P2ENDURE
PLUG & PLAY BUILDING RENOVATION

Technical and alliance plan for temporary local renovation factory at district level

Deliverable D2.7

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P2ENDURE
Plug-and-Play product and process innovation for Energy-efficient building deep renovation

This research project has received funding from the European Union's Programme H2020-EE-2016-PPP under Grant Agreement no 723391.

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Colophon

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Publishable executive summary

This deliverable will focus on local execution of large scale deep-renovation of residential real estates both privately owned and social housing. Questions will be answered on how we can create local circumstances that ensure active involvement of local stakeholders in the deep renovation process in their district and how we can stimulate interests so collaboration between different parties can take place. For this purposes we introduce the local district alliance platform, which is a (digital) platform where all district projects are collected and coordinated. This platform also connects solution providers within the P2ENDURE e-Marketplace with the (local) suppliers to ensure smooth collaboration between different stakeholders and efficient execution of a deep renovation project on a district scale.

For the execution of a large-scale deep renovation project we follow the P2ENDURE 4M process (Mapping - Modelling - Making - Monitoring). The first two steps - Mapping and Modelling will be able to take place in the local district alliance platform together with all the initiatives that are launched in the pre-Mapping phase to create collective demand. Monitoring on a district level is crucial for optimisation of the renovation process and generation of additional demand.

Creating sufficient demand on a district level will generate the possibility to optimise the execution of deep renovation. The approach consists of full prefabrication off-site and 'mount-on-site' (on-site assembly) as well as organizing an efficient supply-chain for a 'compose-on-site' methodology. Depended on project- and product parameters the best execution strategy for district scale can be determined.
This renovation approach will reduce transportation, enhance building quality and minimize disturbance.

In chapter 4 and 5 two case studies will be shown as examples of this strategy. The first study shows deep renovation of the district 'de Reit' in Tilburg. It explains how large-scale deep renovation of the district with a large amount of privately owned dwellings can be organised. It gives an example of a district orientated renovation methodology that enables a district-scale deep renovation using a temporary district factory. The second case-study shows the approach for a renovation strategy of the P2ENDURE Korslokken demo-case in Denmark.

List of acronyms and abbreviations

4M process:	Mapping - Modelling - Making - Monitoring
DoA:	Description of Action
BIM:	Building Information Model
Cap/OpEx:	Capital / Operational Expenditure
EeB:	Energy-efficient Building
EPBD:	Energy Performance Buildings Directive
ESCO:	Energy Services Company
GIS:	Geospatial Information System
HVAC:	Heating Ventilation Air Conditioning
IEQ:	Indoor Environment Quality
IPR:	Intellectual Property Right
LCA:	Life Cycle Analysis
LCC:	Life Cycle Cost
MEP:	Mechanical Electrical Plumbing
nZEB:	Nearly Zero-Energy Buildings
OEM:	Original equipment manufacturer
PnP:	Plug and Play
R&D:	Research and Development
RES:	Renewable Energy Source
RoI:	Return on Investment
SME:	Small and Medium-size Enterprise
TCP:	Technology Commercialisation Platform
TRL:	Technology Readiness Level
VR/AR:	Virtual / Augmented Reality

Contents

1. Introduction

The goal of this deliverable is to enable the optimal functioning of the P2ENDURE 4M process (Mapping - Modelling - Making - Monitoring) at district level and to ensure that all circumstances in the local situation are cultivated to increase the numbers of large scale deep renovation projects substantially. This deliverable focuses on the increase in deep renovation activities in residential dwellings and describes a realistic approach that recognizes our current position of upscaling retrofitting solutions in industrialized production facilities.

The general tendency is that the local customers (private house owners, government, commercial developers or housing associations) are not aware of the innovations and process improvements when local SMEs are in charge. The organization of contracts, subcontractors and risk management tends to stay traditional for the building sector on a local level. Solving this problem is the key for realizing a large scale deep renovation.
Three important tendencies are part of the challenge: building projects and demands getting much more complex than previously, growing awareness for climate issues and decrease of available craftsmen (whether or not cost related).

These developments can be countered with three additional strategies. Firstly, the building process is recognized by disintegrating the four main elements of the building: structure, façade, installations and finishing's. The amount of stakeholders will be substantially reduced and clearly organized. This creates a resilient building process; it decreases building errors, shortens building time and results in more flexible and future-proof buildings. Secondly, the abovementioned categories will be integrated with prefabricated components (or even readymade buildings). The last solution is 'proposition development' and the execution of these propositions in fixed (local) alliances.

The P2ENDURE e-Marketplace is a step in the right direction. Proven innovations are being placed in an open-source sharing environment were clients and other stakeholders in the building sector are able to find them, implement them, test their feasibility and be guided to use them. To implement these innovations in reality and on the local scale we need to facilitate the connection between proposition developers, local proposition suppliers, local SMEs, clients and market innovations.

This deliverable will focus on the connection between the European scale P2ENDURE e-Marketplace and the local district. The deliverable is organized in two parts. The first part focuses on the functioning of a local alliance platform. The second part focuses on the

technical development of temporary district factories as an instrument for optimisation of 'strategies making'.

Chapter 2: A local alliance platform

Within chapter two, considering reaching a large scale deep renovation on district level we propose a tool to share knowledge on the district and connect the local stakeholders. For this we introduce a local alliance platform, a way to facilitate efficient communication between all local stakeholders. Regarding the different stakeholders, three groups can be determined: demand, market and governmental stakeholders. The local alliance platform is able to create the connection between all local stakeholders and create multidisciplinary 'district alliances' between industrial partners, local SMEs, municipalities, real-estate agents, owners etc. It will be able to generate collectives and facilitate initiatives. This can be done by using the BIM model and/or the structured information (database) that are loaded into the platform. These models and databases will also generate the possibility to connect to the European scale P2ENDURE e-Marketplace.

Organizing market alliances will play an important role in this chapter. The diagram below (source: Zero Factory) shows all different roles that are played in a newly organized building strategy. All roles are mentioned from first stage fabrication till delivery to the customer. Producers or System Integrators will have a leading role through product innovations and production of complete components. It's crucial that their products will reach the client, but also the local builders and installers (concept suppliers).
This chapter will focus on how to make the organizational connection between the proposition developer and the local proposition suppliers (SMEs/ builder/ installer). In the scheme below this connection is visualised. In the middle of the scheme the OEM (Original Equipment Manufacturer) takes a central role: the production of prefabricated integrated components. The Tier 1, Tier 2 (and Tier n) companies supply the OEM with the semi-finished components. The proposition owner/developer combines these components into a complete project proposition. The proposition developer is able to organize the building process demand driven and carry liability. He works in close collaboration with the OEM as well as the local proposition suppliers and the client. The proposition owner organises the right SME alliances (builder and installations) for the specific project parameters and chosen concept solutions. We will show how the alliance platform will be able to connect these different roles.

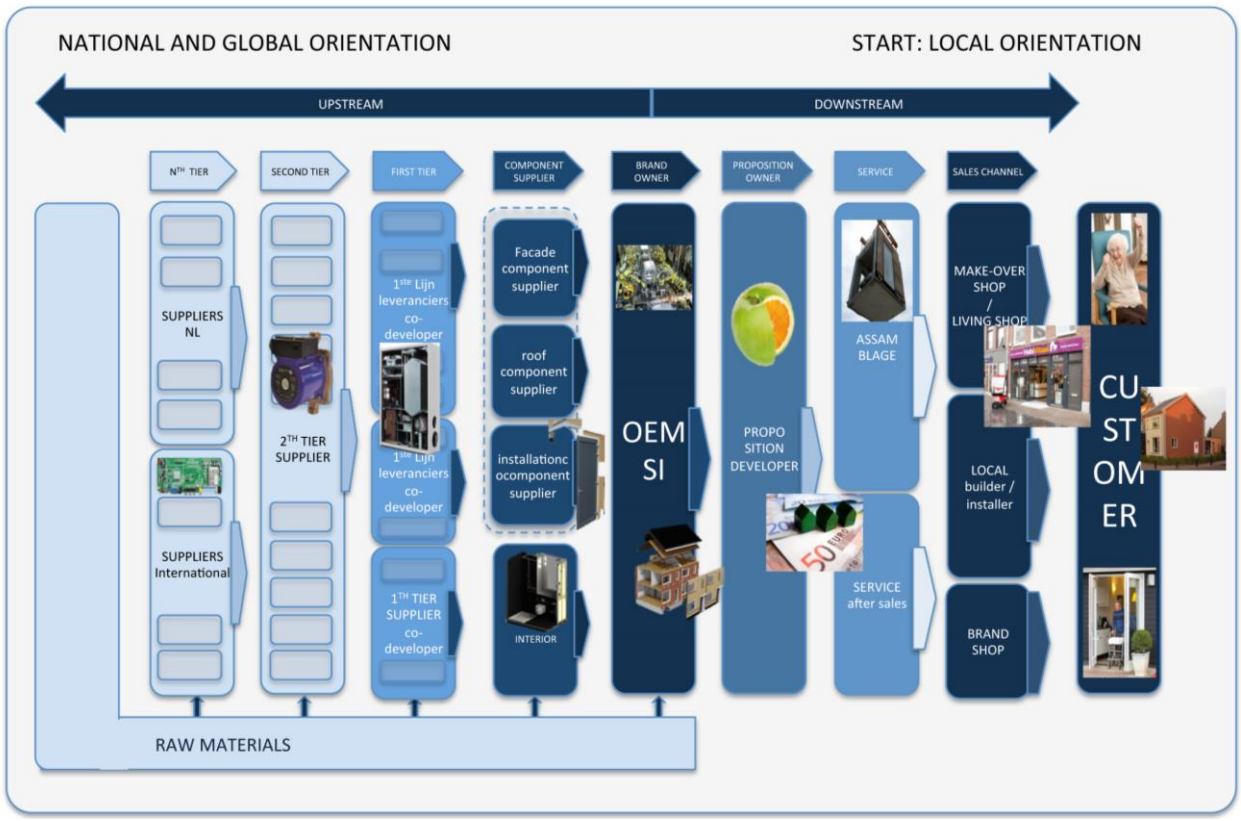

Figure 1: supply-chain. Source: Zero Factory

The organized proposition suppliers (with a proposition developer) are able to upscale the concept locally driven by the repetition potential of a building typology. The goal is to create sustainable local SME alliances (consortia) that are able to upscale a concept for a specific building typology and facilitate a range of solutions that answer the different demands of all kinds of clients in different owner situations. This reorganization of the building process fills the gap between the local execution process and the European scale e-Marketplace.

In this chapter the example of the existing local alliance platform 'Woonconnect' in the Netherlands is introduced as an example of a functioning tool for communication and connecting stakeholders part of renovation of specific housing typologies in the Netherlands. This tool has the potential to, in addition to being a platform and a marketplace, grow into a complete real-estate database for the Netherlands. .

Chapter 3: Technical plan temporal district factory

With a more and more developing industrialization of components off-site in the factory, due to cost-effectiveness, lack of craftsman and higher quality demand, the relationship between industry and final execution gets more important than ever. Just-in-time delivery in combination with assembling prefabricated components on-site reduces building time, nuisance for local residents, risks and transportation. This means that the building site and supply-chain will change completely. The local alliance platform will be able to support in creating a strategy for determining the most efficient and environmental friendly making strategy that fits to the specific project parameters, facilitates the efficiency of the building process and creates the best upscale potential for a specific building typology.

In this chapter we follow the P2ENDURE 4M process of Mapping, Modelling, Making and Monitoring as described in Deliverable 2.1. The first step in choosing the right approach for building renovation is Mapping. The most important parameter that has an impact on the choice of solution, production, assembling and mounting is the upscale potential of a project and the solution. This is highly influenced by the type of owner and the composition of the (local) housing stock. This upscale potential strengthens the business case for large scale industrialization.
Through the Modelling phase, using a complete BIM model, it will be possible to secure the connection between design, production, coordination and efficient supply-chain.
In the Making phase, the alliance platform will provide support (possibly through the connection with the P2ENDURE e-Marketplace) in generating efficient making strategies. In this deliverable we define three 'making strategies': the first one - highly industrialized (customizable) production results in a ‘mount on-site’ execution methodology; the second one - more varied way of upscaling deep renovation results in a ‘compose on-site’ methodology; the third one - ‘production-on-site’ approach. The example of the last strategy is the P2ENDURE façade-printing robotics solution of 'Robot-at-Work'. These three strategies results in two possible efficient building site methodologies: the compact mobile workshop and the field or district factory.

Monitoring the local 'making strategies' will be of large impact for the upscale of deep renovation. Here we will be able to optimize supply-chain and evaluate product supply with the producer, proposition developer and proposition suppliers.

Chapter 4: Case study Tilburg

Several real retrofitting projects in the same district of Tilburg show the different approaches for execution of large scale deep renovation in a district. The district consists of four building typologies with their own challenges and opportunities. These cases show the possible role that the local alliance platform will be able to play in this district case. It will virtually simulate the possible solutions for the complexes and dwellings, show all potential alliances that are able to have added value and generate efficient 'making strategies' that fit to the specific project- and product parameters.

Chapter 5: Case study Korsløkken

The case study in the district of Korslokken shows the result of the 'production-on-site' making strategy for this district located in Odense, Denmark.

2. Creating a district alliance

2.1 Gathering knowledge

This chapter will focus on the role of the district alliance platform as a tool to ensure all circumstances in the local situation are cultivated to increase the number of large scale deep renovations in residential dwellings substantially.

To this end, it is firstly important to collect, compile and share knowledge and experiences in the current districts or city's renovation activities. For this the municipality will be able to play an important role. All the information that is gathered in this way will be shared on a combining renovation alliance platform. This can be done citywide with special attention for district possibilities. In the following chapters we will explain the role of the alliance platform and give an example of it. Furthermore we will give a wide range of examples for connections, alliances and activities currently taking place in the city of Tilburg in the Netherlands which will be part of the local district alliance.

2.2 The local renovation alliance platform

In this chapter we will focus on the platform function of the local alliance. This platform works as a digitalized surrounding of the complete district and city. It is a tool that connects all different stakeholders in the renovation process, similar to the P2ENDURE e-Marketplace, but fully embedded in the local situation. The local alliance platform will be able to function as a portal to the P2ENDURE e-Marketplace and in this way will create a link between the European and local scale. Local SMEs and proposition suppliers will be able share knowledge, quality control and connection to the local proposition suppliers.

The main function of the local alliance platform is connecting local stakeholders and above all creating local demand.

2.3 Woonconnect platform - alliance on local scale

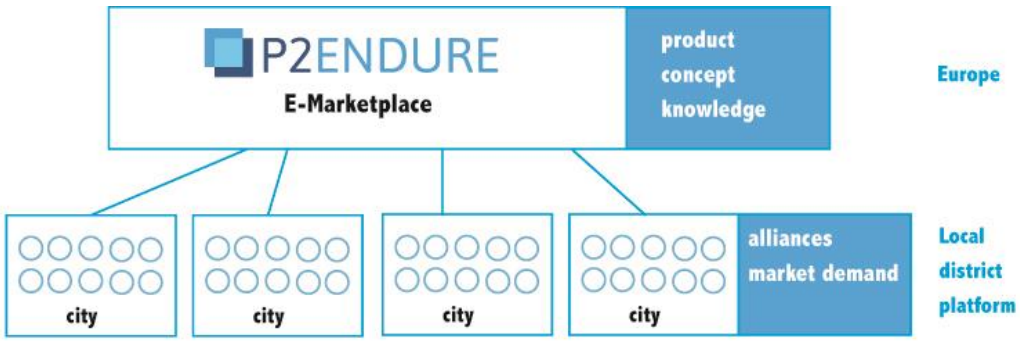

Figure 2: Connection between e-Marketplace and district alliances

A good example for a local district alliance platform is the local 'Woonconnect' platform in the Netherlands. Woonconnect is a very comprehensive platform tool (developed by the firm 'De twee snoeken') with the sole purpose of collecting data for collaboration. A wide range of stakeholders will be able to use the platform, housing owners, builders, proposition developers, industrial partners, real estate agents, municipality etc.

This Dutch initiative is focused on the digitalization of the full housing stock in the Netherlands. These BIM (Building information models) models are used to facilitate an upscaling in deep renovation for private houses, collectively private owned housing and social housing. The potential strengths of this example is the simplicity to join for the private house owner and the potential for local proposition suppliers to connect to the demand. The modelling has already been done and the mapping (self-inspection) will be fully supported.

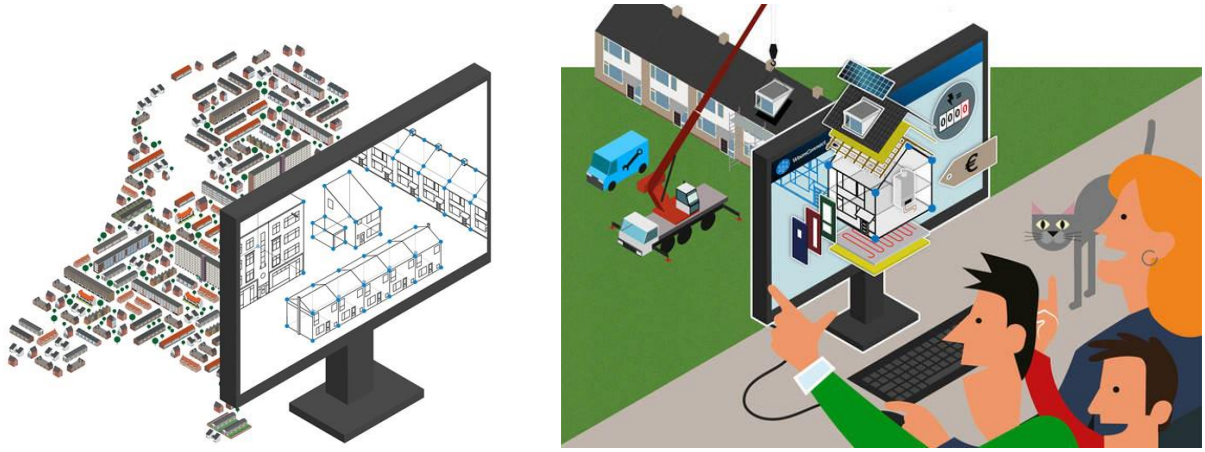

Figure 3: Woonconnect local alliance platform, copyright 'De Twee Snoeken'

The next step is the connection of all urban information and user data (within the bounds of privacy legislation). Think of energy grid potentials or innovative financial tools for example. The result for this strategy is a fully digitalized district model which can be utilized by all stakeholders in the local building process.

The P2ENDURE e-Marketplace will be able to feed the local Woonconnect platform with information and solutions on a European scale and at the same time be fully equipped for the local configurations and parameters. We will show the function of this local alliance platform fitted to the case-study in chapter 4. First we will focus on all the stakeholders and creating connections and knowledge sharing using a district alliance platform.

2.4 The stakeholders

In this chapter we will define the three different stakeholder-groups and zoom in on the most important alliances that can be established with the support of the local alliance platform and establishment of a local district factory.

The local stakeholders can be divided into three main groups: government (municipality), owners/inhabitants (demand) and market (industry, SME and proposition suppliers). For organizing an efficient large scale deep renovation movement it is essential these stakeholder groups connect and collaborate with each other. In this chapter the definition of the different alliances are explained, examples of collaborations are given and recommendations are done to set up multidisciplinary alliances using the local district alliance. The following image gives a schematic representation of possible alliances and initiatives in a local situation.

We will start by describing possible fertile connections between (local) government and demand stakeholders, connections to enhance demand and ways to connect market stakeholders with local demand.

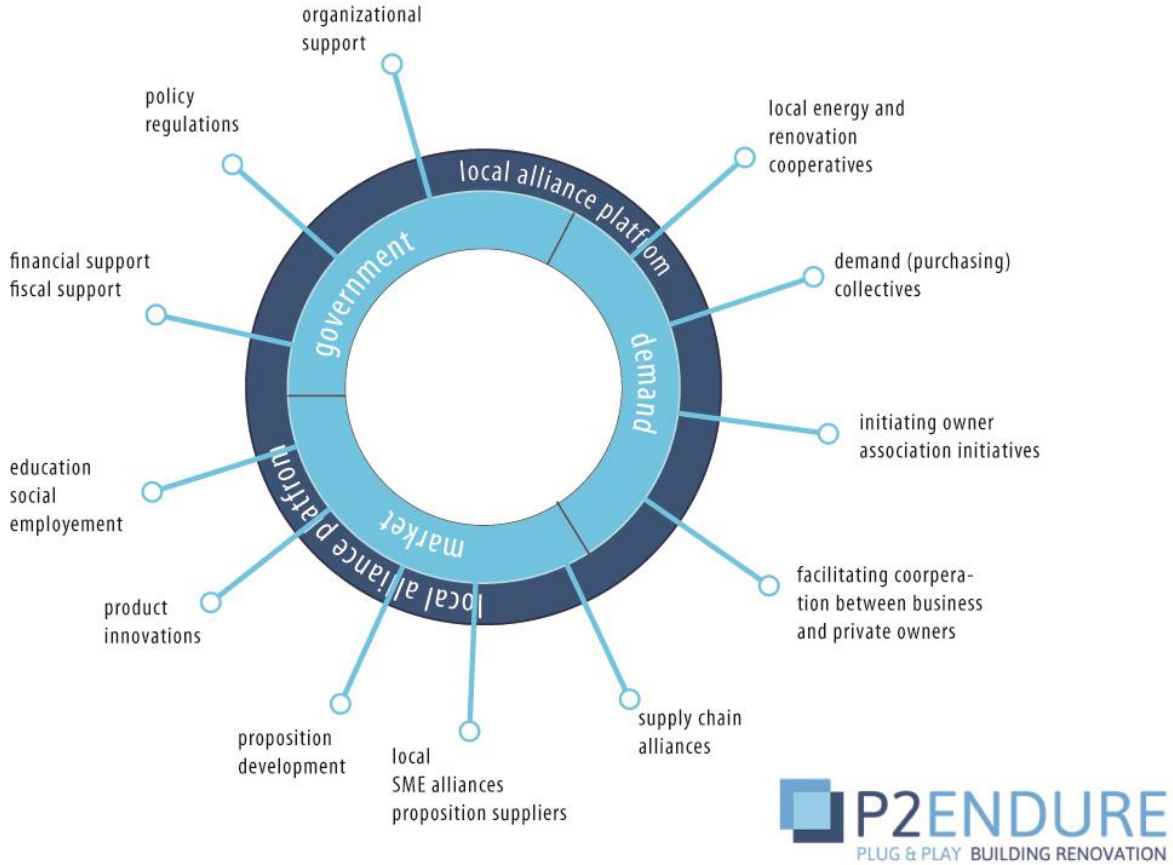

Figure 4: A selection of alliances and initiatives collected in a local

2.5 Enlarge demand on district scale

Connecting demand

Looking at the potential clients, for example in the Netherlands, a large amount of dwellings is privately owned. In the case of upscaling deep renovation, this is definitely a disadvantage. To increase deep renovation numbers creating knowledge sharing between private owners is an effective remedy. The local district alliance platform can play an important role in connecting these separate initiatives.

Self-organized energy-cooperative on district scale in Tilburg (e.g. Energiefabriek013) is a good example where people are organizing themselves at a city scale to collectively renovate their dwellings and organize their own (sustainable) energy supply. They create purchasing advantages with preferred suppliers and organize standard renovation process steps to facilitate the private owner in making their house more sustainable. These energy-cooperatives on district level are numerous in the Netherlands and to learn from each other and resolve the problem of fragmentation even these cooperatives collaborate together.

Tenants are another demand-connection that is of importance for upscaling deep renovation. Looking at social housing situations among others, it is important to create support for deep renovation plans with the current tenants. In most cases of deep renovation plans it is necessary to reach an approval rate of 70% of the tenants. Involving them from the start of the project in a well informed and transparent matter is of great importance for the success of a renovation plan and will enlarge the chance for more ambitious measures. The creation of a district alliance also deals increases the acceptance level and pro-activeness of this stakeholder group.

Connecting government and demand

A powerful collaboration is the alliance between the government (municipality) and the building owners. In the Netherlands we have good examples of such alliances. The first example is the 'Stroomversnelling', which is a governmental initiative to support large-scale deep renovation of social housing. A selection of four progressive housing corporations and four contractors were supported in achieving 'best practice' pilots for deep renovating (zero-to-the-meter renovations) of specific high repetitive building typologies.

A second example of alliances for private owners instigated by the municipality of Tilburg is the "Samen geeft energie' trajectory (translation: together we generate energy. Nationally known as 'blok-voor-blok' approach) is a local translation of a national approach to constitute collaboration between inhabitants at district level. Support in forming a collective, selecting advisors and

collectively choosing the consortium of SMEs to execute the renovations. The municipality facilitated the process and provided financial support.

Next example in the Netherlands is the support of renovation initiatives by the Association of Dutch Municipalities (VNG - Vereniging Nederlandse Gemeenten). First example is a governmental funded trajectory for renovating private dwellings. The focus lies on supporting local SME consortia to execute deep renovation of a series of dwellings with a high repetition potential. The goal is to create successful pilots and enable the creation of well-organized market consortia.

Another example for a governmental initiative (also supported by the VNG) focuses on deep renovation of housing complexes that are privately owned. This trajectory also focuses on the connection between demand and market (proposition developers and suppliers). Emphasis is laying on supporting housing associations in defining their ambitions and financial possibilities and connecting them with the right proposition suppliers.

Besides establishing, enabling and supporting alliances between government and owners an important role of the government is to support deep renovation with a subsidy, fiscal benefits or loans. This support is important too in this phase of deep renovation developments. These support tools for deep renovation can be connected to the local alliance platform. It will be incorporated in the estimated costs and the accompanied obligations, for example quality guarantees, energy-reduction goals etc.

Connecting district knowledge to demand

In most cities a lot of knowledge has been gathered concerning the functioning of the city. Energy demands, maintenance costs, disturbance rates, potential for energy grids etc. When we focus on deep scale renovation on district level all this information can be used to generate solutions that rise above the single renovation project. All information should be collected at district level and provided to all initiatives. In chapter 4 the available information, for example, on energy labels of the existing houses will be explained.

2.6 Connecting demand and market

The connection between client and local proposition suppliers, or in other words demand and supply, is very important. This function of the e-Marketplace is described comprehensively in the deliverable D2.5. For the local situation we propose local (or national) level of the e-Marketplace in the district alliance platform to offer the holistic concept as a complete fitting proposition for specific building typologies, including SMEs for execution. At this level as well as for the larger scale deep renovation, the goal of the local alliance platform is that it functions as a showroom for complete renovation propositions.

Figure 5: Reimarkt info leaflet

For the local connection between supply and demand we also propose physical marketplaces. This will be the extension of local district alliance. At this location private house owners are able to see the Plug-and-Play retrofitting solutions in real life. They will also be able to receive support and organize themselves in collectives. This local 'retrofitting store' is an example of the nuanced way the European-scale e-Marketplace that will be able to find fertile soil in the local situation.
A good example for such an initiative is the 'Reimarkt' store in the Netherlands. Pop-up stores are located in vacant houses in a district; the house is deep renovated and functions as a successful pilot for the whole district. These stores function as a renovation store and supply the inhabitants with support and solutions. At this moment there are six Reimarkt stores operating in the Netherlands.

2.7 Creating market alliances

As explained in the introduction, supplying the client complete holistic propositions will be the new way of organizing the building process. In the new approach for large scale deep renovation, forming fixed partner alliances that are able to act in design-, execution- and even exploitation phase plays an important role reaching the goal for upscaling deep renovation. Organizing these sustainable market alliances will create solutions that are project transcending. For a district upscaling this will give a lot of opportunities.

There are several ways of organizing the execution partners. In Chapter 3 all aspects that lead to the best choice for executive strategies are mentioned; the focus is put on the facilitation of the alliance platform in connecting the SMEs into sustainable proposition providers using components and solutions provided by local, national and European scale marketplaces.

There are two main differences in proposition organization. The first one occurs when the complete product supplier does not need any local SMEs or proposition suppliers. This industrial partner and proposition developer will not need the local district alliance platform to generate specific district solutions other than to connect with clients. The second one is when a local proposition supplier is able to provide a complete holistic proposition with different measurement packages.

Connecting suppliers

Collaboration between industries will also create new supply-chain strategies. Using the local alliance platform will enable a quick and flexible supply-chain organization that is in real-time connected to the district alliance platform, so when another house owner has decided to say yes to a deep renovation proposition. All necessary information and contracts are instantly drawn and provided to the manufacturer who will be able to provide the product extremely quick because of the industrialized production process.

Connecting market and employees

The information-gathering and communication tools that will function in the local district alliance platform will also enable local workers, unemployed and scholars to take a part when possible in the building process that is taking place in their district. A website like 'Werkspot' in the Netherlands could be linked to the local district alliance platform. This site operates as a linkage between independent local construction workers and the client. Also the national unemployment assurance agency (organizing alimony for unemployed people) will be able to connect their (national) database with the local alliance platform.

3. The local renovation factory

This chapter starts with describing existing production facilities that fit the P2ENDURE vision of prefabrication and industrialization of Plug-and-Play products. The four examples will show us the possibilities that are already present and will give an insight into the developments that will keep on going. The role of the 4M process in the complete production/ supply-chain and making process as well as the possible linkage to a local district alliance platform will be elaborated in the last part of this chapter. To conclude different kind of execution solutions to optimize the building process and facilitate upscaling of district deep renovation will be distinguished.

3.1 Production

In the future deep renovation of buildings will be possible by using mainly Plug-and-Play components. Succeeding in a large-scale retrofitting strategy the production of the right products and components is essential. More and more industrialized production will be producing integral components. Automation, robotics, BIM and 3D scanning are developments that generate unparalleled possibilities for industrialization, optimization and customization. This completely fits the reorganization of the building process with a larger role for industrial partners and proposition developers.

Three examples of this production approach show the potential for the retrofitting market:

- The BJW wonen façade (for the P2ENDURE pilot project in Breda)
- The NBU 'Cocoonz' façade
- Factory Zero iCEM installation component

3.1.1. BJW wonen facade

BJW wonen is an industrial system integrator and a proposition developer. BJW offers complete deep renovation propositions for row houses in the Netherlands. These propositions consist of separate integrated building components. Our attention in this chapter goes to the production of the completely finished facade. The facade that BJW produces is produced in a well-organized production line facility with the newest equipment. The pictures below show the lay-out of the factory that's situated in Rijssen and show pictures of the production process. This factory together with a factory in Utrecht is now the supplier for all projects in the Netherlands. If demands will increase extensively opening a new production facility will be an option.

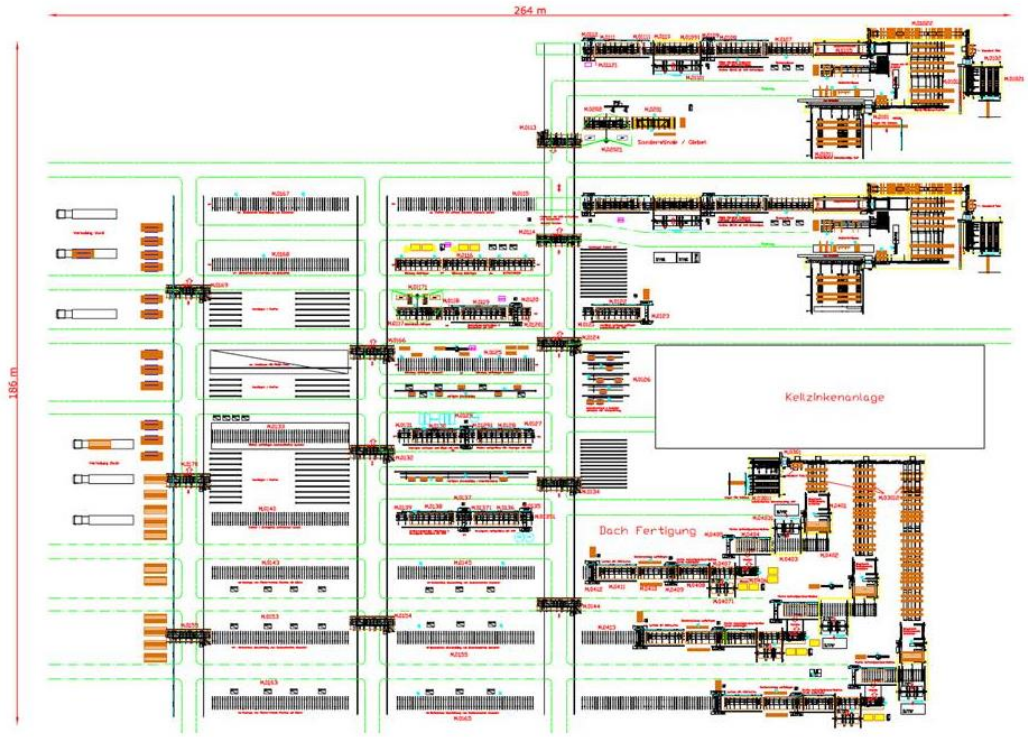

Figure 6: factory layout of production facility in Rijsen for BJW wonen..

Figure 7: Inside the Rijsen factory

3.1.2. NBU Cocoonz facade

The Cocoonz facade is developed by the building firm NBU in the Netherlands. They have created a Plug-and-Play frameless facade for deep renovation of existing housing. The facade is light-weight and completely finished in the factory.

NBU facilitates the whole process from feasibility, tenant accompaniment and monitoring, has its own production facility and is the main contract party. The Cocoonz façade is currently mostly used in social housing (due to scale). The goal is to develop the factory for individual solutions ('series of one') and in this way will also be able to provide private owners with the solution.


Figure 8: NBU Cocoonz facade production facility and transportation of the complete product

3.1.3. Factory Zero iCEM installation component

Zero Factory is an innovative system integrator that is able to produce industrially fabricated fully integrated Plug-and-Play installation components for exterior use. With this machine guarantees are given for a zero-on-the-meter deep renovation. The solutions are also affordable, quick to install, of a high quality and great design. Zero Factory will produce more products for the deep renovation market. They are now developing a roof module and a facade module.


Figure 9: iCEM exterior installation module

3.2 Three making strategies

To create a district level deep-renovation approach we want to be able to provide renovation solutions for all the different owners and tenants in the district. Therefore, we distinguish three different 'making strategies':

A. Mount-on-site
B. Compose-on-site
C. Production-on-site

In the P2ENDURE Plug-and-Play approach the focus is on strategy A 'Mount-on-site'. Complete components with a just-in-time delivery are mounted to the existing building. Most of the work has been done in the factory.
To generate a complete pallet of possibilities and be able to take the full district renovation into account we also add option B 'Compose-on-site'. Here execution is more fragmented and planning/ coordination takes more effort.
The last strategy is the 'Production-on-site' were extremely little is done in the factory but almost all labour and production is done on-site. The P2ENDURE solution of 3D printed refurbishment of the façade is an example of this last approach and is shown in the case-study of Korsløkken. Every strategy has its advantages and disadvantages.

3.3 Optimizing logistics

3.3.1 Supply-chain strategies

Besides creating new industrialization possibilities, the potentials concerning supply-chain are also increasing substantially.
The reference could be the fully automated warehouse technologies that are being developed in e-commerce business, for example, the new bol.com storage warehouse in Waalwijk, the Netherlands (see Figure 10).
Another good example is the supply-chain innovation by Raab Karcher (supplier in construction materials) called Leanworks. This just-in-time/ just-in-place strategy completely organizes the supply-chain and works with 'supply hubs'. These hubs are managed by Raab Karcher but combine also materials/ products that are delivered by other industries. Transportation is minimized in this way. Another result is the minimal storage space that is needed on the building site.
Both examples show that besides production also supply-chain reorganization will be able to reduce transportation, shorten delivery time, create flexibility and enlarge efficiency.

Figure 10: bol.com fulfillment center in Waalwijk, the Netherlands

Figure 11: Raab Karcher Leanworks supply-chain concept

3.3.2 Production and supply-chain

The synergy between engineering and production is extremely important with the BIM model as the 'engine' for this continuity. It is crucial that the BIM model is set up in such a way that production partners are able to produce the products and the liability is properly organized. The P2ENDURE e-Marketplace enables this collaboration between engineering and production partners and integrates the production process of components in the building process. The local district alliance platform will be able to organize and group local demand and thus create the base for real-time supply-chain management on district scale.

Creating fixed supply-chain solutions on district scale will enlarge feasibility of large scale deep renovation on district level.

3.4 The district factory

After an industrialized production the logistical organisation of the building site will transform also. Prefabricated components are customized and directly delivered to the building site (or mounting-site if you will). These just-in-time deliveries are extremely efficient and reduce the handling on-site substantially. But that doesn't mean every building site will look the same. Project variables (repetition potential, location, choice of solutions) and production variables (level of prefabrication, complexity, vulnerability etc.) have a large impact on the chosen supply-chain strategy and building site organization. By weighing the advantages in the possible solutions the best solution for on-site execution will be deducted. To determine the best 'making strategy' the following aspects will be taken into account.

Environmental	• Embedded energy (transport, production etc)
Financial	• Upscale potential (business case) • Transportation costs • Labour costs • Reduction building errors
Social/ Local value	• Disturbance neighbourhood • Use of local products • Supply work local SMEs • Supply jobs for unemployed/ education • Health construction workers
Risk reduction	• Damage during transportation • Damage on-site (weather/ accidents etc.) • Theft • Building errors
Execution quality	• Possible quality control • Clear reliability
Flexibility/ time	• Building time • Short delivery time • Certainty delivery • Flexibility in building process • Customization possibilities

Choosing the best combinations of these project- and process aspects in combination with the best fitted deep renovation solutions will result in the best (combined) strategy that fits the complete district scenario.

For the chosen solution this will result in two types of on-site (or near the site) working facilities: the compact workshop and the local factory. The compact (mobile) workshop

functions as on-site home base for construction workers. The local factory functions as a real factory, with fixed construction steps, but in this case on-site.

3.4.1 Temporal field- or district factory

The temporal district factory is an effective solution when the retrofitting project is of large scale. In this strategy a complete indoor factory is set up to assemble the complete building components. Building time is shortened and transportation is minimized. The location of the district factory can vary. It can be placed on the building site (a field factory) but it does not have to be situated on the building location. It can also be a factory that serves a whole city and thus located farther away from the building site. The chosen location is fully dependent on the scale of demand and complete supply-chain strategy. We will provide three different examples that show the potential of such a factory.

Heidelberg- student housing - Field factory

When the firm LiWooD built a student housing complex in Heidelberg all components produced for Plug-and-Play assembly on-site were transported to a temporal indoor assembly hall (or field factory). After assembling all the prefabricated components (walls, floors, HVAC component, sanitary unit and finishing's) the student room modules were lifted to the right place in the building.

Figure 12: LiWooD student housing, using the fieldfactory to assemble all the modules.

Distribution centre- Germany

The building of a distribution centre in Germany is another good example for an on-site factory. In this case the fully wooden construction components are 'prefabricated' in the field factory on-site. It was most efficient to produce all building components at the location.

Figure 13; Production of components in a field factory, distribution center in Germany

Housing renovation - Think factory

The Think Factory is an example of factory production on a regional scale. Producing complete industrially prefabricated modules in the region of the project ensures extreme short building time, affordability and an ultra-lean building site organization. The prefabricated modules are then transported to the building site and mounted on the existing building.

Figure 14: Think extension of existing home

3.4.2 (Mobile) compact retrofitting workshop

Dealing with complete prefabricated components that arrive at the site completely finished the amount of work on-site is minimal. The little work that has to be done on site is coordinated from a compact transportable or mobile workshop. This methodology reduces disturbance for local residents extremely. When a house has been renovated the workshop moves on to the next house.

An example is the NBU 'Cocoonz' façade. This prefabricated façade component is transported the same day as its mounted on to the dwelling. All the activities NBU has to perform before and after mounting are organized from a transportable workshop which is able to follow the work through the district. NBU renovates a house in two days. One day to prepare the existing dwelling and one day to place the new facade. NBU creates a Just-in-time-full-component-delivery. This approach is ideal for a large scale homogeneous-district retrofitting approach.

3.5 4M process for execution strategies on district scale

With the 4M process as a backbone for deep renovation the same approach can be used also on a district level. With the difference that we introduce a pre-Mapping phase were demand creation trajectories are started and stakeholders are connected using the district alliance platform.

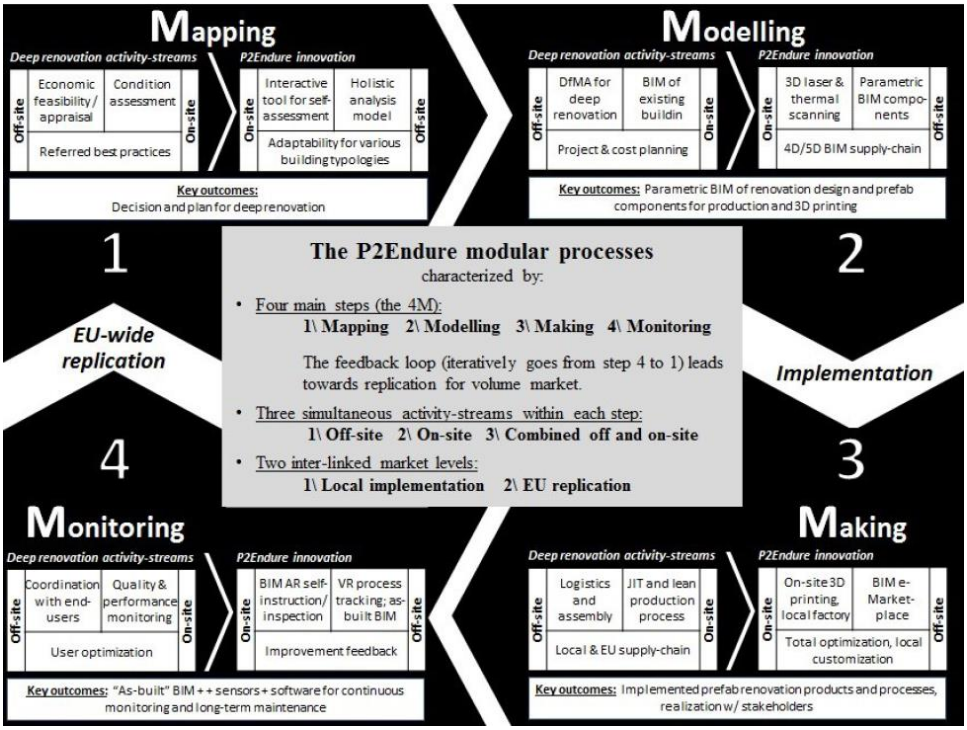

Figure 16: P2ENDURE 4M approach

3.5.1. Pre-mapping - creating demand

Before mapping the enhancement of demand will be able to start. In this phase of the district renovation the municipality plays an important role. They will have the lead in organising information events and initiate the first start for the district alliance platform. For private owners this means they will be able to visit local information meetings, receive advice from renovation experts, learn about financial possibilities etc. Social housing corporations will be supported in renovation decisions and are able to consult with their tenants regarding possible measurements and associated (financial) consequences. The key in this important step is to join forces and collaborate on district level. In the case-study in chapter 4 we will show the importance of the municipality in this pre-Mapping phase.

3.5.2. Mapping

To create an overall strategy and embed the e-Marketplace and 4M process successfully in the local district situation for each specific project it is important to start with the first phase of the 4M process: Mapping. All sorts of parameters influence the final decisions regarding technical solutions, the modus for execution and the potential of a district alliance and factory. In this chapter we will categorize the most important parameters and match them with a selection of fitting strategies.
The first step is embedded in the Mapping phase to gather necessary information on location, size, traffic access, additional district information, building performance, energy consumption, energy grid potentials etc. With regard to residential deep renovation projects we want to emphasize two project parameters that have a large impact on the execution approach of a project at least in this phase of innovations and market developments. That's first of all the owner situation and secondly the potential repetition scale.

The owner

To utilize the full potential of a local situation it's important to distinguish four categories of ownership: The private owner, the collective private owners, investors (and tenants) and social housing (and tenants). Every group has its own interests, opportunities and restrictions. Upscaling deep renovation will demand different strategies for the different ownership models. A SWOT analysis of these four groups gives the following results.

Housing stock and repetition potential

In this phase building typologies with a high level of repetition, indicate a high potential for industrialized component possibilities. It adds up the stakes and generates interesting business cases for the prefabricated building industry. This repetition potential is also an important factor for establishing a district factory.

We will not be able to initiate a local district factory for a small amount of dwellings. In the case of privately owned dwellings it is therefore crucial to generate collectives to organize demand. These 'demand alliances' are discussed in chapter 2. Housing stock repetition should be investigated at least at city level with regard to local renovation factories. New supply chain possibilities will make it possible not to only retrofit concatenated dwellings but also dwellings scattered over the region.

3.5.3. Modelling

In the proposed local district alliance platform a very quick next step is modelling of the dwellings. This modelling can be done by the proposition supplier. In the case-study of Tilburg the modelling is being arranged and financially supported by the government. In the modelling phase the proposition suppliers will finalize their proposition together with the client. Making and finalising decisions concerning district renovation will generate a collective district approach even when different proposition suppliers are active in the district.

3.5.4. Making

Also the making phase takes place on project scale and district scale. In this deliverable we focus on the district level. Chapter 4 will show an example of this phase for the district 'de Reit' in Tilburg. The choice for completely prefabricated components, production or assembling on-site and the supply-chain organisation on-site is all deductible from the results in the Mapping and Modelling phase.

3.5.5. Monitoring

Monitoring on district scale will generate valuable information for improving and optimising the future deep renovation projects in the district as well as in other districts of the city. Monitoring information of separate projects will be able to be gathered for comparison.

4. Case study Tilburg

To show the potential of the P2ENDURE prefabrication and assembly solutions at district scale this chapter will deal with the simulation of a complete district retrofitting scenario were every stakeholder in the district will be invited to collaborate using the local district alliance platform.
The municipality of Tilburg, in collaboration with 'market stakeholders' took the initiative in 2017 to initiate a trajectory to support large-scale deep renovation of privately owned dwellings. PAN+ architectuur is participating in both trajectories as part of a local proposition supplier called ENDIS.
We will show the 4M process and focus on the district alliance platform and the making part of the deep renovation process. In this district case the existing platform 'Woonconnect' will play a role as a local district alliance platform in the future organization and promotion of local large-scale deep renovation.
As explained in chapter 2 we see this local alliance platform as a potential extension of the European scale P2ENDURE e-Marketplace.

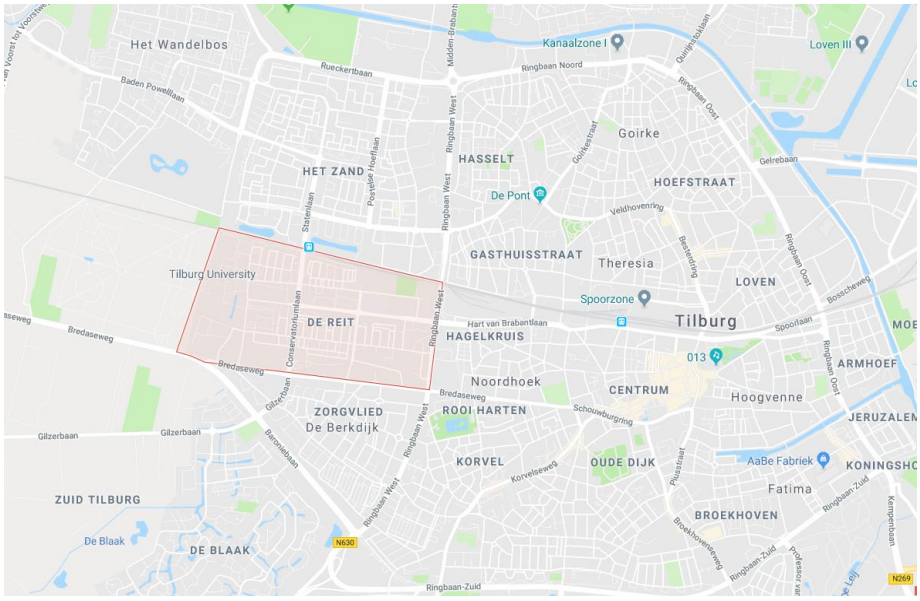

Figure 17: Map of the city of Tilburg, 'de Reit' district

4.1 pre-Mapping, gathering stakeholders and creating demand

Starting the district approach will be a strategic meeting between all stakeholders in the district. In the district 'the Reit' these are:

- Municipality of Tilburg, initiator
- Social housing corporation TIWOS.
- (Local) Proposition suppliers
- Real-estate agents
- Local energy corporation 'De energiefabriek013'
- Local district alliances/ neighbourhood associations
- University of Tilburg
- Pro-rail (railway real-estate owner

These stakeholders will be able to use the first steps of the district alliance platform and together determining the goals and approach. The result for this district is the use of three trajectories for the different building typologies in the district.
Creating private row houses/patio dwellings trajectories to create collectives for deep renovating the houses. District meetings will be organized and client support is created. Municipality or other financial investors will supply loans with low interest. Connection between proposition suppliers will be made from the start. One proposition-supplier will be chosen for holistic deep renovation propositions with complete prefabricated components.
Facilitating lean support trajectories for the privately owned multi-family houses. Creating interest, helping analysing financial situations and creating ambition manifestos for proposition suppliers.
Social housing corporations will start creating internal support and request for first reactions from tenants.
Research is started for the potential of district collectives for energy storage.
The collective district approach is important and must be well communicated. Shared district values will connect all the stakeholders and create a sense community.

These demand connection activities to support the large scale deep renovation an district scale will ongoing during all the steps of the 4M process.

4.2 Mapping

When the first district activities have commenced the project and district mapping can start.

4.2.1 Project parameters - the district

'De Reit' district is located in the east of Tilburg. It is a typical post-war district with high repetition of dwellings, comprising of mid-rise and high-rise multifamily social and privately owned housing and typical row houses and patio dwellings.

The district houses 5280 inhabitants on a surface of 1,43 km^2. In this case we will describe a retrofitting trajectory for all the dwellings in the district. This comprises of

- 6 multi-family privately owned 4 storey housing complexes, portico disclosure
- 10 multi-storey social housing complexes 4 storey high, portico disclosure
- 3 multi-storey social housing complexes 7 storey high, gallery disclosure
- 41 patio dwellings
- 580 row houses

Figure 18: Areal picture of the district 'de Reit' with different building typologies.

The district has a good logistical connection to highway and inner-city traffic. Traffic in the district is normal residential quantity. In the North the district is ended by the railway line. The district is separated by a wide green corridor of 220 meter spanning from West (the university) all the way to the city centre. This area is filled with educational buildings and facilities in a campus typology.

In this Mapping phase the local alliance platform will already be up and running. For example Energy maps linked to the local district alliance platform show us the energy label of all the dwellings in the district. Research has been done in Tilburg regarding the potential for collective energy grids this will also be part of the district deep-renovation approach.

Figure 19: Circulation and zoning district 'de Reit'.

Figure 20: Energy labelling district 'de Reit'

Figure 21: Building typologies in the district

4.2.2 Project parameters - building

All building typologies need a profoundly thorough mapping phase to generate the best customized solution for each complex/ dwelling. This mapping will be done with the help of the local alliance platform and local proposition suppliers. After mapping it is clear what the possibilities are for the dwellings in the area. The approach between the multi-family complexes and the houses is different. In the multi-family housing (privately owned) the owner association takes the initiative to participate in a Mapping phase. The different support trajectories as mentioned in 4.1 will enable all the complexes in the district to take part in a collective Mapping phase. Regarding the multi-family housing it is realistic to use a project coordinator to initiate the Mapping phase and support the owner association. For the row houses this can simply be done by the owner, possibly in collaboration with a local market-alliance, using the local alliance platform.

4.2.3 Project parameters - repetition potential

The row houses, multi-family-complexes and gallery complexes (zone A) are systematically built in the Netherlands. The building period ranges between 1955 and 1975. Upscale potential is large. The multifamily complexes are built in the industrially fabricated 'pronto' system around 1955.
There are estimated to be 270.000 dwellings of portico multi-family buildings built in the

Netherlands of which 10.000 dwellings in the 'pronto' system. The patio dwellings (zone B) are a building typology with a small repetition factor in the Netherlands. In contrast to the row houses and multi-family complexes the patio dwellings are not manufactured industrially. Another problem in deep renovation of this building typology is the large external surface area in comparison to the floor ratio.

4.2.4 Project parameters - ownership properties

The dwellings in this district are divided into privately owned houses and social housing owned by housing corporation TIWOS. This district renovation case deals in the first phase with the privately owned multi-family housing complexes and houses. The Mapping phase in this case emphasizes on the wishes of the diverse owners in a complex, the financial situation of the owner association and the private owners and the building value and state of maintenance.

4.2.5 Conclusion

Due to the high repetition in the Netherlands of the building typologies in the local situation this district gives a good economic opportunity to industrialize components and adapt a project transcending district execution approach. Extra attention is given to the approach for privately owned complexes (with owner associations). Dependent on the possibilities the proposition suppliers will be giving their first propositions using the local district alliance platform. Next one is the clients' decision to proceed.

4.3 Modelling

The (local) proposition suppliers will be able to apply the best P2ENDURE solutions available. They will be able to connect directly with the industrial supplier and receive guarantees and service that provides extra quality and security. It also enables the producer to stay involved during exploitation and ensures better quality and shared interests. Furthermore, it will also be possible for the producer/system integrator of complete components to get directly in contact with the client using the local alliance platform.

All solutions that are complete components are. Local proposition suppliers will be able to compose these separate solutions quickly into complete integral propositions. Proceeding from design, engineering and legal procedures will take place extremely efficient. 3D BIM-design is modelled by the industrial factory and thus, instantly ready to be used for production.

In the case of the ENDIS solution the Plug-and-Play facade concept will be produced by a steel frame factory in the vicinity of Tilburg (15 km). These facades are completely finished and delivered just-in-time with integrated ducts and individual installations.

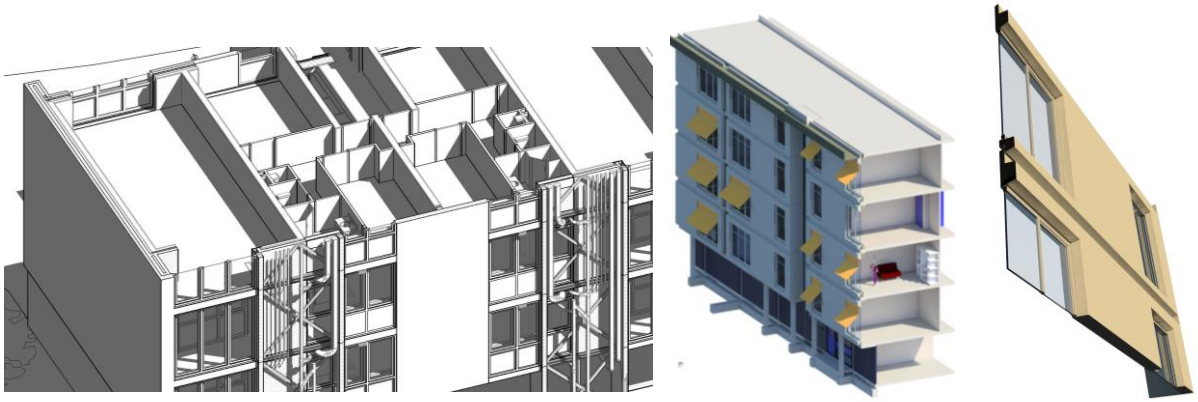

Figure 22: Modelling facade solutions for the multi-family complexes in zone A

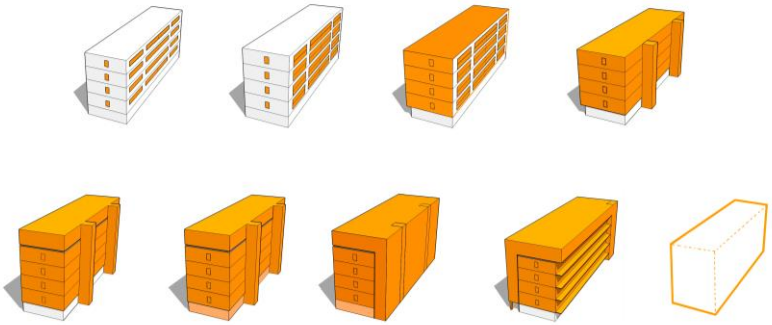

Figure 23: Different scenario's as part of the ENDIS proposition for multi-family complexes in zone A

4.3.1. Proposition customization

Although the local district alliance platform will create demand-alliances chosen solutions will differ per complex and dwelling. To simulate this for the portico complexes we will choose these measurements to create a customized making-strategy and show the result of this approach in the district 'de Reit'. Below you see a possible decision result for the renovation of the six different privately owned multifamily complexes.

complex	facade	windows	roof	elevator	ground floor	installations
A	prefab facade	see facade	rooftop addition	yes	entrance improvement + insu.	HVAC comp.
B	prefab facade	see facade	rooftop addition	yes	entrance improvement + insu.	HVAC comp.
C	prefab facade	see facade	none	no	entrance improvement + insu.	HVAC comp.
D	prefab facade	see facade	insulation	no	none	HVAC comp.
E	Inside insulation	New windows	none	no	none	none
F	Inside insulation	New glass	none	no	entrance improvement	none

This case shows that the choice for integrated prefabricated solutions that are directly found on the e-Marketplace are preferred but that in some cases there are always measurements that demand a more 'compose-on-site' approach. In the abovementioned measurements complexes E and F will not result in the most optimal prefabrication results. These cases should nevertheless be part of the holistic district renovation possibilities. As explained in chapter 3 in contrast to the 'mount-on-site' approach of the components (complex A t/m D) these complexes will be more suited for a 'compose-on-site' approach.

For the row houses and the patio-dwellings we won't choose specific measurements in this case. We will assume chosen solutions are diverse and the 'making strategies' vary. What's important is to group all owners that are willing and able to retrofit their house with the complete component solutions that are on the market. These collectives (that will probably be district transcending) will enable a serial retrofitting and therefore interesting proposition for the owners (and the industry).

4.3.2. Local district alliance platform

All decisions in the Modelling phase are being placed in the local district alliance platform. It will be possible to organize propositions in prefabrication-component-solutions and other solutions (for example windows replacement, inside insulation of walls etc.). In this way demand is grouped and large scale deep renovation with industrially fabricated components has been made feasible.

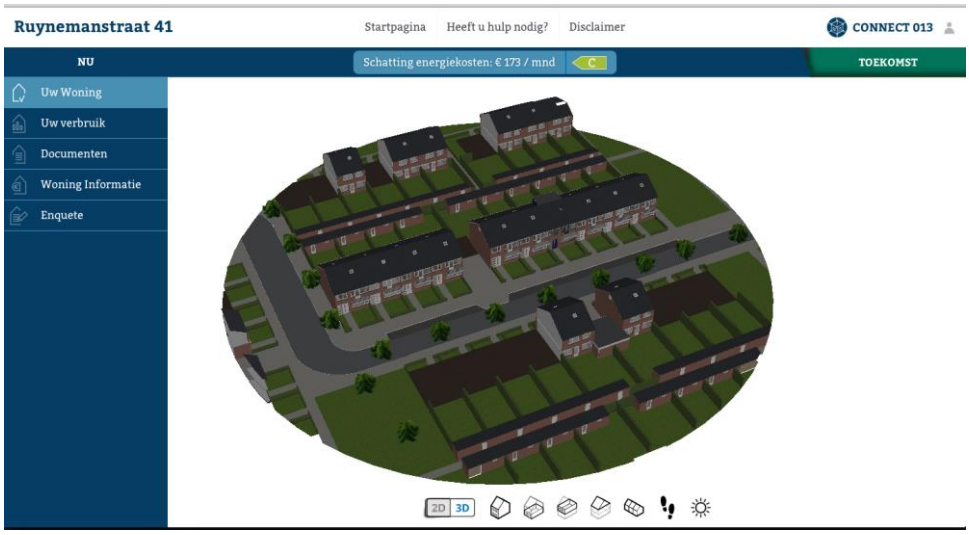

Figure 24: Connect013 - district alliance platform Woonconnect

4.4 Making

When the minimal threshold is reached for the numbers of industrially fabricated deep renovation projects, the chosen proposition supplier(s) will be able to start the making process. We will show one way to organize the large-scale deep renovation process at district scale. We'll focus for now on the southern part of the district.

In the mapping phase the differences between the three parts of this district became clear. We can roughly divide this part of the district in two:

Zone A. The systematically and industrially build row houses, multi-family complexes with portico circulation and gallery complexes. These are building typologies that are very interesting for renovation with prefabricated components.

Zone B. The patio dwellings. More diversity and difficult for (facade) prefabrication renovation solutions.

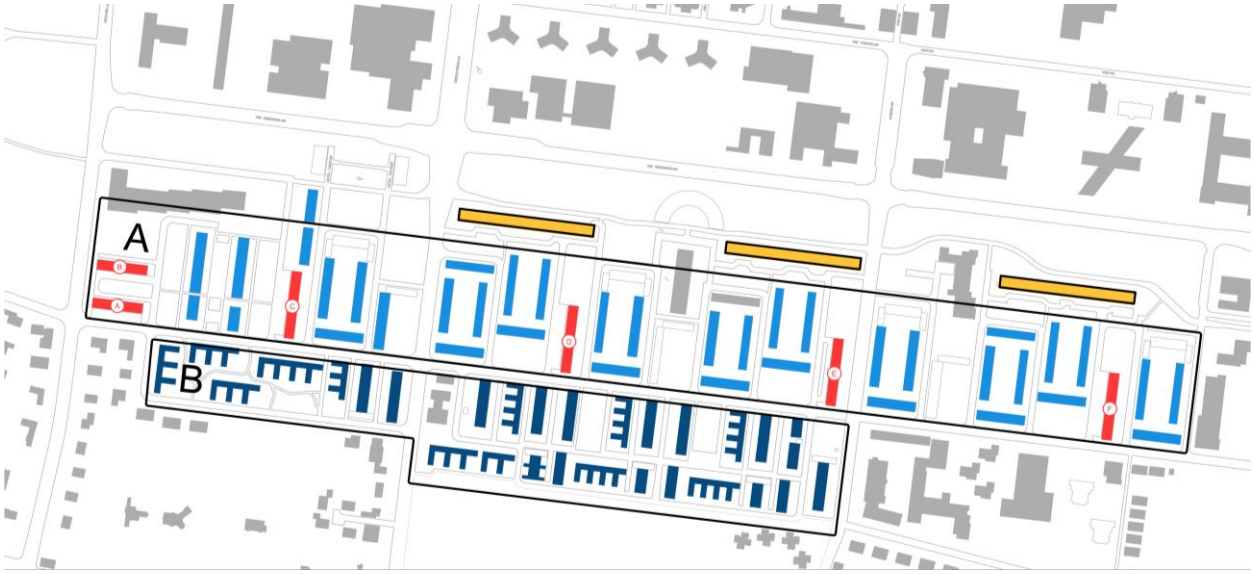

Figure 25: The district divided in two zones

Deep renovation Zone A

We will assume the promotion activities with the help of the local district alliance platform were a success and 60% of all house owners decided to deep renovate their house, that makes up for 120 row houses and 4 multi-family portico complexes. The majority of the house owners choose the renovation-facade but there are a lot of customization options possible.

Several execution strategies are possible but due to the large scale, the possibilities in the district and the technical aspects of the facade concept we choose to set up temporal local district factory.

A large space in a central position of the district will be used as a district factory. The factory will be the size of an estimated 25x 35 meters. In this acclimatized area the facade elements are being composed, fully finished and distributed to the renovating projects. Due to an extreme good coordination using the collected BIM models, products are delivered in exactly the right moment. Self-organizing execution teams tackle a dwelling in 3-6 days depended on the complexity of the individual choices. In contradiction to the prefabricated facade solution the prefabricated roof elements (with solar panels already attached) for example are directly, just-in-time, delivered from the factory at the specific dwelling. The same is the case for the prefabricated HVAC components.

Supply-chain of the district factory will be organised similar as the Raab Karcher Concept. Deliveries of materials to the field factory are done once a day in the morning and are transported from a bigger storage hub outside the city. The security for the field factory is well organized. The central position of this field factory and the high residential density ensure a high level of social control. Parking is organized as to minimise traffic disturbance for the district.

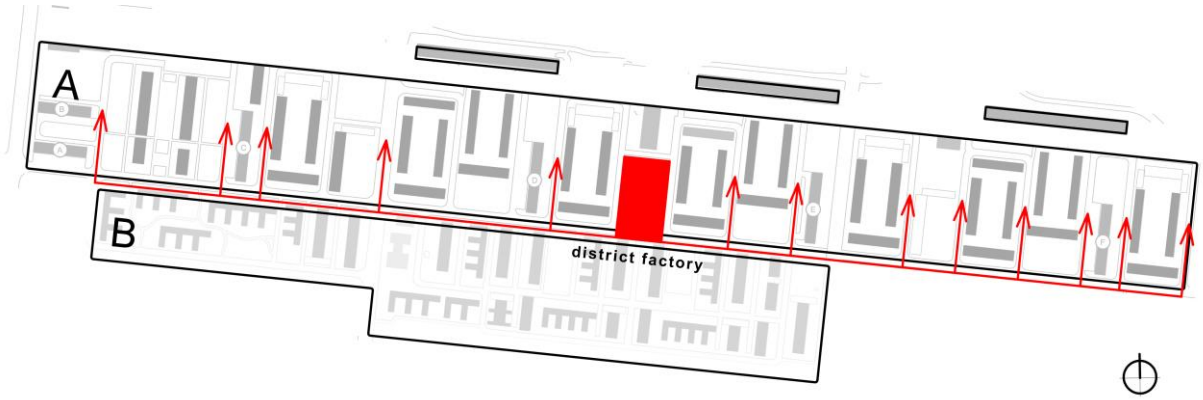

Figure 26: District factory in zone A

Multi-family complexes Zone A

Analysing the result of the assumed measurements for the multi-family complexes we can see that complex A t/m C consist of mostly complete components. With regard to the rooftop modules the HVAC component will be integrated. In these cases the 2D elements of the complete rooftop modules are finished at the field factory, transported to the specific location and composed in the vicinity of the specific building complex. The HVAC components will be installed and the last finishing activities will be executed to the module. The roof structure for the new floor is being placed. When this is ready the complete module is being plugged on the roof of the complex. In the meanwhile balconies are being taken away, the hanging structures for the prefabricated façade are being placed and the façade elements are being mounted.

Deep renovation Zone B

The patio dwellings in Zone B are difficult to deep renovate with prefabricated components. The patio dwellings have a large facade-, floor- and roof surface. Improvements that have to be done on the envelope will have to be done in a compose-on-site methodology. Because of this we see the execution strategy for zone B more diversified. A good option for this part of the district renovation will be coordinating all operations from the main field factory location. Here we have the control centre and stock supplies. Lean multidisciplinary teams will be working, in a compose-on-site methodology, deep renovating the houses in the district in an efficient way. Planning and coordination is crucial, the combined district alliance platform will be able to facilitate this coordination.

Figure 27: Making strategy zone B

4.5 Monitoring

It is important that the executed projects are being monitored to learn and optimize procedures for the next deep renovation projects in the district. It is also important to monitor and evaluate the functioning of the district approach. Collecting results for all the renovated projects will generate useful data. The collection of these data is done through monitoring the usages and comfort of the inhabitants. This can be done using surveys and possibly sensors. The gathered data is collected (anonymously) to guarantee privacy. House owners will be able to compare their data with each other and learn how to fine-tune their behaviour and their installations. The district alliance platform will be able to collect all the data and make them accessible for all the stakeholders in the district.

4.6 Continuity district alliance platform

In this case-study we will assume the first initiative for the district deep renovation approach is taken by the municipality and several trajectories were started to create and support demand collectives and share knowledge. This has already been taking place in the pre-mapping phase. When projects are in process the local district alliance platform will enable new collaborations and spin-off projects in this district and in the city. Some examples of the activities the local district platform can support or initiate during the full 4M approach on district scale.

In the making phase all activities that are taking place are being posted on the district alliance platform. House owners will be able to follow the whole district process. It will generate a collectiveness that connects all the district inhabitants. Unemployed will be able to participate in the renovation projects and even pensioners could assist with the activities.
In the making phase showing all renovation activity on the local district alliance platform will create interest with the owners who are not yet participating. They will be able to ask questions personally and see in reality the impact of deep renovation. The 'early adopters' will be able to support the 'late majority'.
In the modelling phase input for the municipality will create efficient building procedures and permits.

Connecting the owner associations of the privately owned multi-family houses with the housing corporation TIWOS will generate knowledge sharing.
The transparent following of the execution process will make it possible for real-estate agents to create extra value for the property that has been renovated.
Monitoring activities will be able to be collected and maintenance services will be able to be provided on district scale.

5. Case study Korsløkken

The firm 'robot-at-work' located in Odense, Denmark has created a new façade system for renovation and new buildings. This firm uses the collaboration between craftsmen and robots to optimize the building process. A reduction of material use (no waste), transportation and labour combined with the freedom of 3D design and extreme accuracy characterizes this building technique.
The 'robot-at-work' technique will, in the future, not only be applicable for reinsulating the gable, but it will be a strategy that's possible for reinsulating all brick facades. In this case study we will assume the gables of the buildings In the Korsløkken district will be renovated with the 'robot-at-work' methodology.

5.1 pre-Mapping

In the district of Korsløkken we will not be dealing with privately owned housing stock. This influences the pre-mapping phase. In the first phase all efforts are invested in creating agreement of the tenants with the renovation plans. This is reasonably promising with the possibilities of the 3D design of the 'robot-at-work' technique and the possibility for customization.
It is imaginable that after the completion other building owners will be enthusiastic about the solution also. This technique is interesting for apartment buildings but also for private dwellings. Promotional actions and information meetings will be able to increase awareness and therefore upscaling of this technique in a local (and non-local) setting.

5.2 Mapping

5.2.1 Project parameters – the district

The Korsløkken region is characterized by a spacious composition of buildings. A lot of free space surrounds the buildings. The district includes 5 types of buildings. All of them are social housing. Together the district comprises of approximately 850 apartments (and 26 gables). The district is well accessible for traffic.

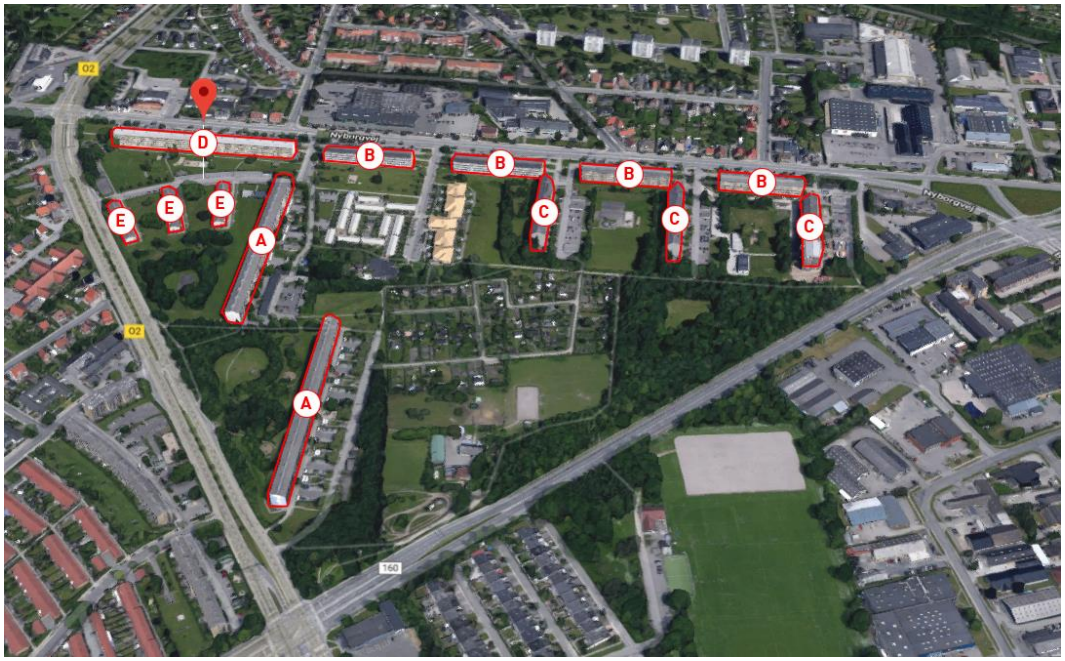

Figure 28: Korsløkken district

5.2.2. Project parameters – building

The buildings are of high quality although the gables of all building blocks are of low energy performance. The other facades are in good condition and have a good energy performance.

Figure 29 Korsløkken district buildings

5.2.3. Project parameters – repetition potential

In contrast with the need for repetition potential in of the district 'de Reit', were we are working with components that are produced in a factory and composed in the district factory and we mainly rely on a 'mount-on-site' making strategy, the 'Robot-at-work' methodology belongs to the 'produce-on-site' methodology. This results in an extremely flexible production method because of the generic replicability of the solution. The solution is applicable for every solid façade; the market for this solution is in theory very large.

5.3 Modelling

5.3.1. The building technique/ methodology

At this moment the technique for reinsulating the building with the assistance of robots is being further developed with every pilot project. The first project in Korsløkken is finished and a lot has been learned from this experience. In the first projects insulation was mounted on to a gable using scaffolding. After that a robot is mounted on a movable platform. This robot first mills the insulation layer to create a 3D design on the façade. The last step is to render the wall with plaster. For this the milling head of the robot is replaced for a spray nozzle.

Figure 30: Milling with the robot

Figure 31: Spraying on the finishing layer

'Robot-at-Work' is now developing an improved process to achieve a reinsulating of the façade and create an architectonic freedom for prints on the façade more efficiently. This new methodology works with a mountable frame that is placed in front of the façade. This frame makes it possible for a computer controlled nozzle to spray the plaster on the mounted insulation layer. There is no need for a moveable platform any more. Mounting the insulation layer is still done using scaffolding.

The next step in development for 'robot-at-work' is to optimize the insulation material and create the opportunity to spray the insulation material directly on the façade. In this case the mountable frame is placed in front of the façade and the computer controlled nozzle first sprays on the insulation. This insulation material has to dry quick, preferably in a few hours (this will have to be optimized in the future). When this layer is ready the nozzle is changed and the same setup is used to add the finishing layer (climate shell). This layer will be added in two phases.
This last methodology will be used in the representation of the district approach for the Kørslokken district.

5.3.2 Scanning and modelling

The 3D scanning of the existing facades will create an important starting point for the renovation process. Once the gable is completely scanned and placed in the BIM model the design can be prepared for the specific gable. Calculations are made to define the needed material and create a well-defined planning of all the gables in the district. Exact scanning is needed for a selection of the gables. The computer controlled nozzle is equipped with sensors as to define boundaries in the field.

5.4 Making

In case of this 'production-on-site' methodology production-off site is minimal. Organizing material supply, planning of equipment use and finding a solution for climate control during the spraying phase are the three essential points for this methodology.
The spray-on material that will be used for insulation will most likely be a specialized material that's produced in a selected factory. We assume this material will be supplied at one moment for the whole district. Local storage of this material is possible in for example a temporal (replaceable) storage unit.

Figure 32: temporal storage unit

The execution time for one gable will be 3 to 4 days: half a day for mounting the modular frame, half a day spraying on the insulation layer. Drying time of this layer is approximately 4 hours. The last two layers are the climate shell layers. These will take 1,5 day. In this case one mountable façade frame will be needed 3,5 day per gable. The nozzle that's used for the insulation layer is used 0,5 day per gable. The nozzle that's used for spraying on the two finishing layers is occupied 1,5 day per gable. Taking this as a starting point, remembering the district comprises of 26 gables, and with the most optimal use of the existing nozzle's and computer equipment we could deduct the need for 7 gable-façade frames, one insulation nozzle and one finishing layer nozzle. All gables will be able to be adapted in approximately 16 days.

Furthermore the façade frame will be able to protect the treated gable from weather influences. This is done through a reusable plastic weather shield that will be attached to the frame.

To conclude, with this methodology the field factory is reduced to a mountable façade-frame with attached computer controlled nozzle and a moveable storage unit. The nozzle and computer equipment is, when not in use, stored in a safety storage that is part of the moveable storage unit.

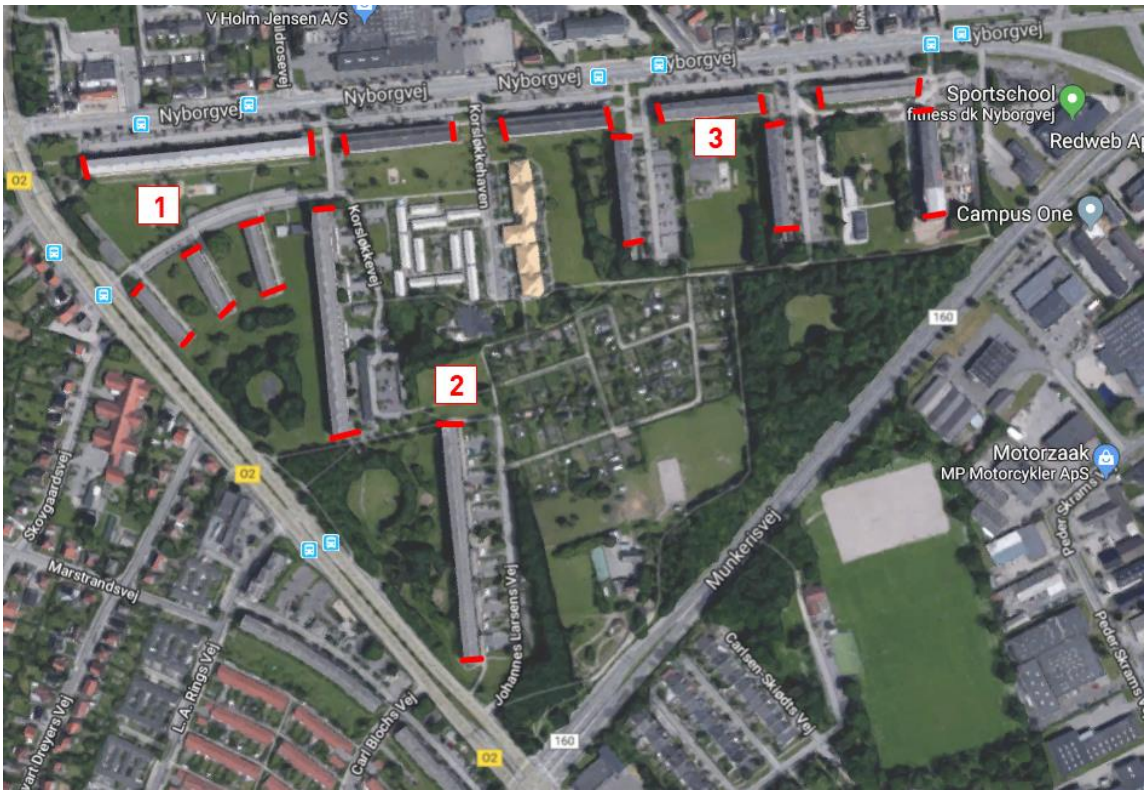

Figure 33 Temporal storage places projected in the district

6. Conclusion

The goal of the district alliance platform is to create collaborations between all stakeholders on city and district levels. Connecting the right stakeholders should facilitate an acceleration of the increase in building renovation. The municipality, facilitating the district alliance platform, will play a crucial role in this approach. It is therefore important that the policy of the local municipality is dedicated to reduce energy consumption and increase comfort in the existing housing stock. In a later stadium of the approach the district alliance platform will be able to function independently. Private and public stakeholders will share responsibility for the continuity of the platform. Organising this commitment will only succeed when the benefits are sufficient (investments and benefits are in balance) for everyone and IPRs are clearly stated.

In the following part of this study we will elaborate the connection between the P2ENDURE e-Marketplace and the local alliance platform in order to answer the following questions in more details: how we can facilitate the realisation of large scale deep renovation using P2ENDURE solutions in the local situation using the alliance platform concept; how we can make sure local SMEs or proposition developers are able to apply the P2ENDURE solutions in such a way that quality, price and performance of the integrated end-result are compliant with the initial proposition; where the modelling take place; which parties are responsible for the definitive proposition, etc. We will keep approaching this issue from a local and practical point of view.
In this context, we will organise a stakeholders meeting for the district in Tilburg and investigate a possible connection between the local alliance platform in the Tilburg situation and the P2ENDURE e-Marketplace. These experiences will result in recommendations for EU wide use and will be first tested within the P2ENDURE consortium. We will then be able to categorize differences in local alliance platforms dependant on local circumstances.

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ANNEX 1 - SWOT owner properties

	Strength	Weakness	Opportunities	Threats
a. Private owner	- simple decision making - chances for early adopters/ innovations - owner has interest in energy reduction.	- no large scale financial possibilities.	- creation of collectives - creating process support - development of customized PnP IDRP in a series of one - affordable pilot project	- knowledge fragmentation -
b. Collective private owner	- medium scale investment - owner has interest in energy reduction.	- difficult decision making - diverse financial situation	- creation of process support - development of integrated PnP IDRP products.	
c. Investors	- simple decision making - chances for early adopters/ innovations - medium/large scale	- odds are owner has less interest in energy reduction.	- creating process support for investor	
d. Social housing	- large scale investment	- tenants need to be 'on board'		