent, but smaller meetings happened more often. There was not a strict schedule for periodic meetings, instead meetings were scheduled when something necessary arose or information was needed. There were separate meetings for specific topics, and general meetings for information that concerned all.

The communication of the organization and the coordination of the teams had to be adapted to the new work conditions due to the pandemic. Therefore, the work and communication system were mostly developed online.

The communication and coordination between team members can be divided into four groups (Figure 23).

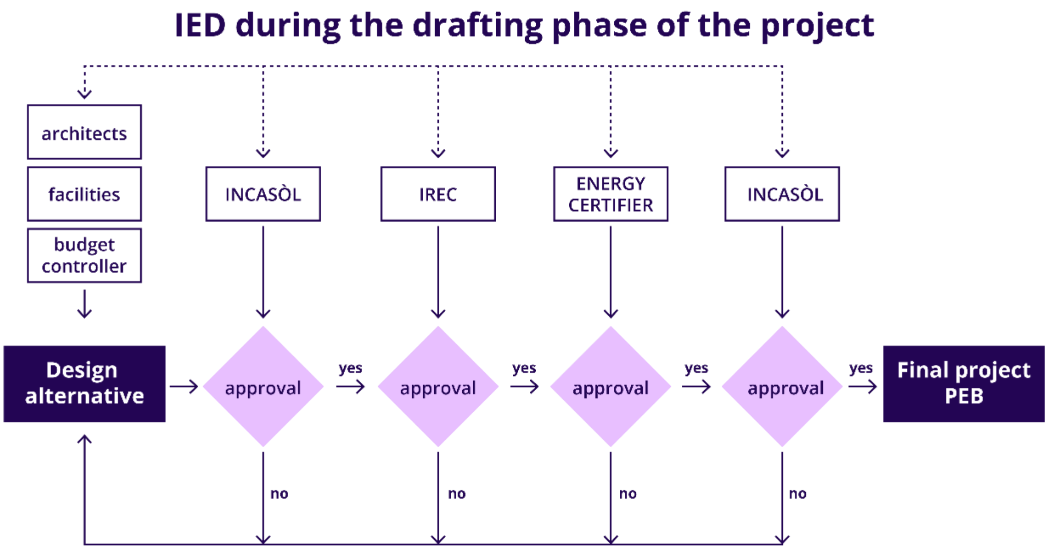


Figure 5: A schematic representation of the design process for the Spanish demo.

First, the main part of the building design was developed by the design team (architects) and the INCASOL building team. In this case, the relationship lasted from the beginning of the design phase and throughout the execution of the works. It was an open and ongoing collaboration, and doubts, improvements, etc., regarding the project are discussed and solved in an immediate shared way. Deadlines and paces set were not altered.

The second group is the tandem coordinators of the project, INCASOL-IREC. It is based on the collaboration and exchange of knowledge and ideas, as well as the resolution and contribution of documentation to other project partners with coordination twice a month.

The third part is the monthly global coordination meetings among all the agents related to the energy design: Ratvellat arquitectes, INCASOL, Ecopenta, IREC and QI Instal·lacions.

The fourth group is the internal relation at INCASÒL/Building department AND INCASOL/syn.ikia coordination. The communication among these two groups was frequent, not only because they are part of the same organization, but also because there is physical proximity. Therefore, the exchange frequency is continuous.

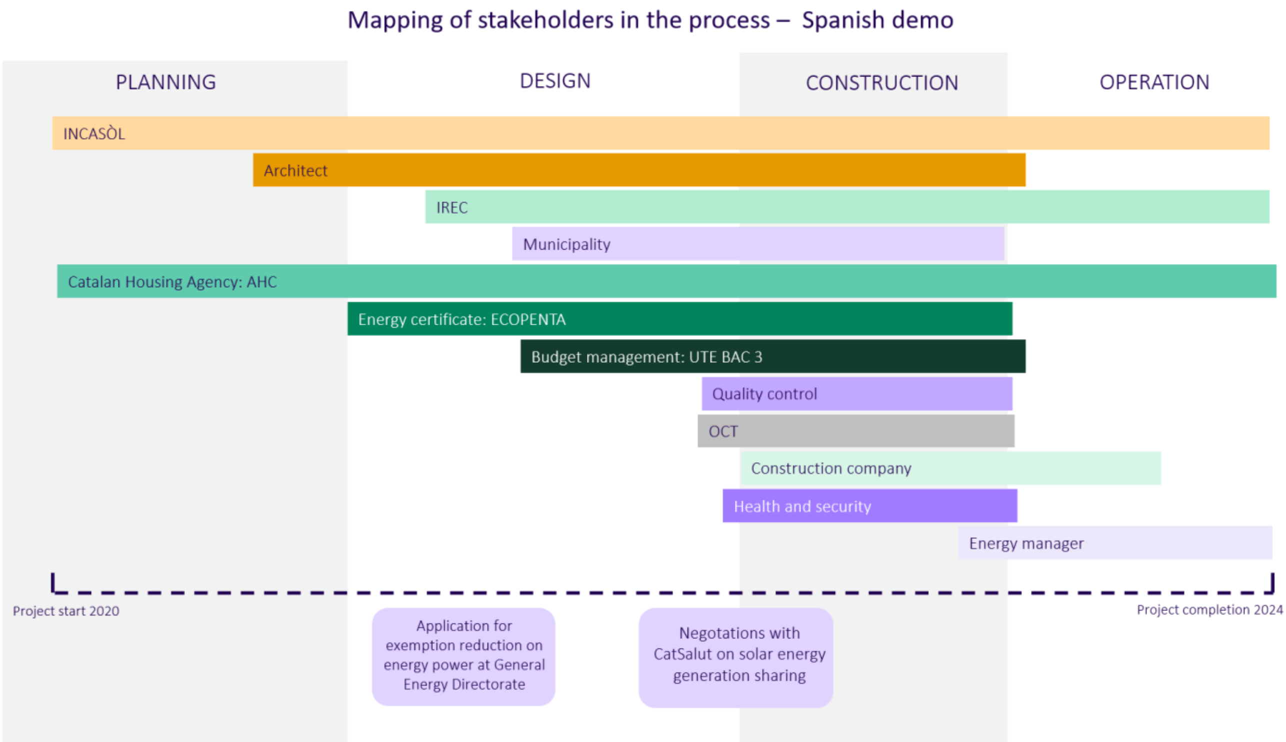


Figure 24: Mapping of the stakeholder's involvement in the different phases of the process from planning to operation for the Spanish demo.

Design decisions and iterations

The process has been a consecutive and cyclical evaluation of different design alternatives to improve the building performance. It allowed the team to take key decisions on the heating and DHW centralization system, shading, material absorbency, photovoltaic generation, insulation optimization, optimal window proportion and their distribution and performance.

The design team (architect + engineers) won an architectural contest with a proposal, which was the starting point for the design provided to INCASÒL. IREC, as an energy advisor, would propose to study or modify something about the energy design to the architect and engineers. They would then look at it, and a decision was made together based on whether the solution would work and would be within the project budget. For example, the wall design went through such a process. IREC studied the thermal insulation of the wall design, and proposed a thicker wall with more insulation, which the architect then incorporated into the design. Another example is the openings of the building. Here, IREC analysed three different window configurations proposed by the architect, shown in Figure 25.

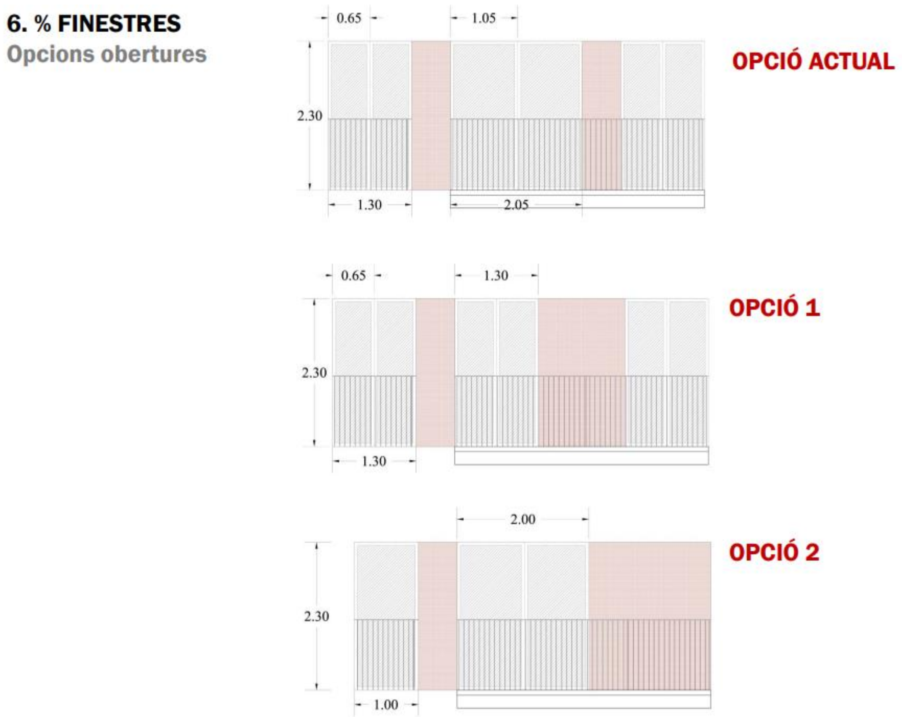


Figure 25: Three different window configurations proposed by the architects, and then analysed by IREC in terms of energy and indoor environment.

IREC performed technical analysis together with the engineer from the design team, and then INCASÓL did the economic analysis for the proposed solution. The first option was chosen based on the analysis by IREC, with the goal of achieving a positive energy building. Integrated energy design with analysis of different options and design iterations is time consuming and challenging, but the design team (architect and engineers) were very motivated and worked a lot on the project. INCASÒL always took the final decisions as they had to fit within the budget constraints.

An external company performed the energy certificate for the building to see if it complies to the Spanish building code. The energy certifier analyses the building according to the standard, and is not a part of the iterative energy design process.

Studies by IREC show that the power of the energy system for the building is oversized. Thus, with IREC's support, INASÓL submitted an exemption to adjust the regulation requirements on power for the building to the entity responsible for this subject (General direction of energy). The possibility of reducing simultaneity rate would reduce the power from 261 kW to 216 kW, which would also result in monetary savings of approx. 3.000€ for the developer. This is a minimum approximation, as the improvements from the passive strategies for heating and DHW efficiency systems, and the incorporation of renewable energy were not considered in the studies. Unfortunately, the exemption was not approved by the General Direction of Energy.

Specific workshops on the demo case have not yet been conducted. For INCASÒL, the basic and yet unknown part is monitoring and obtaining data on both consumption and generation. The team has participated in different events and congresses and worked on dissemination of the project to show the public that it is possible to achieve sustainable plus energy neighbourhoods.

Methods and tools

The method used in this project, and in contrast to more conventional projects in which we participate, is the specialized technical support on energy issues. This support has been carried out by IREC, the syn.ikia partner in the project. The participation of IREC has been essential for modelling the energy behaviour of the building. INCASÒL and IREC discussed design alternatives and improvements have been proposed during the lengthy process to achieve a positive energy balance.

The tools used are the following:

- REVIT: It is a BIM based project, where the project was modelled in 3D during the design phase.
- TRNSYS: Energy simulations and design iterations for energy efficiency were performed in TRNSYS. The software was used to analyse different energy designs and thermal comfort conditions. The extensive efforts made to reduce the energy consumption and increase thermal comfort is different from a conventional project, where such measures are not studied in the same detail.
- HULC: The software was used for the energy certificate.
- BEDEC: The software was used for prices and environmental data of the materials and constructive solutions used. It is also used for the budget of the project, to keep track of costs.

The results to date have been positive and the different teams have responded well to the expectations and objectives set. It must be said that these are very specialized teams with a lot of experience in the relevant topics for the demo project. The tools used were enough to guarantee the objectives established in the project.

Quality Assurance
INCASÒL as a public developer, with both an economic and social side, implements a protection system on its projects by reviewing and requesting quality levels for projects, not only technical or constructive, but also economic and social. Most buildings developed by INCASÒL are for affordable rent, and they will remain their property and management for many years. Thus, knowing the profile of the end user and the evolution of the life of the building (materials, installation, etc.), long-term quality parameters are set.

The management of the building throughout its life cycle is significant and based on long-term plans that ensure facilities maintenance and social care for users. Usually, maintenance and regular social care work is carried out by the Catalan Housing Agency (AHC), which is the body that acts as the facility manager of the apartments for affordable rental housing owned by INCASÒL.

The need for an energy manager emerged when it was decided to have a central energy system to increase the energy efficiency of the buildings, and to ensure efficient operations and reach a plus energy balance for the apartment building.

There is no doubt that one should set objectives for constant improvement, hence the importance of the data provided with the monitoring, and interpretation and management of the data obtained in the demo case.

Contracting
A total of seven public contracts were established. The project was divided in specialized contacts, instead of including all the aspects in one unique contract with the architect. In this case it was not necessary to contract a specialized consultant on energy efficiency as it was already included on the tasks of the syn.ikia project and was carried out by IREC.

The following companies were included in the design phase:

- Architect: RAVETLLAT ARQUITECTURA. Responsible for project drafting, direction of the work and general coordination.
- Technical architect: UTE BAC 3. Responsible for direction of execution and budget drafting.
- Energy certification: ECOPENTA. Responsible for simulations and energy certification on project phase and of finished works.
- Technical management of the project: BSP SERVICIONS DE CONSULTORIA TÈCNICA SL. Responsible for project evaluation on structure and watertightness.

- SiS Coordinator: IDEA 10 INTEGRAL SL. Responsible for the Security and Health plan drafting and security coordination on the designing and building phases.
- During the execution phase, there were 2 contracts:
- Works contact: COSPLAAN SL. Responsible for works execution.
- Quality control: BAC ENGINEERING SL. Responsible for tests, controls and material trials, commissioning, and installations.

The Energy Manager

The responsibilities of the energy manager are divided into five aspects; energy management of the building, maintenance of the building, full-service guarantee for the energy service, improvements, and renovations of the facilities to maintain positive energy building conditions, investments in energy saving and renewable energy. Thus, the energy manager will have several jobs; operation of the building, invoice the apartments, maintenance of the building and facilities, manage the PV system and energy sharing to other buildings. In other projects, INCASÒL do not have centralized systems. Then, the facility manager (Catalan Housing Agency – a public group) do the maintenance of the building, and they have specialized contracts for each aspect (elevator, electrical system, parking…).

In the role description of the energy manager, it is stated that the manager must work to achieve of the positive energy balance as considered in the syn.ikia project, optimize the powers and offer a competitive price to both the user and the promoter, acting as an investor if necessary, and acting as an aggregator according to the indications of the European Energy Efficiency Directives.

Management includes production, distribution, and marketing. The manager will act as a contact person and negotiator with the different operators on behalf of INCASÒL, and always with their timely authorization.

The manager will be responsible for the coordination and treatment of all the existing production facilities in the building, which make up the set of renewables that provide shared energy to the sector. For this reason, the manager will coordinate the energy community (s) or other bilateral relations in which the described property is incorporated.

Further, the manager will deal with the issues arising from the charging of the electric vehicle, acting as a charge manager, and ensuring compliance with the requirements prescribed in the specific regulations.

The energy manager will be ensuring the global security of both thermal and electrical installations and at the level of building and housing, as well as in public and private spaces.

Difference from Conventional Process

The main difference for the project in Santa Coloma de Gramenet compared to a conventional social housing project is the special support for energy efficiency from IREC. There were no differences in the procedures for the first phases with the Master Plan and the Urban Development Plan as both plans were already approved upon the beginning of the project. A possibility, if the plans did not exist already, would be to ask for a high level of energy efficient buildings in the plans, but this would require analysis. To set energy targets in the Urban Development Plan would be beneficial, such as a PEB (as it is allowed to set height and area restrictions). In general, the Urban Development Plan is developed mostly by architects, and the energy aspect is not mentioned.

The specialized support for energy efficiency from IREC lasted from the beginning of the design concept and throughout the construction and use phase, as the building will be monitored. Another difference from a conventional project in the operational phase is the energy manager. The building will have a dedicated person that operates the building, bills the attendants, controls the renewable energy systems, and ensures that the energy sharing with the medical centre is working. A conventional project would only have more general maintenance and cleaning personnel hired from an external company. A more detailed overview of the differences from a conventional project to the Spanish syn.ikia demonstration project can be found in Table B.1 in Appendix B.

Reflections

For this project the specialized energy support was provided through the syn.ikia project by IREC. In future projects, that are not part of a research project for sustainable plus energy neighbourhoods this supports needs to be accounted for in the budget.

It is difficult to know the exact additional costs, but INCASÒL is certain that to reach positive energy buildings it is necessary to have energy specialists. A possibility is to use the energy certifier for energy analysis, and not just for the energy certification. The companies that perform energy certificates usually have knowledge to also advice on energy efficiency, but then they need to be involved earlier in the project and it is necessary to specify what they should do in the procurement.

The time frame was challenging as the iterative procedure delayed the project a little bit. INCASÒL needed more time for this project as it is the first time that they execute such an ambitious project. The energy certificate company came in very late in the process, and it would be an advantage to have them involved earlier in the process as it is another source of knowledge and point of view.

Lessons Learned

- The importance of integrated energy design. To design buildings as more efficient spaces with lower energy consumption and onsite energy generation, we have some fundamental design requirements, which must incorporate new specialized professionals, which became vital to the project. IED incorporate design analysis and modelling of the building on energy management aspects. This additional energy efficiency support will be a part of all future projects.
- Acceptable Economic impact. The cost of a positive energy building/neighbourhood does not necessarily have to be higher than a traditional one. While investment costs increase, the pay back is fast with the current cost of energy and the market outlook. On one hand, the generalisation and standardisation of more efficient materials and solutions reduce the price of these products significantly and constantly. On the other hand, with the high price of energy and the negative forecasts of the energy market, the amortization of both heating systems and renewable generation systems has shorter deadlines. Society is waiting for actions, both environmental to fight against climate change, and economic to allow a real reduction of the individual energy bill and the eradication of energy poverty. IED is a step in this direction.
- The energy directives must be updated. We need to be bold in our impact on sectorial regulations, especially in the energy sector, adjusting the regulations to the current technology and demand reality. An open approach allows for room to adapt to new future possibilities, facilitating the incorporation of new and more efficient technologies that favour clean energy. This is necessary to achieve sustainable positive energy neighbourhoods.

Loopkantstraat, Uden, The Netherlands

Figure 6: Image of the demonstration project in Loopkantstraat, Uden, The Netherlands.

Project Description

The Dutch demonstration case is a new residential development in a mid-sized town named Uden and consists of an apartment complex. The building development is a follow-up from the “Social Beautiful” concept which was developed in collaboration between Labyrint (Support in sheltered housing), Area (housing company), the municipality of Uden, and Hendriks Coppelmans (developer). The concept aims to provide an answer to changes in various policy areas and the changing demands of society.

Project Team

The project Team consists of the initial landowner and contractor Henrik Coppelmans, the developer and new landowner AREA, the architect, structural engineer, systems advisor, subcontractors, the municipality, and the syn.ikia partners (TNO).

Area has internally appointed a general project leader who is responsible for obtaining internal decision-making and focuses on time, money, and quality during the development. In addition, Area appoints a social project leader who is responsible for the implementation of the Social Beautiful concept. Finally, specifically for this project a syn.ikia manager has been appointed, who implements the concept of syn.ikia in the project.

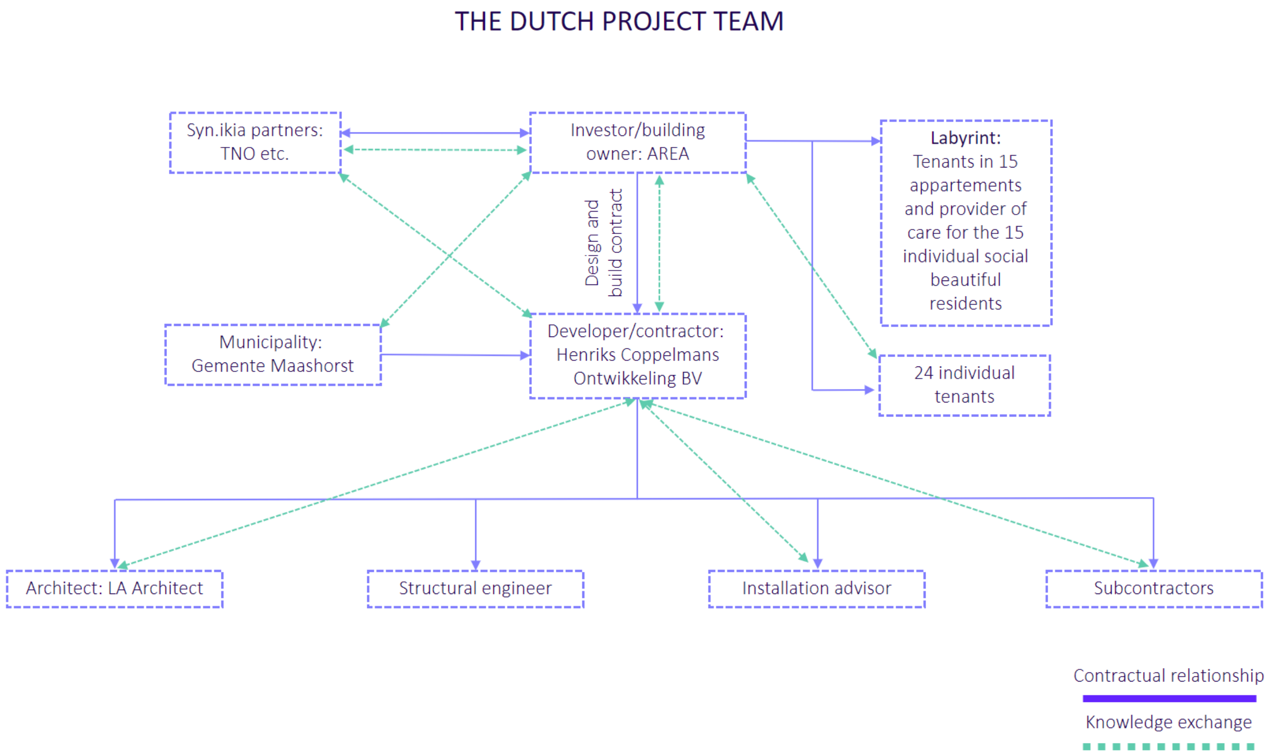


Figure 7: A representation of the project team of the Dutch demo and the contractual relationships and knowledge exchange.

Project Ambition and Boundary Conditions

The main ambition is to connect living, working and caring (for each other), while achieving a plus energy neighbourhood.

In our society, people are increasingly relying on their own strength. Even if there is an additional care requirement involved. To this end, in collaboration with Hendriks Coppelmans and the municipality of Maashorst, Area has developed a social concept that responds to this development: Social Beautiful®. The core ingredients are affordable housing, a pleasant working environment and the range of various neighborhood services that come together in one location. The concept Social Beautiful basically consists of the following components:

- Living, working and neighborhood services are brought together in one location. A multifunctional residential and service center will be realized at this location.
- Housing is shaped by the realization of financially accessible housing suitable for the target group. The type of housing is adjusted to the target group, so this can also be sheltered/protected living.
- Work takes place at or from the same location. Work has a social function within the neighborhood. Wage-related work should contribute to providing structure in the daily activities of the residents.
- Neighborhood management is organized from a location in the surrounding neighborhood. A service package is provided from the residential and service center that contributes to the ability of residents to live independently for longer, to strengthen the social network and to improve the quality of life and safety in the neighborhood.
- The houses are always suitable to be used for regular rental. That is why the communal facilities must be realized within the contours of a regular apartment.

The energy ambition developed throughout the project. The minimum energy performance requirements of the building must comply with the Building Decree. However, during the development of the project, this requirement was eventually raised to the ambition of achieving an energy-neutral (EPC = 0) building.

The ambition was set at the right level. It should be noted that there was a certain amount of luck because construction had started before building prices started to rise explosively.

Design Process

Collaboration and communication

In the chosen contract form, the developer/contractor is responsible for the design, planning and spatial procedure. For this project this concerns Hendriks Coppelmans Ontwikkeling I BV. The contractor agreed to be a part of syn.ikia on the conditions of not delays and no higher costs. They organized design team meetings attended by the architect, constructor, and other advisors, such as energy consultants and landscape architects. The consultants provide possible solutions and recommendations, for example solutions for the HVAC system, and then the contractor takes the final decision. The decisions are usually made together. TNO, the syn.ikia partner, was integrated into the project as an energy specialist, but the project also had a “normal” energy specialist. Periodic consultations were held with Area Wonen regarding the design principles, costs, and planning.

Mapping of stakeholders in the process – Dutch demo

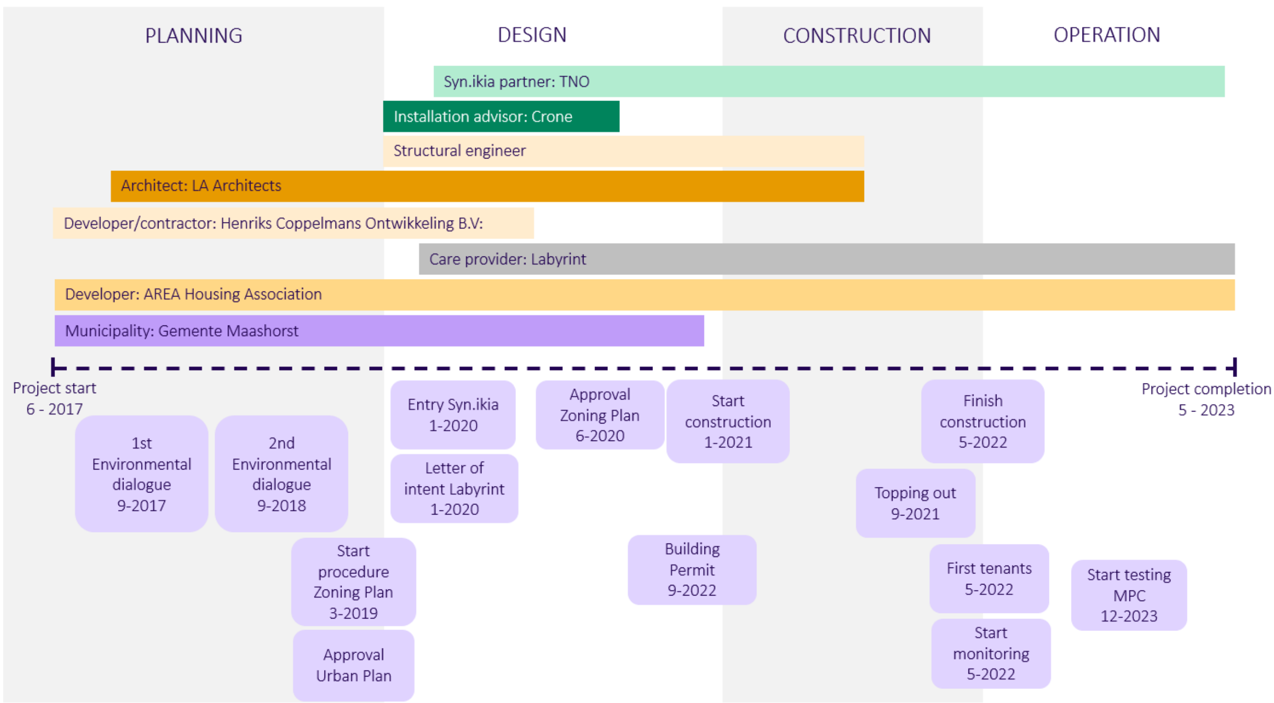


Figure 88: Mapping of the stakeholder's involvement in the different phases of the process from planning to operation for the Dutch demo.

In order to streamline the design and realization processes within Hendriks Coppelmans, a standard process diagram is used. This scheme uses the name "realistic dream process" (Figure 29). This is a process scheme with an ideal course of design and realization. The process is divided into separate steps (considering no delays), and after each step, the team has to go through the process and evaluate it. If everything is going well, they can move forward to the next phase.

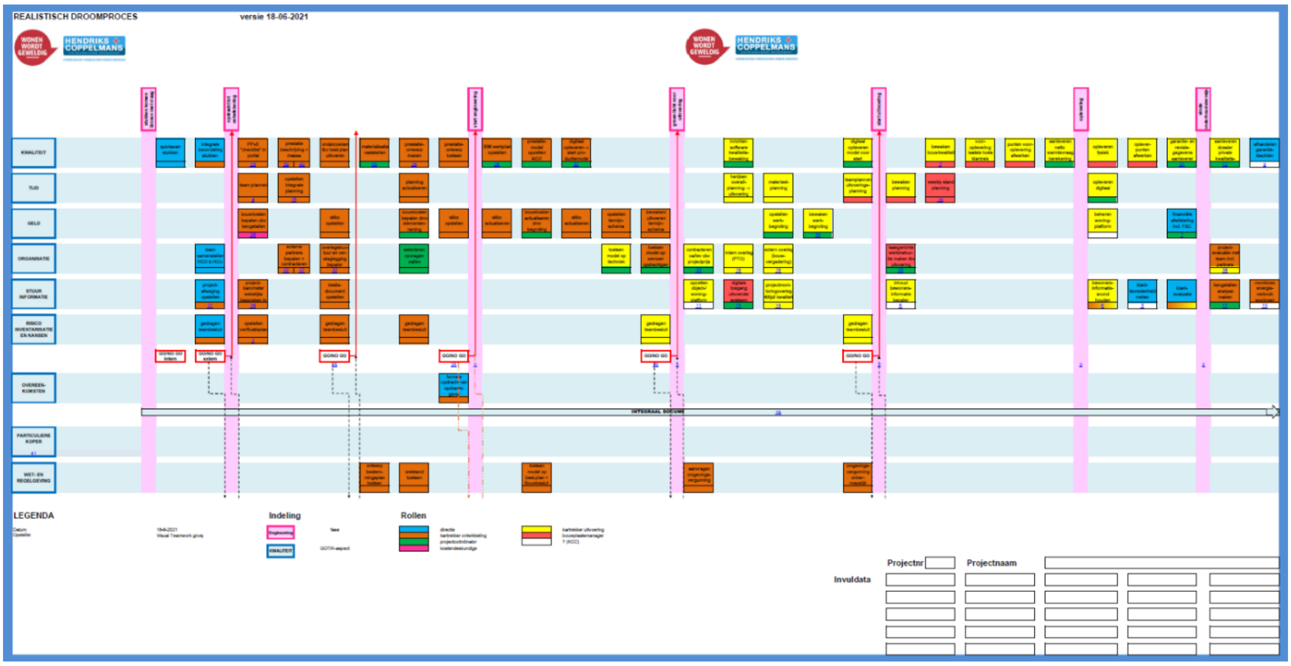


Figure 29: A representation of the "realistic dream process" used by the contractor in the project.

Many disciplines come together in the development of a new construction project. The task of the project manager is to coordinate the projects and, in the design phase, to make sure the preliminary and final designs are made. Further, the manager is responsible for the selection and contracting of consultants and the executing party within the framework of the tender procurement policy. During the realization, the project manager is responsible for the management and the chairmanship of the construction meetings. Ultimately, the project manager takes care of the transfer to the management phase of the homes. Given the number of tasks, and in most cases having multiple projects on hand, this is a full-time job. For the demo project it was therefore decided to place a syn.ikia manager next to the project manager. The syn.ikia manager collects and brings the necessary information from the syn.ikia consortium and implements syn.ikia's concepts and ideas in the project and maintains close contact with the construction project manager.

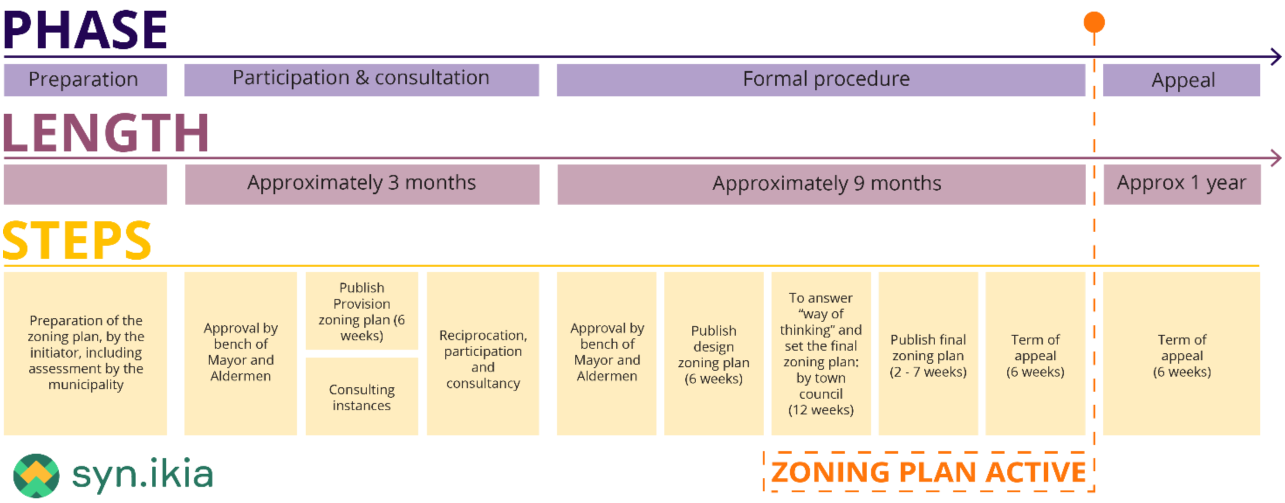


Figure 30: Representation of the planning process of the Dutch demo.

Design decisions and iterations

The project team spent resources and measures to reduce the energy consumption of buildings and the residents, and to improve the sustainability of construction projects. The following measures were incorporated: solar panels are installed on parts of the roof surfaces, attention is paid to building materials that are less harmful to the environment, and construction waste is kept to a minimum and collected separately as much as possible.

Syn.ikia came in late in the project, and therefore they were unable to change the design of the building to improve energy efficiency. However, this was not the case for the energy system. The design team had specific design meetings with TNO to improve the energy system, and a lot of decisions were made quickly. In regard to this, the design team experienced that a lot of big decisions had to be made within a short timeframe, which was demanding. The result was good, but it involved some luck as they did not have sufficient time to thoroughly evaluate every alternative.

The syn.ikia manager had to take many decisions rapidly as syn.ikia had to follow the timeline of the project. Area as a housing association is forward thinking and is willing to make decisions, and trust project managers to take decisions on their own. Not everyone needs to be consulted to make a decision, which reduced time and makes the process more efficient.

The project team has worked extensively on developing a model predictive control (MPC) of the heat pump to increase the efficiency of the system. AREA prefers to use heat pumps for the heating and cooling of buildings in their construction projects, and for this project they used a turn-key contract, where the contractor select the system and deliver within the specifications of the contract. In the beginning the contractor chose a standardized system with a heat pump and a reliable ventilation system (Alfa-Innotec). However, for the syn.ikia project, it was necessary to find a heat pump provider that would allow the team to control the heat-pump. Alfa-Innotec did not agree on these terms, but the company ITO agreed and could provide access to the settings of the heat pump. There were no simulations or calculation on the best performing heat pump, and it was selected based on access to the heat pump settings. The contractor was resistant to using a different heat pump, but after a meeting with AREA, the contractor and ITO, they agreed on this heat pump as it was important for the syn.ikia project to work on the control of the heat pump.

Individual heat pumps are more common to use instead of having one large central system, and in addition AREA do not need to bill the occupants for energy consumption. The contractors are used to installing small individual heat pumps rather than large installations, there is a larger market for small heat pumps, and therefore they are cheaper to install. Open-circuit systems need a permit (usually takes 9 months), while closed-circuits do not need permits and are cheaper. Small units are easier as they do not require the developer or contractor to apply for permits for systems installed in the ground.

The MPC started with modelling the digital twin. The monitoring equipment was installed after construction, and then the team had to the adjust settings of the heat pump. There were issues with the setpoints of the heat pump. A slot for the MPC control was added in the heat pump, but a signal was sent to the heat pump it was overloaded with information and shut off. This required testing to figure out why it was overloaded with information. By removing the standard IOT card (installed for the possibility of smart control in the future) the MPC worked. The control is currently working. First, the MPC is tested in testing apartments, and only when it is fully working it will be applied to all the apartments.

Exhaust ventilation system is used (and not balanced ventilation) because it is common in the Netherlands. Several years ago, it was common to use balanced ventilation, but then it got a bad reputation for not being healthy (and people wanted to open their windows), and therefore it is most common to use mechanical exhaust system now. No heat is recovered from the exhaust air. With low temperature heating in the floor and exhaust ventilation, there is a high risk of draught and discomfort (however, occupants will also complain about not getting fresh air if it is balanced ventilation). In future project Area would choose a balanced system to increase the efficiency of the system.

There are some practical issues with a lot of monitoring equipment in the building, as the sensors and devices often fall out of position, and they receive errors. Then, it is necessary to physically go and check the sensors, which requires more work.

Environmental Dialogue

Prior to the planning phase of the urban plan, the developer conducted a dialogue with stakeholders from the plan area. The stakeholders were mostly neighbours, either residential or people who work there, and they were invited by letter to participate in the environmental dialogue.

During the first meeting, information was provided about the construction plan and a dialogue was held with those who were present. The stakeholders were asked for input on several topics: accessibility (of the area), property separation, building height, positioning, and green structure. The urban plan was then composed with the input from the first round. During the second meeting, the project team explained how the input from the previous meeting was incorporated into the plan, and those present were again given the opportunity to respond.

Figure 31: An image from the Environmental dialogue, where the neighbours and people working in the area are discussing the plans and providing their input.

As a result of the comments made during the second meeting, the reactions of residents after the second meeting and the individual explanation, the urban plan has been adjusted on the following points:

- In order to give more air and space to the street President Kennedylaan, a big part of the facade has been placed further back.
- More connection has been sought with the neighboring plot on President Kennedylaan by lowering the block on the corner, an apartment has been omitted here.
- A facade on President Kennedylaan was completely made of brick, now is decided to use two materials, brick and wood cladding. This creates more layering in the facade and the suggestion of a roof, just like on Loopkantstraat.
- The strict monotonous construction of the facade on President Kennedylaan worked like a solid block, this has been softened by jumps in the facade, the material variation as named above and adapted detailing.
- The building has a number of balconies located outside the facade on Loopkantstraat; these have been given a closed bottom edge to reduce the cluttered appearance of balconies.
- More greenery has been added to the plan on both ends of the building around the escape stairs, this also softens the connection to the neighbouring plots.
- The third storey on the side of Loopkantstraat is fitted with tiles, creating the impression of a roof.

Valuable information was obtained from the two rounds of the environmental dialogue for the construction plan. The discussion was mostly about building height, density, and privacy regarding positioning and sizing of windows. This was incorporated into the urban plan, and the zoning plan was further elaborated and brought into procedure. It is not mandatory to have an environmental dialogue, but it was very beneficial as it reduced the resistance to the project. Partly thanks to the extensive environmental dialogue, no objections were lodged against the plan during the zoning plan procedure.

Methods and tools

The method used to make design choices deviates slightly from the conventional method. In conventional projects, Vabi (NTA – 8800 software) is used to make the energy performance calculations, the demo project also used the TRNSYS software in combination with TNO's Digital Twin.

The cooperation with the heat pump supplier in the field of data sharing and willingness to apply a test set-up was decisive for choosing a type of heat pump.

In addition to the standard software tools for communication and presentation (Office 365), the project-specific tools below have also been used.

- REVIT 3D, designsoftware: The building and installation concept is fully modelled in 3D. This means that the building has already been virtually built once, which ensures that the failure costs in construction are kept to a minimum. The setup of the installation is also fully developed in 3D, which ensures that the limited available space is used optimally. What differs from the conventional process is that the REVIT 3D model is also used as input for TNO's Digital Twin.
- Uniec EPC and TRNSYS calculation software: Because the building permit was applied before the 1st of January 2021, Uniec's EPC calculation method was sufficient. Based on this, energy performance calculations were made to demonstrate that the building could meet the EPC = 0 requirement. Deviating from a traditional approach, additional use was made with the TRNSYS software to determine the energy demand of the building.
- Vabi Software: Vabi (NTA-8800) software was used to determine the energy labels of the houses.
- Webportal BeNext: Area and TNO use the Be-Next web portal to monitor the actual energy consumption, the generation efficiency of the solar panels and the IAQ. This deviates strongly from the traditional approach in which no monitoring takes place during the use phase of the building. The data collected from the monitoring of the apartments is used to feed TNO's Predictive Twin.

Quality Assurance

Area Wonen uses a standard performance description for the quality level to be achieved at all its projects. This describes the minimum requirements that the building must meet for all building elements. The document serves as the basis for all developments and turnkey purchases of buildings.

Specific tasks are performed to reduce problems and errors in the design and construction phase. The following were done:

- The team perform clash tests of the BIM models from the architect, constructor, installers, and suppliers, and thus remove errors from the models.
- The contractor uses an internal inspection plan during construction to ensure that it is built according to the plans.
- Control measurements are performed to ensure that the building and systems performs as designed. That includes airtightness measurements, and measurement and adjustment reports for installers.
- Checks for energy labels. To have an energy label you must check if everything in the apartment/building is implemented according to the drawings. This must be proved with pictures/receipts etc.

- Delivery points with STA software is checked. When the project is nearly finished, the head of the construction site documents all faults and mistakes and ensure that it will be fixed by the trade/ company responsible. This is all documented in the software.

Contracting

The chosen contract form is a consequence of the ownership position of the location. Hendriks Coppelmans owned the location where the demo project was realized. As a result, it was decided to work with a Purchase/Design & Build agreement. Area first purchased the land, and then paid for the design and construction. With this integral way of contracting, in addition to the implementation task, the design task is also assigned to the (developing) contractor. The contractor is responsible for the design, obtaining the required permit and realizing the building within budget. The contractor contracts the architect and other advisors and maintains contact with the municipality to successfully complete the zoning plan procedure.

Difference From Conventional Process

In the Masterplan phase the project in Loopkanstraat, Uden looked at the possibilities for sharing energy and storing it locally, which is different from a conventional social housing project. The urban and zoning plan did not differ from a conventional process, but from the schematic design and throughout the detailed design there was a specialized focus on energy efficiency with analysis of different scenarios, in addition to plan for electric car charging. The energy support continued through the construction process, where TNO made sure the energy system and monitoring equipment was installed correctly. Lastly, the operational phase also differs as it includes extensive monitoring of the energy consumption and indoor environment, will include smart controls of the heat pump, and residents will be continuously informed on the energy consumption and how to be energy conscious. A more detailed overview of the differences from a conventional project to the Dutch syn.ikia demonstration project can be found in Table B.2 in Appendix B.

Reflections

When they started the syn.ikia project team they did not know where they were going and had to figure it out on the way. That made it challenging to convince partners to join without really knowing what it would entail. It is easier to convince someone with a proven concept rather with something new and untested. It was a significant learning process.

For a long time, there was uncertainty about who should do what with the digital twin, Hendriks Coppelmans' expectations were higher than the result. This was due to lack of efficient communications of what the digital twin would provide to the project. Another challenge of the project was that the installer did not want responsibility of the heat pump if they changed the internal settings. Therefore, Area had to take responsibility of the heat pump. In general, the contractor always has the responsibility, and not the advisors/consultants giving the advice.

The Social Beautiful concept is so far proving to work as intended. It is good to see what was achieved with all those involved, and hopefully it will prove itself in practice.

Lessons Learned

- **The environmental dialogue reduced friction in the process.** They gained insights from the attendees and experienced a procedure without objections. However, the environmental dialogue was a pilot within the municipality, which caused delays and the work processes within the municipality were not yet adapted to this.
- **Good and efficient collaboration in a large team of many stakeholders is possible**. The advantage with the syn.ikia project was that the contractor and the partners saw the extra value of being a part of syn.ikia and learn about energy efficiency and how to implement syn.ikia into the project.

- **Energy efficiency and environmental sustainability need to be considered from the beginning**. The syn.ikia involvement came late in the design process, so not all options were still open, and decisions had to be made quickly.
- **Regular in-person meetings improve the decision making**. Covid made decisions challenging when they had to communicate digitally and not physically, and more regular in-person meetings would make it easier to take decisions.

Gewin Gnice, Salzburg, Austria

Figure 32: Image of the demonstration project GNICE, in Salzburg, Austria.

Project Description

The Austrian demo project is a sustainable settlement development consisting of 17 new buildings, and will include 251 apartments and several other usages, like a kindergarten, a doctor's office, and an office for a charity organisation. The project is developed by a non-profit housing association, and several related stakeholders. Additionally, a group of elderly people formed a residential community in one house with social activities. The main focus is the collaborative development of high-quality outdoor spaces (high proportion of green; Greenpass© certified), buildings (mixed constructions with low heat demand; Klimaaktiv© certified), energy supply (heat pumps with PV systems; plus-energy© certified) and high-quality and sustainable mobility concepts (mobility point; klimaaktiv mobil© certified).

Project Team

The main actors of the design team are the developer, the city of Salzburg, the energy planner, the architects, the sociologist, the Salzburg institute of regional planning and housing (SIR), the energy consultant ABUD, and representatives from different thematic working groups, see Figure 30. The main goal of this so called "project group syn.ikia" is to coordinate the steering and working groups, to meet decisions, to keep all relevant stakeholders informed, both internal and external, and to ensure the defined goals are achieved.

The design team is professionally supported by four thematic working groups, which work on the urban design, buildings, energy infrastructure and utilities, and mobility concepts. The different stakeholders and project team members are part of at least one group. The roles and contributions of each team member are described in Table 3. For example, Inge Strassl from SIR is the leader of the project group syn.ikia. The main focus of this group is the coordination of the steering group and the working groups. The list of participants is very long, therefore, the group meet each other only 3-4 times per year. Final decisions are made by a so-called "steering group", which is also the interface between the local authority and the politics.

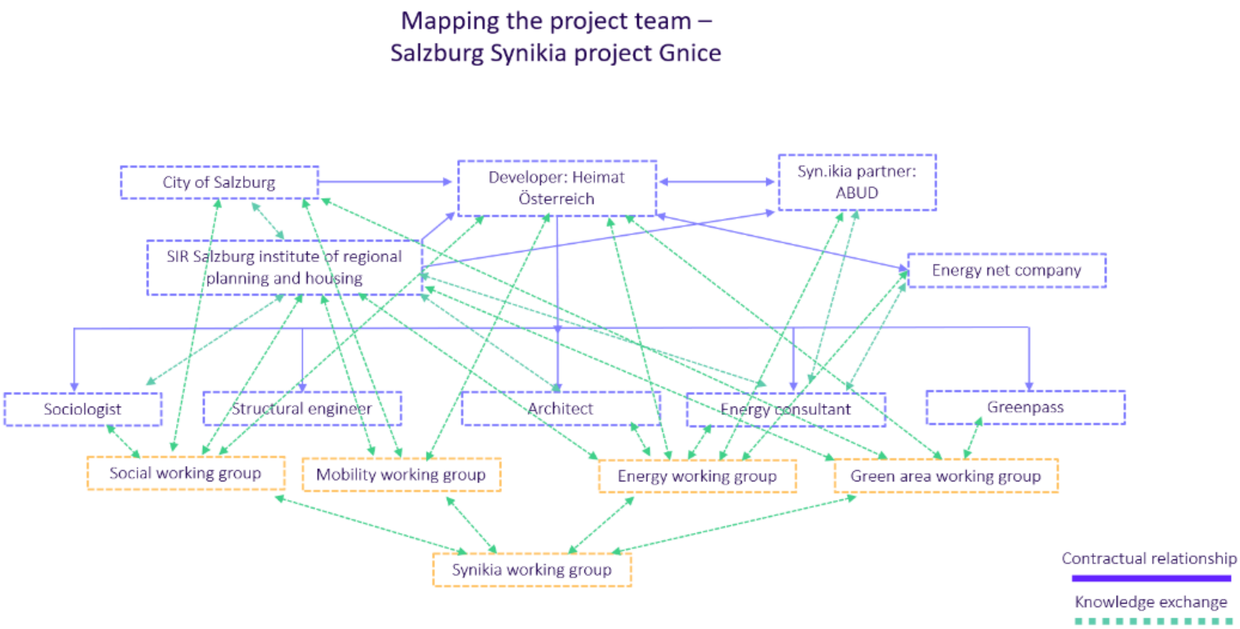


Figure 33: A representation of the project team of the Austrian demo and the contractual relationships and knowledge exchange.

Figure 94: A photo of the syn.ikia working group. Photo: SIR

Table 3: The organization diagram of the Austrian demo project.

	Steering group	**Project group syn.ikia**	**Working group** **urban planning**	**Working group** **buildings** (implemented in urban planning)	**Working group supply** (partly coop with buildings)	**Working group mobility**
Main themes	• Urban planning • Housing subsidies • Stakeholder involvement	• Project planning • EU-funding • Stakeholder involvement	• Offers on-site as well as surroundings • Variety of usage – base of building • Accessibility • Open space • Microclimate • Plus-Energy beyond property line	• klima**aktiv** building standard • Building physics	• Heat supply • Power supply • Drinking water supply • Waste prevention	• Road design • Pedestrian and bike infrastructure • Public transport, alternative offers • Cars

Participants	• Heimat Österreich (Gröger, Pac)
	• SIG, kindergarten (NN)
	• City of Salzburg
	  ○ MA 5, urban planning (Hörbinger, Polito, Kunze)
	  ○ MA 6, kindergarten (Groß)
	  ○ MA 2/02, schools (Kodat)
	  ○ MA 3/03, housing office (Steiner)
	  ○ MA 6/04, thoroughfare (Handl)
	• State of Salzburg
	  ○ 06, state road administration (Gebhard)
	  ○ 10 Land, housing subsidies (Lederer)
	• Architects (Strobl)
	• Sociologist (Raumsinn – Untner)
	• SIR (Strassl)
		• Heimat Österreich (Pac)
		• ECA (Stampfer)
		• SIR (Strassl)
		• City of Salzburg (Reich)
		• Housing office (Steiner)
		• Architects (Strobl)
		• Sociologist (Raumsinn – Untner)
		• Representative from the working groups
			• Heimat Österreich (Pac, Seywald)
			• Caritas (NN)
			• MA 5, urban planning (Hörbinger, Polito)
			• Sociologist (Raumsinn – Untner)
			• Architects (Strobl)
			• Carla Lo
			• Greenpass (Florian)
			• SIR (Strassl)
			• ABUD (Magyari)
				• Heimat Österreich (Seywald)
				• Building physics
				• Architects
				• SIR (Radermacher)
				• ABUD (Magyari)
					• City of Salzburg, Smart City (Huemer)
					• ECA (Stampfer)
					• SAG (Klinger)
					• SIR (Mair am Tinkhof)
					• ABUD (Magyari)
					• State of Salzburg (Weinberger, Thor)
						• Heimat Österreich (Pac)
						• City of Salzburg, Smart City (Reithofer)
						• Mobility planner (NN)
						• SIR (Gugg)
						• ABUD (Magyari)

Tasks/goals	• Important resolutions • Coordination city / state / interface function administration - policy • Equal level of information considering all topics	• Important content related decisions • Coordination steering group / working groups • Equal level of information considering all topics • Quality management – funding • Communication / participation internal/external	• Principles urban planning • Guideline for planning, implementation and operation • Quality management	• Principles building concept • Guideline for planning, implementation and operation • Quality management	• Principles energy concept • Guideline for planning, implementation and operation • Quality management • Plus Energy approach in syn.ikia project	• Principles mobility concept • Guideline for planning, implementation and operation • Quality management
Number of meetings	2-3 times/year	3-4 times/year	Meeting depending on work progress and cause	Meeting depending on work progress and cause	Meeting depending on work progress and cause	Meeting depending on work progress and cause
Invitation/lead	City department MA 5 Preparation SIR - Strassl	SIR - Strassl	SIR - Strassl	SIR - Radermacher	SIR - Mair am Tinkhof	SIR - Gugg

Project Ambition and Boundary Conditions

The goal of the syn.ikia project is to develop a sustainable plus energy neighbourhood, with energy efficient buildings, a surplus of renewable energy generation, and positive feedback from the users after the move-in. Further, the project's ambitions are to reach the requirements of the local building code, the local housing subsidy directive, the Klimaaktiv standard for the whole neighborhood, the Klimaaktiv standard in gold for all buildings, and the Greenpass standard for the blue and green infrastructure. All these ambitions were described and decided in a quality agreement.

The boundary conditions can be separated into different topics; social, architectural, urban planning, energy, and financial. The area is planned for social housing, includes an existing residential area with single family houses, and will have a kindergarten and assisted living homes. From an architectural point of view, the density is limited to 0.9, which means that it is not possible with more than three to four floors. From an urban planner point of view, the area is a green field with existing infrastructure, and has improvement potential. From an energy point of view, there is existing gas infrastructure in the neighborhood and local district heating will not be available. However, the area is suitable for the construction of a microgrid based on low temperature and renewable energy, and there is interest in forming an energy community. Regarding the financial boundary conditions, the project costs are defined and limited by the local housing subsidy directive. It is not possible to build an ambitious project with local market prices.

Reflections and Lessons Learned

The ambitions were set at the right level, but it took more than a year to discuss and define the goals in the quality agreement. There was a three-way discussion about the ambition, Klimaaktiv standard, needs from Salzburg (social housing and positive energy district) and the syn.ikia ambition. It was challenging to synchronize all these ambitions. The quality agreement took long, because not all relevant stakeholders were on board from the beginning of the discussion process. The architects were selected on a later development stage. In addition, the challenging financing of the planning phase stopped the workflow. Another reason was that the city of Salzburg did not want to discuss the quality agreement on a political level. Therefore, opportunities had to be researched, to keep the discussion on a content-based level. Last but not least, it took some time to explain that the document is not legal binding.

The main obstacles were the social boundary conditions. As described, the project will be built in an upscale residential area. Thus, the existing and newly formed local initiatives had to be managed and integrated into the planning and decision-making process. There is a social planner that works on this case. One challenge is that the new buildings are social housings and will be implemented in an area with existing single-family housing. Thus, the project will bring other cultures into the district and leads to a social mix ("poor" and "rich" people, young and elder people, different education level). This process must be managed to reduce social conflicts.

Planning Process

Collaboration and communication

The process can be divided into three phases: phase 1 is the pre-planning phase, phase 2 is the detailed planning phase, and phase 3 is the implementation phase.

For Phase 1, pre-planning phase, the building developer and city of Salzburg tried to include all interested stakeholders in the development process by a cooperative planning process. The following figure shows the carried-out procedure and dates: joint inspection, workshop 1, workshop 2, workshop 3, and public presentation. Each workshop had different goals and participants, as it is visualized in Figures 32 and 33. The interest for the workshops were high, as illustrated in the photos in Figure 34. The social planner is responsible for the social planning consultation, and to ensure public relation and participation in the project.

Figure 35: A representation of the carried-out procedure and date for the pre-planning phase: joint inspection, workshop 1, workshop 2, workshop 3 and public presentation. Strategy teams = Planning teams. (SIR).

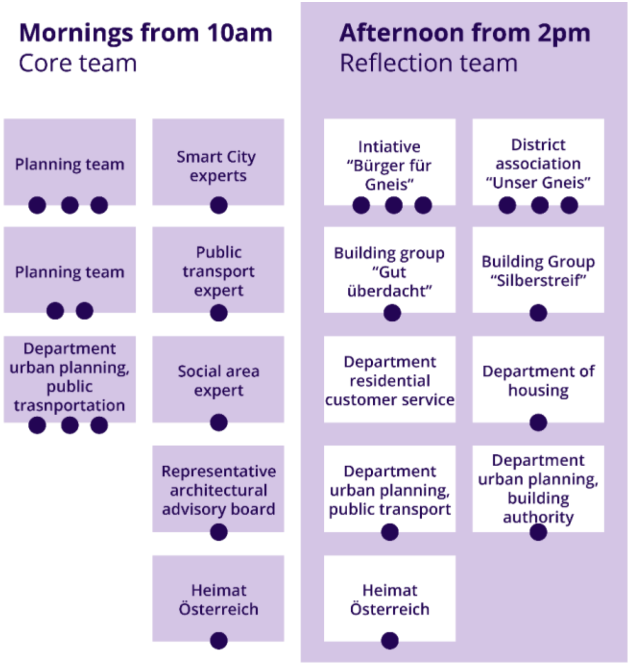


Figure 36: The program of one of the workshops (SIR).

Figure 37: Photos from workshops (SIR)

In Phase 2, the **detailed-planning phase**, the architectural team was selected through a public competition and the main planners were commissioned (energy, social, building physics). In the working groups, the ambitions were discussed and implemented in the design. The building developer managed the process and tried to fulfill all formal aspects of the building permission.

Figure 38: A model of the neighbourhood project.

Phase 3 will be the **implementation phase,** in which the buildings and infrastructure will be erected. Small changes of the original planning are possible. One main challenge is to get a company to construct the building for the defined price. Another challenge is to react flexibly on the market prices. The social planner will be moderating the handover of the apartments and the settling-in period.

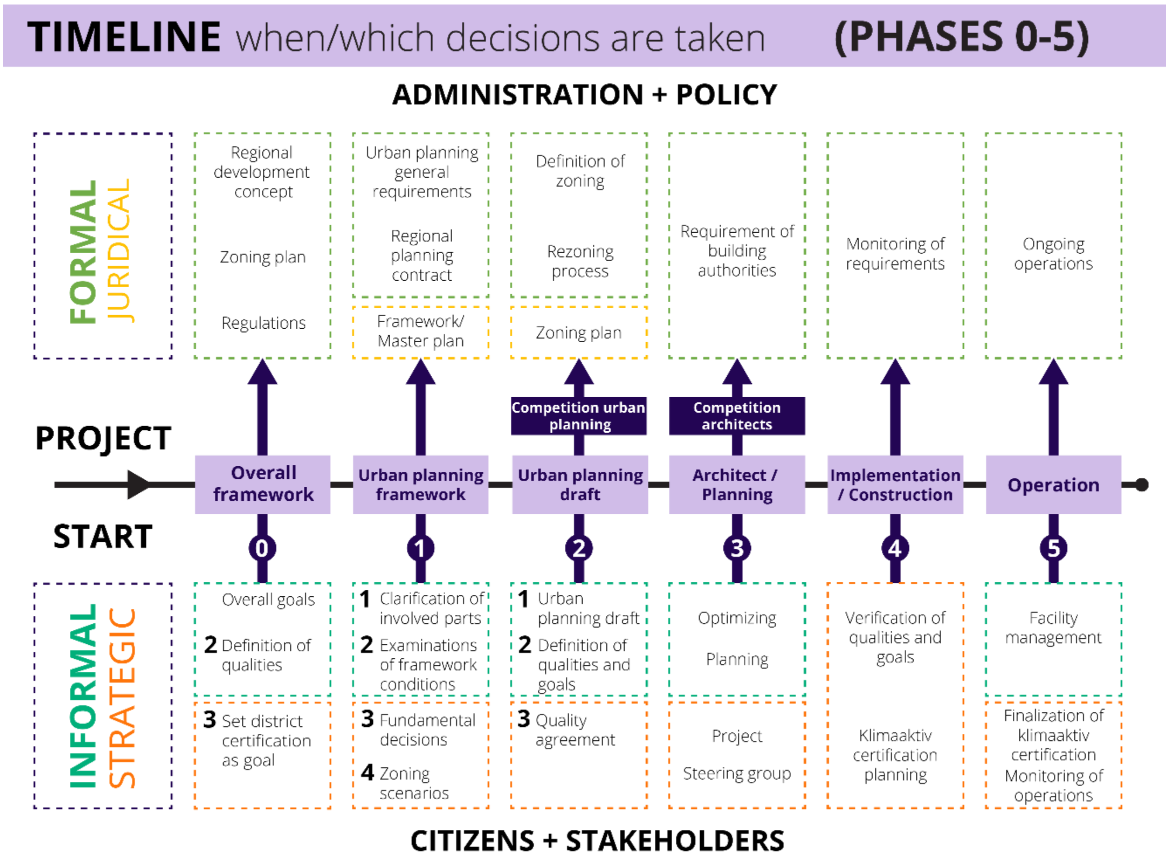


Figure 39: Project timeline overview with significant decisions for the Austrian demo.

Design decisions and iterations

The process for the energy concept started with the passive options, then moved to active options, and lastly renewable options. For the passive options, the focus was on the thermal envelope and materials, and where and how materials were sourced. For the active options, the system was selected based on experience from a recent project that works well, but with certain design changes to adapt to the site conditions. It was an iterative process that started with an initial energy concept, then, several options were explored and evaluated against each other. The decisions were taken as a team. A Ground Source Heat Pumm (GSHP) system was selected based on lifecycle cost, legislations, and the energy supply potential.

One central question in the discussions around the energy concept was: Should the energy concept for the thermal and electric energy only focus on the project area or include parts outside the project area? The decision was to focus on the new built project area for the heat supply. Regarding renewable energy communities through the sharing of PV electricity, negotiations with the neighbourhood are still ongoing. The second question was: What kind of energy sources are available in the project area and should be used? The final decision was sewage and groundwater. The ambition was to use as much energy from wastewater and groundwater as possible. In the project "Inhauserstraße" in Salzburg, the experience with that system is very good. In this area there was the wish not to have any kind of fossil energy nor any "burning heating" like pellets. In order to reach a plus-energy standard and to receive funding, the team had to calculate the size of the PV-installations given the existing framework conditions, like the quality of the buildings and a standard electricity demand. Then, they researched the possibilities for placement of the PV-system, to have it on the roof or other available surfaces. The financing of the energy system is currently not decided upon, and the project team has to select a business model for the system.

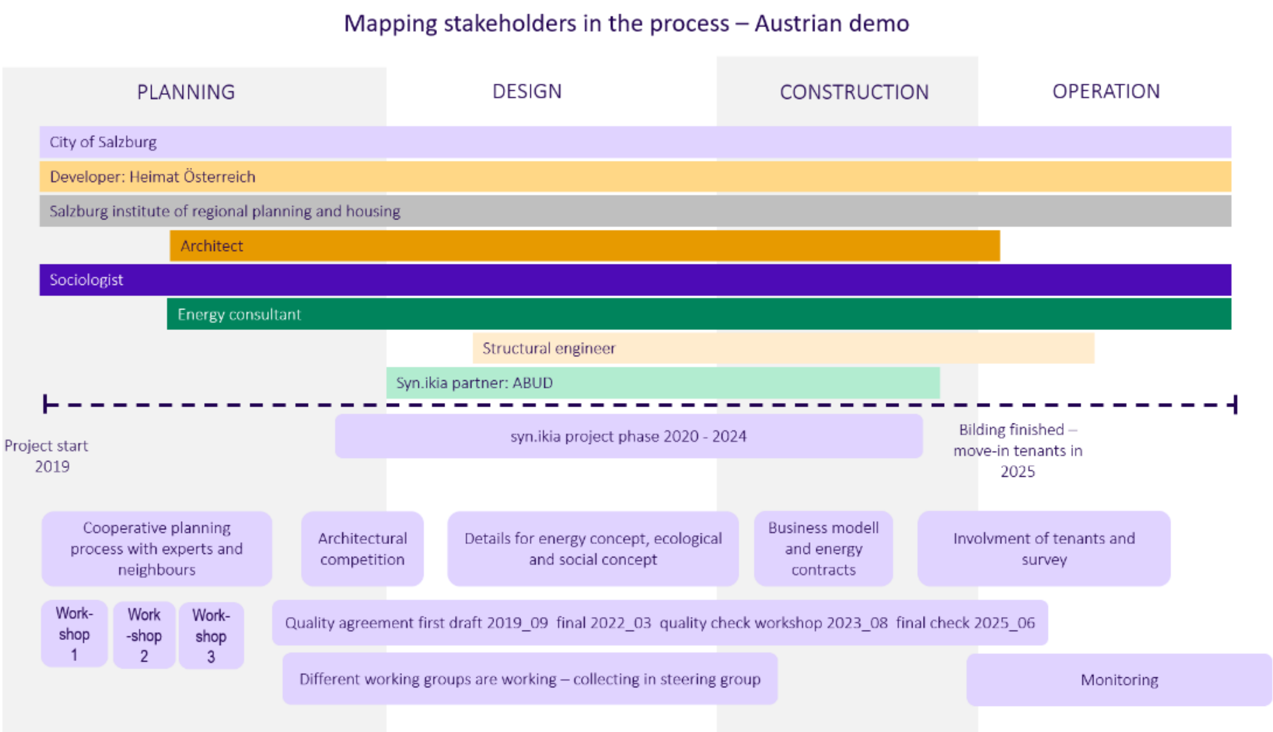


Figure 40: Mapping of the stakeholder's involvement in the different phases of the process from planning to operation for the Austrian demo.

Methods and tools

The main goal is to implement a neighbourhood that reaches the goals defined by the steering group, and described in the quality agreement, and to a certain degree in the national Klimaaktiv standard for settlements. The developed concept was evaluated from an independent auditor that provided feedback on what additional measures would be necessary to reach a higher standard. Based on this information, the urban development concept, the building concept, the energy concept, the mobility concept, and the planning and communication processes were developed further. The updated concepts were sent to the auditor, that again checked the quality, and the project was awarded the Klimaaktiv certification for design in October 2022. In this way, the planning process worked in a 'Plan-Do-Check-Act' cycle.

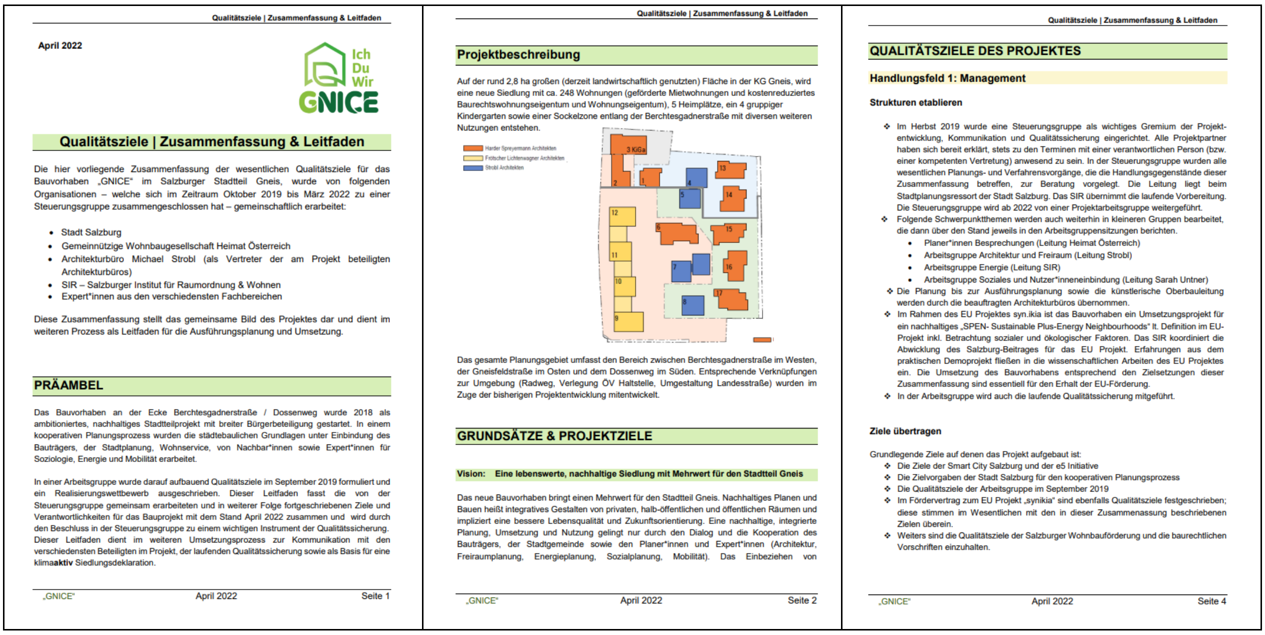
In general, the master tool was the criteria catalogue from the Klimaaktiv standard, as it provides feedback on whether the goals from the quality agreement will be reached or not.

The software tools used in the project were:

- GEQ: A software to calculate the Energy Performance certificate for the buildings, and to check that they comply with the building code requirements.
- PHPP: A software used to calculate more detailed energy flows for heating demand and electricity consumption in the buildings.
- PV-SOL: A software to calculate the hourly PV-generation for the neighbourhood development. The amount of PV-generation needs to be compared with the electricity demand to ensure a plus energy balance.
- TRNSYS: A software used to calculate detailed energy flows of the energy system.
- PLUSEnergie Excel: Software used to calculate the plus-energy-balance in terms of the Austrian plus-energy-standard.
- Nachweis Klimaneutralität: Software to calculate the greenhouse gas emission balance regarding the Austrian Klimaaktiv standard.
- Klimaaktiv Mobilitätstool: Software to calculate the energy and greenhouse gas emissions from mobility in the neighbourhood.
- econCal: Software to calculate life cycle costs of the project.
- CEA: City Energy Analyst is an open-source urban simulation platform designed for the assessment and optimization of energy systems in urban environments. It was utilized for early design feedback on scenario analysis, assessment of renewable and HVAC options, and gauging the performance of early designs, thereby facilitating informed decision-making towards low-carbon and energy-efficient urban development.
- Radiance: Enables precise lighting simulations for design scenarios. It was used to calculate Daylight Autonomy, Daylight Factor, and Useful Daylight Illuminance (UDI) for buildings, aiding in optimizing natural lighting and energy efficiency.
- EnergyPlus: A comprehensive building energy simulation program, adept at modelling energy consumption, and detailed building physics. It was utilized to compute building energy demand, analyse energy flows, evaluate thermal energy storage performance, and conduct thermal comfort calculations, thereby aiding in the thorough assessment and optimization of building energy performance, occupant comfort and summer overheating.

Quality Assurance
All three phases will be accompanied by a quality assurance process. The main elements of this process are defined in the quality agreement and in the Klimaaktiv standard. The two documents are used as checklists to ensure that the goals are reached. The outcomes are reports that document the progress and quality of the project.

The quality agreement is an agreement between the project developer, the city of Salzburg, the architects, and other relevant planners, that describes the goals/qualities for six topics (management, communication, urban development, buildings, energy, mobility). The quality agreement is the result of a communication process and expresses what goals must be fulfilled at the end of the project to ensure that all stakeholders say: "It is a successful project". It is more or less a summary and documentation of the main visions, ideas and measures that were discussed and set as objectives within the development process. It shall also be used as a communication instrument when new people join the project team. It is evaluated in each phase of the project, and at the end. On one hand, the document is a guideline for all relevant stakeholders that are a part of the project in the planning, implementation, and use phases. On the other hand, it functions as a quality check at the end of the project, to understand if the project was implemented successfully or whether some qualities were lost in the process. It is a voluntarily instrument and not legally binding.



Qualitätsziele | Zusammenfassung & Leitfaden

April 2022

Ich Du Wir GNICE

Qualitätsziele | Zusammenfassung & Leitfaden

Die hier vorliegende Zusammenfassung der wesentlichen Qualitätsziele für das Bauvorhaben „GNICE" im Salzburger Stadtteil Gneis, wurde von folgenden Organisationen – welche sich im Zeitraum Oktober 2019 bis März 2022 zu einer Steuerungsgruppe zusammengeschlossen hat – gemeinschaftlich erarbeitet:

- Stadt Salzburg
- Gemeinnützige Wohnbaugesellschaft Heimat Österreich
- Architekturbüro Michael Strobl (als Vertreter der am Projekt beteiligten Architekturbüros)
- SIR – Salzburger Institut für Raumordnung & Wohnen
- Expert*innen aus den verschiedensten Fachbereichen

Diese Zusammenfassung stellt das gemeinsame Bild des Projektes dar und dient im weiteren Prozess als Leitfaden für die Ausführungsplanung und Umsetzung.

PRÄAMBEL

Das Bauvorhaben an der Ecke Berchtesgadnerstraße / Dossenweg wurde 2018 als ambitioniertes, nachhaltiges Stadtteilprojekt mit breiter Bürgerbeteiligung gestartet. In einem kooperativen Planungsprozess wurden die städtebaulichen Grundlagen unter Einbindung des Bauträgers, der Stadtplanung, Wohnservice, von Nachbar*innen sowie Expert*innen für Soziologie, Energie und Mobilität erarbeitet.

In einer Arbeitsgruppe wurde darauf aufbauend Qualitätsziele im September 2019 formuliert und ein Realisierungswettbewerb ausgeschrieben. Dieser Leitfaden fasst die von der Steuerungsgruppe gemeinsam erarbeiteten und in weiterer Folge fortgeschriebenen Ziele und Verantwortlichkeiten für das Bauprojekt mit dem Stand April 2022 zusammen und wird durch den Beschluss in der Steuerungsgruppe zu einem wichtigen Instrument der Qualitätssicherung. Dieser Leitfaden dient im weiteren Umsetzungsprozess zur Kommunikation mit den verschiedensten Beteiligten im Projekt, der laufenden Qualitätssicherung sowie als Basis für eine klima**aktiv** Siedlungsdeklaration.

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Qualitätsziele | Zusammenfassung & Leitfaden

Projektbeschreibung

Auf der rund 2,8 ha großen (derzeit landwirtschaftlich genutzten) Fläche in der KG Gneis, wird eine neue Siedlung mit ca. 248 Wohnungen (geförderte Mietwohnungen und kostenreduziertes Baurechtswohnungseigentum und Wohnungseigentum), 5 Heimplätze, ein 4 gruppiger Kindergarten sowie einer Sockelzone entlang der Berchtesgadnerstraße mit diversen weiteren Nutzungen entstehen.

Das gesamte Planungsgebiet umfasst den Bereich zwischen Berchtesgadnerstraße im Westen, der Gneisfeldstraße im Osten und dem Dossenweg im Süden. Entsprechende Verknüpfungen zur Umgebung (Radweg, Verlegung ÖV Haltstelle, Umgestaltung Landesstraße) wurden im Zuge der bisherigen Projektentwicklung mitentwickelt.

GRUNDSÄTZE & PROJEKTZIELE

Vision: Eine lebenswerte, nachhaltige Siedlung mit Mehrwert für den Stadtteil Gneis

Das neue Bauvorhaben bringt einen Mehrwert für den Stadtteil Gneis. Nachhaltiges Planen und Bauen heißt integratives Gestalten von privaten, halb-öffentlichen und öffentlichen Räumen und impliziert eine bessere Lebensqualität und Zukunftsorientierung. Eine nachhaltige, integrierte Planung, Umsetzung und Nutzung gelingt nur durch den Dialog und die Kooperation des Bauträgers, der Stadtgemeinde sowie den Planer*innen und Expert*innen (Architektur, Freiraumplanung, Energieplanung, Sozialplanung, Mobilität). Das Einbeziehen von

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Qualitätsziele | Zusammenfassung & Leitfaden

QUALITÄTSZIELE DES PROJEKTES

Handlungsfeld 1: Management

Strukturen etablieren

- Im Herbst 2019 wurde eine Steuerungsgruppe als wichtiges Gremium der Projekt-entwicklung, Kommunikation und Qualitätssicherung eingerichtet. Alle Projektpartner haben sich bereit erklärt, stets zu den Terminen mit einer verantwortlichen Person (bzw. einer kompetenten Vertretung) anwesend zu sein. In der Steuerungsgruppe wurden alle wesentlichen Planungs- und Verfahrensvorgänge, die die Handlungsgegenstände dieser Zusammenfassung betreffen, zur Beratung vorgelegt. Die Leitung liegt beim Stadtplanungsressort der Stadt Salzburg. Das SIR übernimmt die laufende Vorbereitung. Die Steuerungsgruppe wird ab 2022 von einer Projektarbeitsgruppe weitergeführt.
- Folgende Schwerpunktthemen werden auch weiterhin in kleineren Gruppen bearbeitet, die dann über den Stand jeweils in den Arbeitsgruppensitzungen berichten.
  - Planer*innen Besprechungen (Leitung Heimat Österreich)
  - Arbeitsgruppe Architektur und Freiraum (Leitung Strobl)
  - Arbeitsgruppe Energie (Leitung SIR)
  - Arbeitsgruppe Soziales und Nutzer*inneneinbindung (Leitung Sarah Untner)
- Die Planung bis zur Ausführungsplanung sowie die künstlerische Oberbauleitung werden durch die beauftragten Architekturbüros übernommen.
- Im Rahmen des EU Projektes syn.ikia ist das Bauvorhaben ein Umsetzungsprojekt für ein nachhaltiges „SPEN- Sustainable Plus-Energy Neighbourhoods" lt. Definition im EU-Projekt inkl. Betrachtung sozialer und ökologischer Faktoren. Das SIR koordiniert die Abwicklung des Salzburg-Beitrages für das EU Projekt. Erfahrungen aus dem praktischen Demoprojekt fließen in die wissenschaftlichen Arbeiten des EU Projektes ein. Die Umsetzung des Bauvorhabens entsprechend den Zielsetzungen dieser Zusammenfassung sind essentiell für den Erhalt der EU-Förderung.
- In der Arbeitsgruppe wird auch die laufende Qualitätssicherung mitgeführt.

Ziele übertragen

Grundlegende Ziele auf denen das Projekt aufgebaut ist:

- Die Ziele der Smart City Salzburg und der e5 Initiative
- Die Zielvorgaben der Stadt Salzburg für den kooperativen Planungsprozess
- Die Qualitätsziele der Arbeitsgruppe im September 2019
- Im Fördervertrag zum EU Projekt „synikia" sind ebenfalls Qualitätsziele festgeschrieben; diese stimmen im Wesentlichen mit den in dieser Zusammenassung beschriebenen Zielen überein.
- Weiters sind die Qualitätsziele der Salzburger Wohnbauförderung und die baurechtlichen Vorschriften einzuhalten.

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Figure 41: An excerpt from the quality agreement of the project, which served as a guideline for the process with defined ambitions and goals, and a checklist to ensure that all objectives were considered in each of the project phases.

The Klimaaktiv standard is an instrument from the Austrian ministry for climate and is used to define and declare quality standards for buildings and housing settlements. The declaration for single buildings defines a standard for the energy performance and sustainability. The declaration for a housing settlement defines quality criteria in six fields: Management, Communication, Urban planning, Buildings, Utilities, and Mobility. The demo project "GNICE" achieved a score of 80 %, which corresponds to the "Silver" status, see Figure 39.

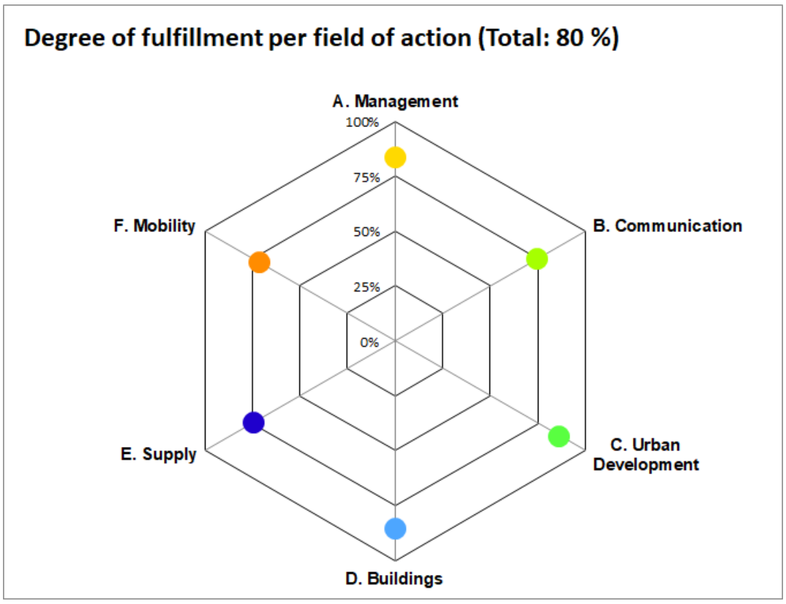

Figure 42: The result from the Klimaaktiv certification for the project. It achieved a score of 80 %, which is the "Silver" status.

Contracting

Heimat Österreich made a contract with the landowner that regulates how the land can be used (building legislations). Standard contracts were made with the architects and the experts. The quality agreement is a special contract used to steer the quality assurance process, and this contract has no legal validity. It worked well as a common goal, and then all the stakeholders knew the goals and had a common framework to follow. They could always refer to the quality agreement if questions arose.

Differences from conventional process

In the Masterplan phase, the main difference from a conventional process was the additional quality agreement for the project which stated ambitions and goals that were to be fulfilled. The zoning plan included assessments of the amount of green space in the neighbourhood, as well as considerations on the type of energy supply. The phases from detailed plan to schematic design, design development, and detailed design included extra focus on energy efficiency of the buildings and plans and designs for mobility solutions and energy supply were developed. Energy flexibility was planned in the construction and commissioning phase with demand-response and peak shaving. An energy community is to be formed in the operational phase, and common bicycles are implemented to improve sustainable mobility and social qualities.

Additional measures outside the project are planned to ensure a well functional neighbourhood. They are:

Measure 1: An energy community will be established to connect the following producers and consumers: Hydropower plant (30 kW), PV system in Berchtesgadnerstraße 70+72 (65 kW), PV system GNICE (up to 505 kW; producer) including 4 apartments in Praxmayer Mühle, 28 apartments in Berchtesgadnerstraße 70+72, and 251 apartments in GNICE. Because of the renewable expansion law, the framework conditions for such projects are ideal, and include lower grid prices and the energy price between the participants can be set individually.

Measure 2: A mobility concept, that also considers the area outside the project, is planned. It includes moving the existing bus station, implementing a mobility point, and establishing a central parking station for all cars of the neighborhood.

Measure 3: The existing buildings outside of the project area are currently heated with fossil fuels. Therefore, a district heating system for the whole neighborhood was planned. With the (not finalized) renewable heating law, existing fossil heating systems must be replaced till 2040.

Measure 4: A free energy consultation was offered for the whole district Gneis. The people are interested to implement the following measures. Figure 40 shows the result of a survey carried out to identify the interest to each single measure. A total of 68 % of the asked people interested in the implementation of a PV system.

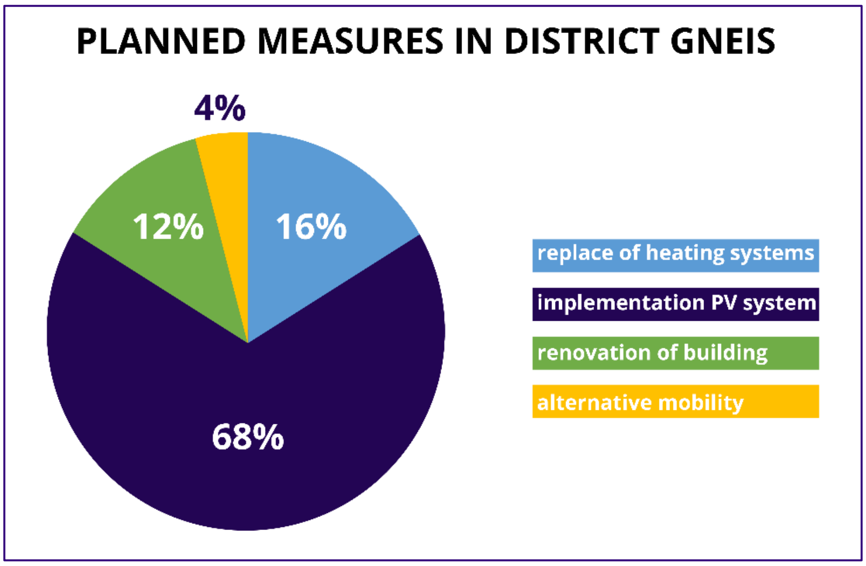

Figure 43: A presentation of the planned measures in the project and the percentage of the people in the Gneis district that expressed interest in the different energy and climate measures .

Reflections

The team's cooperation is excellent, with the advantage that the team members had worked together in other projects. The syn.ikia project provided additional funding for such a multidisciplinary collaboration, which is different from a conventional project. In future projects, a secure and continuous financing is necessary from the start of the planning process. The development of a project with about 250 apartments needs a lot of time. The team worked since 2018 on the project and will start with the implementation in 2024. It is important, that all relevant stakeholders work intensively on the project for these 6 years intensively. However, common financing schemes ensured sufficient financing of all the experts for only 1, 2 or 3 years. Therefore, every year it was necessary to find a solution to finance the development of the sustainable plus-energy-neighbourhood. Luckily, it worked to have a continuous project chain with 4 different projects and clients. For the future, it will be necessary to have continuous financing for a longer period for a such project (at least 5 years, but preferably for 10 years).

The methods and tools used were useful. An improvement potential is to have financing for different architectural teams for the various project in the neighbourhood, instead of having one architectural team for all the buildings in the area.

Good cooperation between the developer and the community is important, as several significant topics do not end at the border of the planning field (bicycle infrastructure, recreation areas, public transport and car-sharing, energy communities with the neighborhood, social exchange).

It is necessary to include the neighbourhood into the planning process. The project developer is responsible for his own project area, but in many cases, it makes sense to also implement measures outside of the project area, or to take external framework conditions into account. It is in many cases a perfect window of opportunity to start the necessary transformation process in city districts. For example, the project developer can develop his own energy system, or check the potential outside of his project area. In many cases it makes sense to build a larger heating central and supply the buildings outside the project area with renewable energy as well.

Lessons learned

- The city must play an active role in such projects because additional measures outside of the project area are necessary (such as mobility measures, including mobility hubs and parking for electric vehicles outside of the neighbourhood). Thus, the city must play an active role in terms of making it easier for the developer to plan and build ambitious neighbourhoods, where regulations limit the boundaries. The city can play a more active role by participating in the planning processes, and not only in the authority processes. For example, in the GNICE project, the City of Salzburg is a part of the steering group and therefore an equal planning partner. If regulations limit the boundaries (e.g., number of parking spaces), the city can react directly.

- **The quality assurance process must start early** and is optimally moderated by an external expert.
- **Define responsibilities, rules, processes, and goals** from the beginning.
- **Moderation of the processes is necessary**. It can be done by commissioning a moderator or so-called project accompanist. In this case, SIR acted as this independent accompanist. SIR is also listed as competence partner of klimaaktiv. Our main task is, to bring all relevant stakeholders together and to moderate the process.
- **Participation processes must start open-ended**, which means that the results of the process should not be set before the start of the process.

Verksbyen, Fredrikstad, Norway

Figure 44: Image of the demonstration project Verksbyen in Fredrikstad, Norway. The highlighted two buildings are the syn.ikia demo buildings.

Project description

Verksbyen is one of the largest urban developments in Fredrikstad with a planned development of approximately 2 000 new homes. Fredrikstad is the sixth largest town in Norway with approx. 90 000 inhabitants. The land area in Verksbyen took its shape in the second half of the 19^{th} century as an important industrial area along the Glomma River, with its brick and lumber industries. Today, these industrial areas are transformed into modern and sustainable neighborhoods.

The total area for residential constructions is approx. 215 000 m^2, of which Arca Nova owns 180 000 m^2. The remaining areas make up 17 percent and are owned by Fredrikstad municipality. The syn.ikia project focuses on two apartment buildings: block K and L, with 22 apartments in each building. The SPEN’s are private residential housing for sale in the market.

Figure 45: From traditional old industries to a modern sustainable neighbourhood.

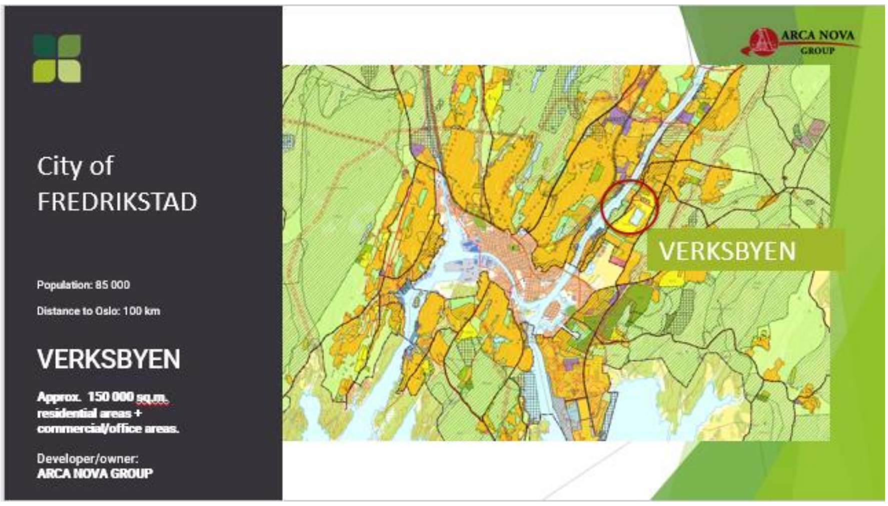

Figure 46: The location of the project, on the outskirts of Fredrikstad in a previously industrial area.

Project Team

The project is developed by the private developer Arca Nova, and the syn.ikia partner is Arca Nova Bolig. The design is developed by GRIFF Arkitektur, together with the structural engineers PRO-Consult and Contiga. Energy advisers are Multiconsult, Zijdemans Consult, Solcellespesialisten (PV) and Kelvin (thermal energy). Nova Energy, a part of the Arca Nova Group, will be the energy manager for the buildings.

The project also involves the planning of a large outdoor area around a small lake (Sorgenfridammen) at the 'heart' of Verksbyen. Multiconsult has been the adviser on the development of a landscape plan for the park areas. In connection with the development of Verksbyen, *Naturformidling Bjørn Frostad* has been commissioned by Arca Nova, in cooperation with the municipality and other stakeholders, to investigate the possibilities of safeguarding Sorgenfridammen as an attractive area for nesting wetland birds and biological diversity, within the framework of the adopted regulatory plan.

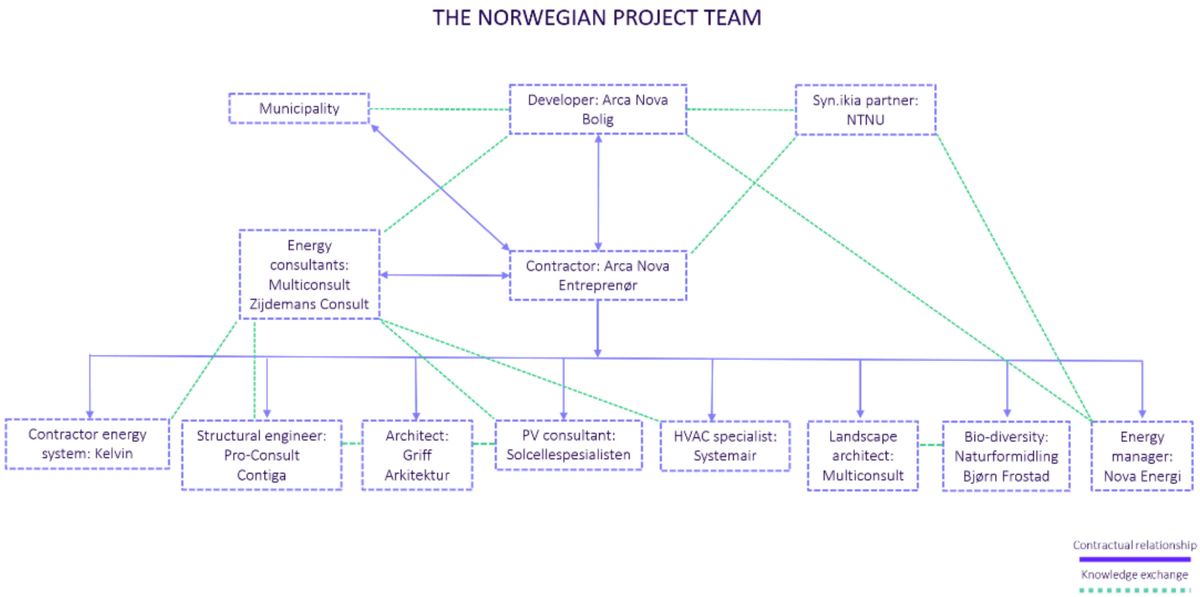

Figure 47: A representation of the project team of the Norwegian demo and the contractual relationships and knowledge exchange.

Project ambition and boundary conditions

The main ambition is to create an environmentally sustainable plus energy neighborhood (SPEN), and to develop Norway's most innovative housing project so far. This involves the following elements/innovations:

- Energy efficient buildings with low energy demand.
- Local production of renewable energy (solar and thermal).
- Renewable energy sources linked to SMART ICT-based components.
- Energy sharing, distribution, and storage at a neighborhood level.
- Low carbon design of the buildings.
- Social sustainability
- Affordable housing in use in terms of lower energy bills for the residents.

Figure 48: An aerial view of Verksbyen, and the building Panorama up close.

The primary boundary condition is the lack of a legal framework for energy sharing at a neighborhood level. The Norwegian Energy Regulatory Authority (RME) has recently proposed a new expanded scheme for sharing locally produced solar energy between buildings on the same property, which was approved by the Ministry of Petroleum and Energy (OED). It ia a significant expansion of the current scheme with "plus customers" to also include residents of multi-family homes, apartment complexes and commercial buildings. The upper limit of the scheme is set at 500 kW installed power per property. In this case, renewable energy within a property will thus be able to leverage solar production to reduce their own consumption of energy from the grid and grid costs.

The maximum allowed energy requirement for residential blocks in Norway is 95 kWh/m^2. The realized net energy requirement for Verket Panorama and Atrium built according to the Norwegian passive house standards (NS 3700) is expected to be 60 kWh/m^2. The building standard applied in Verksbyen goes beyond current Norwegian building standards.

Design process

Collaboration and communication

The planning of Verksbyen started in 2018. Arca Nova got funding from Enova (A Norwegian state enterprise that provides funding for energy efficiency measures) to perform an initial planning study for the energy concept of the whole neighbourhood of Verksbyen. The feasibility study was led by Multiconsult, and the objective was to explore the development of a housing project based on renewable energy sources and low carbon design. The feasibility study explored the following topics: a renewable system working in tandem with local power suppliers, climate friendly energy and mobility solutions to improve everyday life for residents, smart and sustainable buildings where residents thrive, and a neighborhood that provides space for physical and health promoting activities.

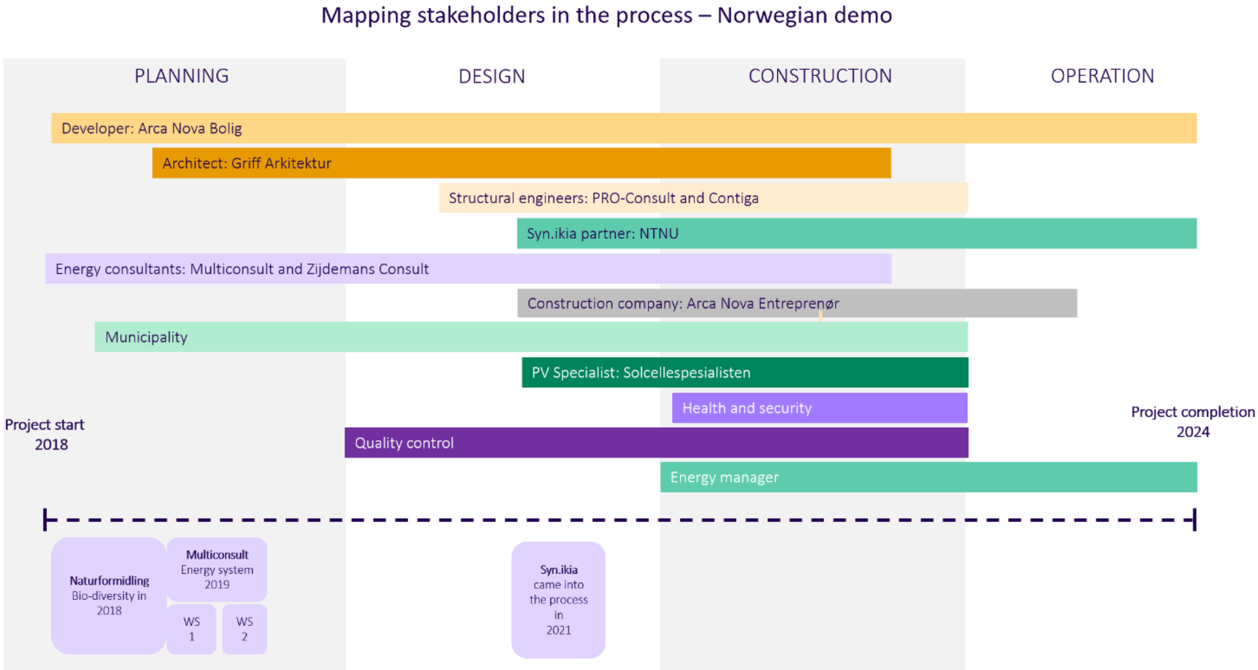

Figure 49: Mapping of the stakeholder's involvement in the different phases of the process from planning to operation for the Norwegian demo.

Figure 50: Photos from the two workshops in May and August 2018.

In the early phase of the feasibility study, the developer Arca Nova facilitated two workshops and invited relevant stakeholders from private and public sectors and academia that could contribute to the development. Approximately seventeen different stakeholders were present av the workshops. Workshop #1 was held in May 2018, soon after the start of the concept study. The purpose of this Workshop #1 was twofold:

1. To inform about the plans and ambition for the study.
2. To identify opportunities and boundary conditions important for the various sub-concepts and further work.

Workshop #2 was held in late august 2018. The purpose was twofold:

1. To inform and discuss issues on quality assurance, power balancing, as well as to map whether there were any significant premises and conditions that had not come to light so far.
2. To highlight and discuss current measures related to mobility and business model for the planned energy system.

The next step (2019) involved the participation in the Enova-sponsored *MicroFlex* project. The aim of the project was to demonstrate how local and flexible energy communities (LEC) can contribute to reducing the need for investments in central and regional power grids, by exploiting the interaction between electrical and thermal energy sources in a flexible local marked. This involved local power production, self-consumption and sharing of locally produced energy. Verksbyen (the initial development areas of the neighborhood Verkshagen and Capjon Park) became the main testbeds. Because regulatory and commercial innovations had yet to be developed and implemented, the Norwegian Energy Regulatory Authority (RME) developed a regulatory sandbox solution, granting a temporally regulatory exemption for Verksbyen. *MicroFlex* will be completed in 2024.

The result so far from these two innovation projects provided Arca Nova with clear indications of the possibility of utilizing local and renewable energy (solar and thermal) as significant energy sources in Verksbyen. In the case of Mixroflex, Arca Nova participated in 2 workshops arranged by Enova. Both studies have laid much of the foundation for developments made so far (Verkshagen, Capjon Park), and have provided us with important insights and experiences for further developments of Verket Panorama and Atrium, especially in the early design phase.

Figure 51: The photo to the left shows Block L, K (Panorama) and A (Atrium) in February 2023. The photo to the right show Block K and L (Panorama) in February 2023.

Before the project started, the developer had a meeting with the neighbourhood residents who would be affected by the construction. The participants expressed resistance against the project, but this has changed because housing prices have increased in the area. In addition, the recreational area developed within Verksbyen is highly valued and used by the rest of the neighborhood.

Design decisions and iterations

In general, the project team has worked with different groups of specialists, e.g., PV company, to develop the design for the buildings and energy system. The feasibility study provided the initial framework for the design of the energy system of the neighborhood.

A surplus of local renewable energy generation is essential to reach the energy ambition of a plus energy neighborhood. This has implications for the design, specifically integrated photovoltaic panels (PV) on the facades and roof. The work with the PV specialist and local company Solcellespesialisten started early, and the design of the PV system was a collaborative process between Arca Nova, Griff Arkitektur, and Solcellespesialisten. The orientation of the main roof was tested to ensure high energy generation. The project team communicated with the municipality and the municipality was positive about the project ambition. Therefore, in the detailed planning phase (there was a total of three detailed design iterations) they were allowed to deviate from the municipal regulations and change the roof shape and increase the building height with one floor to improve the solar energy generation potential.

The ambition was to implement solar panels as a natural part of the architecture. The team set out with the ambition to create a set of buildings where the energy generation on roofs and facades were to be integrated in the building design and architecture. The aim was to reduce the technological look and add a more rustic character to the project. The architect expressed *"It is challenging to ensure good aesthetics by introducing PV panels on the façade"*. The developer and the architect had continuous meetings to solve design issues, which was an ongoing process for a long time due to challenges with meeting the energy ambition. The architect worked extensively on the façade design to achieve sufficient energy generation, while maintaining a desired architectural expression. Both the overall look of the architecture and more detailed studies were done to test the options in small and large scale. All the facades went through an iterative process, where detailed 3D models were used for evaluation of different design solutions. The different options were evaluated upon the criteria of visual aesthetics, technical solution, solar energy effect and cost (Figure 36-38). Another issue is that the size of the photovoltaic panels changes often, which challenges the design of the buildings as it needs to adapt to the new panel size.

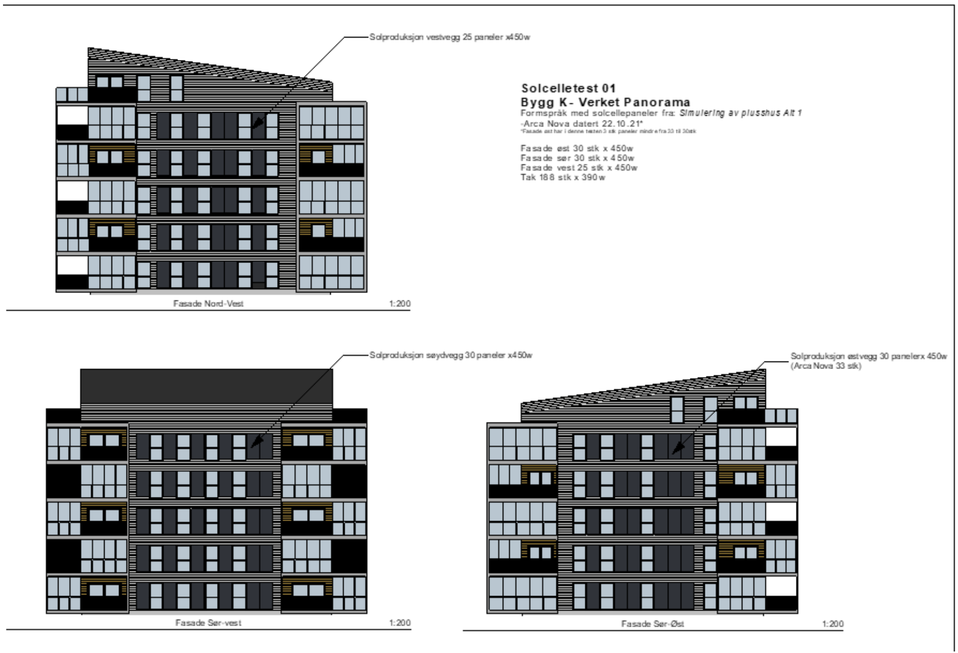

Figure 52: Early-stage test of maximizing number of PV panels on the facade and roof.

Figure 53: A version with increased surface for the main roof to enlarge the area for PV panels.

Figure 54: Detail studies of the integration of PV panels in the facade.

The project team had a long process with the district heating company Fredrikstad Fjernvarme. They had worked together in previous processes, and the project team contacted them because they wanted to use district heating as auxiliary heat and back-up heating solution, after the main heating source of a ground-source heat pump. The company has significant operational competence and is therefore a valuable resource.

Figure 55: Representatives from the architectural company in the project, Griff Arkitektur.

Methods and tools

The architect experienced a lack of tools in the preliminary stages as it is difficult to know the implication of design choices. For example, for Panorama, the balconies limit façade area for PV generation and they found out that to have generation on the balconies is not worth it compared to the impact on the aesthetics and resulting energy generation.

Now, the architect has access to a program which uses AI simulations to balance the daylight access and energy generation – by a company called Data Tree. This gives earlier input for different design configurations and makes it easier and faster to understand design implications. However, for this demo project they had to manually test it out with daylight access and energy generation.

The following tools were used:

- HOMERpro (Hybrid Optimization Model for Multiple Energy Resources): Simulating five different scenarios with a focus on optimizing NPC (net present cost).
- ArchiCAD: Software for architectural 3D modelling and drawings. Also used to perform daylight studies. For the design of the PV system on the façade ArchiCAD was used to create alternatives in 3D models, and for final tests visualizations from a third parti render company were included. The first test was made in a simpler 3D representation, and after narrowing down to fewer options more detailed renderings were used for final decisions.
- EDrawings: to check DWG files
- Solibri: to view IFC files
- Simien: Software to perform energy calculations and code compliance against the Norwegian passive house standard (NS3700).

Quality Assurance
Quality assurance is closely linked to risk management. The increasing use of interconnected and innovative digital systems to perform critical tasks introduces new vulnerabilities compared to traditional buildings. It is therefore of great importance to put a special focus on ICT security during the design, planning, construction and commissioning phases. This is a project with innovative, partly immature, and partly complex ICT solutions. Errors in these solutions, especially in an early phase of the project will be particularly unfortunate. A systematic approach to risk is therefore important throughout the planning and construction phase.

Multiconsult was involved in the quality assurance process in the early design phase, to control preliminary performance goals. The goal of plus energy and to meet the passive house standard was constantly reviewed and internally checked to see if the project was on the right track to reach the ambition. The feasibility study has a section about risk related to the energy concept, which provided an upfront heads up about possible issues. The section describes the most significant risk related issues, their consequence potential, the existing knowledge about the function, and the complexity. For example, the energy management system is concluded as a high-risk function, with a large consequence potential if a malfunction in the energy system occurs, with varying experience for control of the different installations the system comprises of, and the complexity is high due to involving a large set of housing units with many components in total.

The energy system planned for Verksbyen will be challenging in terms of risk. This does not mean that it will not be possible to establish a well-functioning system with sufficient risk control, but it will require systematic risk management as it includes novel solutions. To handle this risk, the developer established a separate company, Nova Energy, owned by the Arca Nova Group, to function as energy manager for Verksbyen, and manage all solar installations, energy centrals, distribution of energy between buildings and measurements of both solar and thermal energies. This includes administration and management of local power production, storage, and monitoring.

The sale of apartments is crucial for the finances of the project. There was uncertainty related to how home buyers relate to innovative environmental projects. Is there a willingness to invest more in smart houses with lower running energy costs, than homes built according to the existing building code (TEK17)? Are such homes considered more attractive in the market than traditional homes? So far, there has been a positive trend in the interest in, and the sales of, these apartments compared to the market in general. The current energy crisis has triggered home buyers' interest in projects that can lower their energy bill.

Contracting
The developer writes contracts based on functions rather than specific products, and there is no difference in the contracting process compared to a conventional project. However, new descriptions for procurement of services related to the energy system had to be made.

The energy system is placed in a different company (still owned by the developer) than the developer (as advised by Multiconsult). Thus, the energy central is run by the developer through their own external company.

The challenge right now is the war in Europe, which affects the contracts and prices. It is difficult to have subcontractors sign contracts.

Difference from conventional process
There were no changes in the Masterplan phase and there was existing Zoning plan from 2005. A significant difference from a conventional process is the energy concept plan that was developed for the whole area, with the focus on reaching a plus energy balance for the neighbourhood. For detailed plan, the developer got permission to deviate from the existing regulations and increase the building height with one floor and change the roof angle to increase the opportunities for energy generation.

The schematic design and design development were performed simultaneously, as opposed to in a more traditional sequence. This was due to the extra focus on energy efficiency and local renewable energy generation, with specific focus on placing the PV panels. The detailed design also included a strong energy focus with the further development of design and interactions to meet energy ambition of the Passive House standard (NS3700) and a plus energy balance, and design the energy systems for the whole neighbourhood.

Due to the use of new technology and energy solutions the construction and commissioning phase has increased risk compared to a traditional project, as new and unfamiliar installations most likely require more effort in commissioning. This extends into the operational phase, because as the energy system is more complex, it requires more management to operate efficiently as it has new and not thoroughly tested solutions.

A more detailed overview of the differences from a conventional project to the Norwegian syn.ikia demonstration project can be found in Table B.4 in Appendix B.

Reflections
Early design choices could limit energy generation possibilities. For example, design choices for building A on the orientation of the apartments makes it difficult to reach the plus energy balance, as a lot of the façade is occupied and cannot be used for energy generation.

Two companies they have worked with, E2U and FreeEnergy, went bankrupt. Using and testing new and innovative technologies involves higher risk than conventional solutions.

Lessons learned

- **The importance of understanding risk.** Risk assessment is of great importance. One should never underestimate technological risks. Systems might not function as intended, due to new and immature technologies and challenges related to system integration. It is obvious that the energy management system planned for Verksbyen will be challenging in terms of risk. This does not mean that it will not be possible to establish a well-functioning system with good risk control, but that it will require systematic risk management. Risk management should thus be an integral part of the planning process, and the result of risk assessments should be included as a central part of the process.

- **Sustainable business models and regulatory barriers.** An important element in realizing a well-functioning local energy system is paying attention to the development of good business models and mapping of regulatory barriers. Further to ensure that the right choices are made when investing and operating, so that the potential value creation can be realized.
- **Local energy manager.** Arca Nova has established Nova Energi as the local energy manager. The reason for this is that it is assume that the high complexity of the energy system cannot be left to the residents. A local energy manager will have the following responsibilities:
    - Production and distribution of heat to cover all housing units' needs for space heating, ventilation heating and hot tap water.
    - Agreement with Fredrikstad Fjernvarme (District Heating), including the purchase of peak loads and reserve capacity.
    - Customer management, including invoicing of heat consumption for each individual housing unit.
    - Ownership and operation of local solar plants, charging stations for electrical vehicles, and common facilities for electricity.
    - The local energy manager will not take over the local network company's (area concessionaire Norgesnett) responsibilities related to security of supply and delivery quality, etc., as regulated by the Norwegian Water Resources and Energy Directorate (NVE).

8. Acknowledging EU funding

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 869918.

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NTNU
Norwegian University of Science and Technology

DTU
Technical University of Denmark

BPIE

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ENFOR

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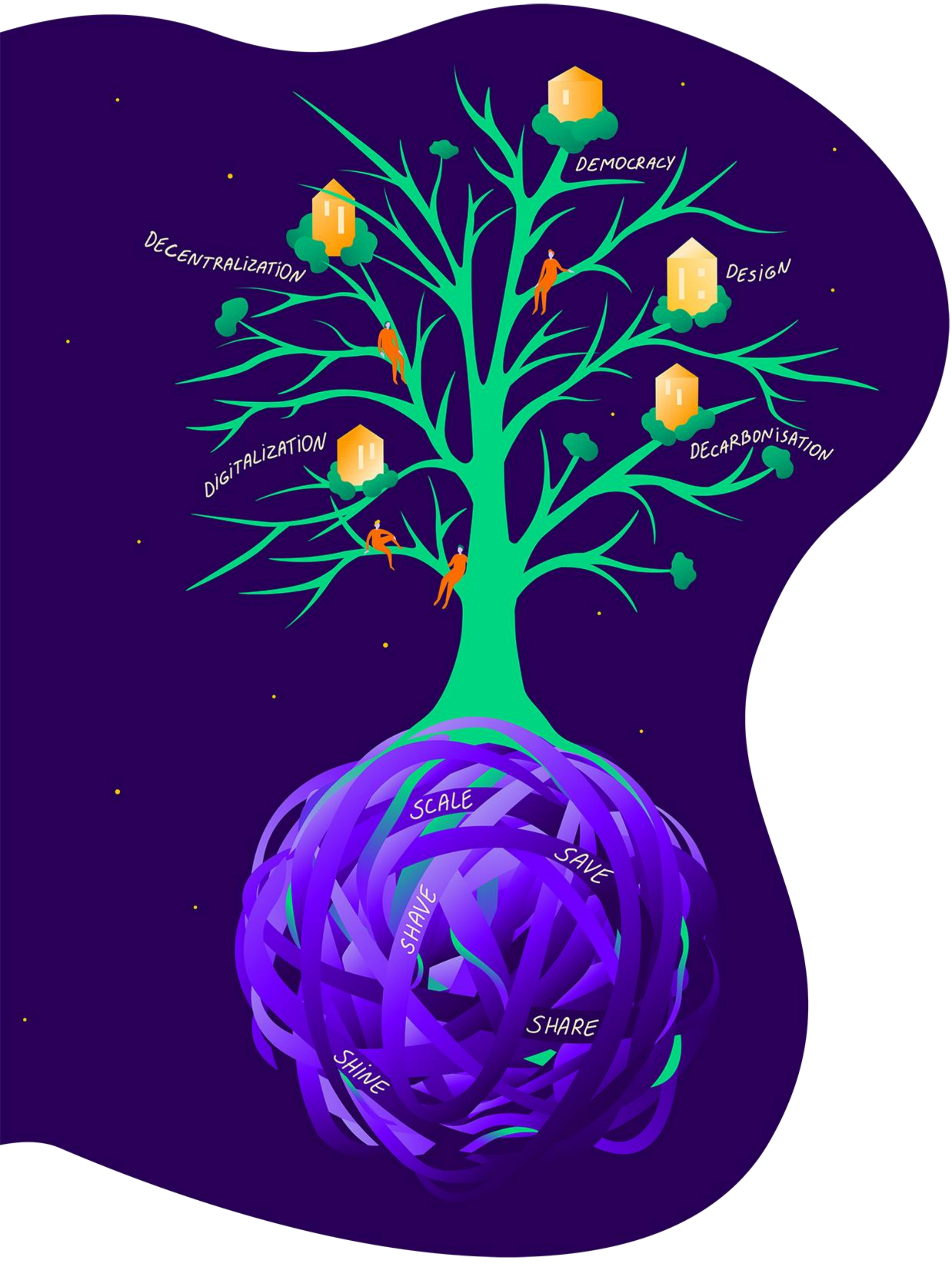
ECA ENERGY CONSULTING AUSTRIA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SAVE
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